Arklow Bank Wind Park 2

Environmental Impact Assessment Report

Volume III, Appendix 3.4: Arklow Bank Wind Park 2 Constraints Analysis

sse Renewables

Arklow Bank Wind Park 2 Constraints Analysis

Ireland Constraints Overview & ABWP2 Feasibility Assessment

PREPARED FOR

SSE Renewables

DATE
22/04/24

REFERENCE
0708109

DOCUMENT DETAILS

DOCUMENT TITLE	Arklow Bank Wind Park 2 Constraints Analysis
DOCUMENT SUBTITLE	Ireland Constraints Overview & ABWP2 Feasibility Assessment
PROJECT NUMBER	0708109
Date	29/05/24
Version	03
Author	Ross McNally, Bernd Okkels, James Taylor, Madeleine Tholen, Taliesin Slatter, Sean Peedle, Jordana Palmer, Roy Spence, Josiah Mault, Liam Dickson, Liam Porter
Client name	SSE Renewables

DOCUMENT HISTORY

				ERM APPROVAL TO ISSUE		
VERSION	REVISION	AUTHOR	REVIEWED BY	NAME	DATE	COMMENTS
1	01	Ross McNally, Bernd Okkels, Madeleine Tholen, Taliesin Slatter, Mark Wilson, Sean Peedle, Jordana Palmer, Roy Spence, Josiah Mault, Liam Dickson, Liam Porter	James Taylor, Steve Freeman, Gareth Lewis	Gareth Lewis	20th November 2023	
1	02	Ross McNally, Bernd Okkels, Madeleine Tholen, Taliesin Slatter, Mark Wilson, Liam Dickson, Liam Porter	Gareth Lewis	Gareth Lewis	19th December 2023	
1	03	James Taylor, Mark Wilson, Taliesin Slatter	James Taylor	James Taylor	12th January 2024	

SIGNATURE PAGE

Arklow Bank Wind Park 2 Constraints Analysis

Ireland Constraints Overview & ABWP2 Feasibility Assessment

0708109

Gareth Lewis
Partner
Global Lead, Development Services
Renewables Advisory

ERM Limited
2nd Floor Exchequer Court
33 St Mary Axe
London, EC3A 8AA
United Kingdom
M +44 7748104884

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

Acronyms	Description
AoI	Area of Interest
ABWP1	Arklow Bank Wind Park 1
ABWP2	Arklow Bank Wind Park 2
CAPEX	Capital Expenditure
COD	Commercial Operation Date
CPI	Consumer Price Index
CTV	Crew Transfer Vessel
DaS	Dumping at Sea
DECC	Department for the Environment, Climate and Communications
DEVEX	Development Expenditure
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction
ERM	Environmental Resources Management
ESA	Ecological Sensitivity Analysis
EV	Electric Vehicle
FDI	Foreign Direct Investment
FIV	Foundation Installation Vessel
GHG	Greenhouse Gas
GIS	Geospatial Information System
GW	Gigawatt
GWA	Global Wind Atlas
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IMMA	Important Marine Mammal Area
IPP	Independent Power Producer
IREP	Integrated Renewable Energy Planning
LCoE	Levelized Cost of Energy
LNG	Liquefied Natural Gas
MAC	Maritime Area Consent
MPA	Marine Protected Area
MSL	Mean Sea Level

MW	Megawatt
NCF	Net Capacity Factor
NDC	Nationally Determined Contribution (under the Paris Climate Agreement)
NECP	National Energy and Climate Plans
NI	Northern Ireland
NMPF	National Marine Planning Framework
O&G	Oil and Gas
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
OPEX	Operational Expenditure
OREDP	Offshore Renewable Energy Development Plan
ORESS	Offshore Renewable Electricity Support Scheme
OSS	Offshore Substation
OSW	Offshore Wind
PPA	Power Purchase Agreement
RE	Renewable Energy
Ro-Ro	Roll On Roll Off
ROI	Republic of Ireland
RPO	Renewable Purchase Obligations
SAC	Special Area of Conservation
SOV	Service Operation Vessel
SPA	Special Protection Area
TJ	Terajoule
TW	Terawatt
TL	Transmission Line
UK	United Kingdom
USD	United States Dollars
VAT	Value-Added Tax
VGF	Viability Gap Funding
WTG	Wind Turbine Generator
WTIV	Wind Turbine Installation Vessel

EXECUTIVE SUMMARY

ERM has undertaken a macro level review of constraints to offshore wind in Ireland's Exclusive Economic Zone (EEZ) to identify suitable areas for offshore wind energy development. A hard constraints heat map was developed which identifies suitable areas and no-go areas for offshore wind energy development in these waters. This exercise highlighted very limited technical potential for fixed development on the west coast with a key driver being wave heights and the electrical grid, and also pointed to restricted potential on the south coast with key drivers being wave heights and seabed geology. Furthermore, these regions had an increased presence of environmentally sensitive areas and a lack of ports suited to support offshore wind construction activities. The east coast has been identified as the least constrained region within the EEZ with shipping lanes running north south, one of the limited hard constraints in the region.

In the context of this constraints study, the east coast of Ireland is considered a suitable region to develop the Arklow Bank Wind Park 2 (ABWP2) project.

A more detailed analysis of site-specific constraints for offshore wind energy developments was then conducted. Overall, ERM considers the ABWP2 site as well suited for future project development based on the currently available data considered in this desktop study. Key factors in this include:

- The MPA Advisory Group's recently undertaken Ecological Sensitivity Analysis outlining potential new marine protected areas (MPAs) in advance of the Marine Protected Areas (MPA) Bill, the Array Area for ABWP2 does not overlap with, and is furthest away from, these potential MPA sites compared with offshore wind developments in the region, making the site ideally located when considering interaction with the constraints outlined in the analysis. This is a key advantage over other offshore wind projects in the region, particularly those that have been successful in Offshore Renewable Electricity Support Scheme (ORESS) rounds.
- Suitable depths for fixed-bottom offshore wind turbine generator foundations, mainly of around 25 m to 40 m. The ground conditions within the site boundaries are also well suited to the technology, which were identified as mostly sand substrates and sandstone-based bedrock.
- Favourable wave conditions when benchmarked against the wider region, with mean annual wave heights of 0.5 m to 0.75 m and 100-year significant wave heights expected to be in the region of 8 m to 9 m, which are significantly lower than on the west coast.
- Proximity to preferred ports with current and/or upcoming capabilities in supporting offshore wind turbine and foundation installation.
- Minimal fishing and shipping vessel activity within the site

ABWP2 also has wider strategic advantages when compared to similar projects:

- Proximity to demand centres on the east coast, reducing the need to transfer electricity from power plants on the west coast.

- Inclusion of the required grid connection and substation in EirGrid's 2023-2032 Transmission Development Plan and already consented onshore cable route.
- The Project has been granted a Maritime Area Consent (MAC) as a Phase One project and is now proceeding through the planning permission process.
- The Project is aligned to the National Marine Planning Framework, 2021 policies, specifically ORE Policy 1, assist the State in meeting the Government's offshore renewable energy targets in line with OREDP and its predecessors and ORE Policy 2, as a Relevant Project being prioritised for assessment under the new consenting regime that will ultimately support delivery of Government ORE targets.
- The Project area is aligned to the OREDP, 2014 developable areas for fixed-bottom offshore wind energy on the east coast.
- The Project is aligned to the interim review of the Offshore Renewable Energy Development Plan (OREDP), 2018 which supports early mover advantage, helping to stimulate the supply chain.
- However, ERM recommends consideration of the following when proceeding with further project development:
- Disturbance and / or displacement of marine ornithology is considered a risk to project development due to a significant number of seabird species located within the region. Impacts and mitigations will require consideration.
- The presence of harbour porpoise and grey seals within the Irish Sea necessitates consideration of their disturbance.
- ABWP2's proximity of 6-15 km from shore, including popular recreational and tourism destinations, makes visibility from land certain and potentially impactful on local communities and businesses.
- Tidal currents of up to 1.5 m/s are seen in the region, increasing seabed mobility and impacting foundation and cable design, potentially leading to increased capital expenditure (CAPEX).
- The current offshore substation (OSS) design has no interlink between the two OSSs and will cause significant impacts in case of a single export cable fault. ERM recommends that inclusion of an interconnection is further considered during the planning and detailed design phases of the Project.

1. INTRODUCTION

The Arklow Bank Wind Park (ABWP1), located offshore County Wicklow on the east coast of Ireland, entered operation in 2005 and is surrounded by the larger proposed ABWP2 site. This report aims to reassess the most suitable regions for offshore wind development in Ireland and site suitability to offshore wind, on the basis of the most up-to date data enhanced mapping tools and a greater understanding of offshore wind development than two decades prior. On the basis of this information this report reevaluates the suitability of the project's location.

To summarise the mapping and analysis of constraints on offshore wind development throughout Ireland, a hard constraints heat map was produced of the Ireland-wide offshore wind technical potential, i.e., areas that are technically feasible for offshore wind development when considering key engineering and environmental factors only. This was enabled by mapping hard constraints throughout the seas surrounding the country and excluding any areas unsuited to offshore wind development.

The Marine Protected Area Advisory Group completed an Ecological Sensitivity Analysis (ESA) of the western Irish Sea to identify marine protected areas (MPAs) in relation to the development of offshore renewable energy (ORE). MPAs aim to maintain, conserve, and restore coastal and marine ecosystems, with cultural, social, and economic considerations. The drafting of the Marine Protected Areas Bill is ongoing, so this analysis was undertaken to safeguard areas of environmental sensitivity to ORE development in the near term. Key datasets from the constraints identified for the ESA have been mapped out alongside ABWP2 to assess the project feasibility. This includes seabed habitats, spatial protection, shipwrecks, fishing, vessel activity, and ORE. These constraints have been investigated further by ERM alongside additional regulatory, engineering, infrastructure, and environmental constraints.

Once an understanding of the key constraints to offshore wind development in Ireland was established, a closer examination of the ABWP2 site was carried out in order to assess the interaction of the site with the various constraints. This analysis fed into an overall project re-appraisal.

2. CONSENTING REGULATORY

2.1 PLANNING AND DEVELOPMENT POLICY SUPPORTING OFFSHORE WIND

Irelands first Offshore Renewable Energy Development Plan (OREDP, 2014) provided a framework for the development of offshore wind energy and other ORE projects in Ireland and identified a number of assessment areas with suitable development potential for bottom-fixed offshore wind including East Coast (North) and East Coast (South). This plan sets out key principles, policy actions and enablers for delivery of Ireland's offshore wind potential. Furthermore, the plan provides technology capacity limits for delivering offshore wind technologies in key locations along the east and southeast coastline and is considered the key plan for guiding the Government's policy target of 5 GW of ORE by 2030. An interim review of the OREDP in 2018, recommended the support of early mover projects to stimulate the supply chain and act as a clear signal that Ireland is open for business. An update to the plan, OREDP II is currently at draft stage and sets out Ireland's future spatial strategy for offshore renewable energy development.

The National Marine Planning Framework, 2021 (NMPF), contains overarching marine planning policies that are applicable to all proposals in Ireland's maritime area. The NMPF as it relates to ORE includes 11 planning policies including:

- ORE Policy 1 – Proposals that assist the State in meeting the Government's offshore renewable energy targets, including the target of achieving 5 GW of capacity in offshore wind by 2030 and proposals that maximise the long-term shift from use of fossil fuels to renewable electricity energy, in line with decarbonisation targets, should be supported.
- ORE Policy 2 – Proposals must be consistent with national policy, including the OREDP and its successor. Relevant Projects designated pursuant to the Transition Protocol[1] and those Projects that can objectively enable delivery on the Government's 2030 targets will be prioritised for assessment under the new consenting regime. Into the future, areas designated for offshore energy development, under the Designated Maritime Area Plan process set out in the Maritime Area Planning Bill, will underpin a plan-led approach to consenting (or development of our marine resources).

The Climate Action Plan 2024, contains a series of actions in support of Government Policy on climate change to achieve 80% renewable energy share by 2030 and offshore wind to represent at least 5 GW by 2030 including an action:

> Increasing renewable generation to supply 80% of demand by 2030 through the accelerated expansion of onshore wind and solar energy generation, developing offshore renewable generation, and delivering additional grid infrastructure.

[1] The Transition Protocol, published alongside the General Scheme of the MPDM (as the Maritime Area Planning Act 2021 was then titled) in January 2020, provides guidance to the sector regarding the treatment of certain offshore wind projects "Relevant Projects" in the context of the Maritime Area Planning Act 2021. The Protocol governs the approach for these projects and enables them to transition to the regime that was developed under the MAP Act. 'Relevant Projects' are those that either applied for or were granted a lease under the Foreshore Act 1933, or offshore wind projects that were eligible to be processed to receive a valid grid connection offer in December 2019. The Government have since adopted a phased approach to offshore wind development with all "Relevant Projects" now refered to as Phase One projects having been awarded a MAC.

2.2 CONSENTING LEGISLATIVE CONTEXT

The Maritime Area Planning Act 2021 as amended (MAP Act) overhauled the Irish maritime planning regime and introduced a new State consent regime, a Maritime Area Consent (MAC) and development consent process for offshore wind energy projects.

As a Phase One project, ABWP2 was granted a MAC in December 2022 by the Minister for Environment, Climate and Communications and the project is now proceeding through the planning permission process which includes the preparation of a robust environmental impact assessment (EIA) report and a mandatory Environmental Impact Assessment and determination by An Bord Pleanála (ABP).

2.3 ROUTE TO MARKET

The Renewable Energy Support Scheme (RESS) is the primary route to market for renewable energy projects through the provision of financial support through the Government of Ireland. This support is allocated through auctions with a primary focus on cost effectiveness. The RESS also delivers on a number of policy objectives for Ireland, including an enabling framework for community participation in projects; encouraging technology diversity; delivering on renewables policy out to 2030; and ensuring a secure and sustainable energy system. EirGrid have the responsibility of administering these auctions on behalf of the Department of Environment, Climate and Communications (DECC) with multiple auctions scheduled out to 2030. Included in these scheduled auctions are offshore specific auctions – ORESS. The first of the offshore specific auctions ORESS1 took place in H1 2023.

ABWP2 qualified to participate in this first auction having received a MAC as a "Relevant Project". Although ABWP2 was unsuccessful in ORESS1 the Project is committed to progressing through planning permission under the Planning and Development Act 2000, as amended and constructing and delivering the project as a key contributor to Ireland's 2030 climate action targets. As the most advanced offshore wind project in development in Ireland currently, having undertaken extensive public consultation, 2000 km^2 of geophysical surveys to inform project design, secured planning permission for the onshore grid infrastructure for connecting to Ireland's transmission system, and a green light from Wicklow County Council for the development of the Projects O&M base in Arklow, the Project is well placed to secure an alternative route to market and contribute to Ireland's 2030 climate action targets.

ABWP2's awarded MAC[2] provides facilitation of non ORESS projects and alternative routes to market. Within the projects MAC conditions, Commercial Operation Date ("COD") means the date that the project achieves commercial operation, as defined in the ORESS Terms and Conditions or, in the case of non-RESS projects, an equivalent project delivery milestone. Furthermore, the Commission for Regulation of Utilities (CRU) announced a grid connection pathway in December 2023 for unsuccessful ORESS1 projects once securing of planning permission and an alternative route to market is secured as per the particulars schedule within the projects awarded MAC.

[2] https://www.gov.ie/pdf/?file=https://assets.gov.ie/243766/b64d94fe-97d2-4b23-babf-797f98147975.pdf

2.4 MARINE PROTECTED AREAS

In 2019 the Government commenced a process for the expansion of Ireland's MPAs. An expert group, the MPA Advisory Group, was established to provide independent expert analysis advice and recommendations on this expansion process. This involved the delivery of a technical report to the Minister for Housing, Local Government and Heritage, further informed by online engagements with key stakeholders through focus groups and survey. A public consultation was also undertaken in tandem with the Minister's review of the expert group's findings with over 2300 individual submissions received which were independently analysed and reported upon in March 2022. In December 2022, the Minister requested that the MPA Advisory Group carry out an ESA of the western Irish Sea with a view to screening suitable areas for MPA protection in advance of the enactment of new MPA legislation, the MPA Bill and proposed to work in parallel to the MAP Act alongside additional biodiversity protection legislation such as the EU Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds), Habitats Directives (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora), the Marine Strategy Framework Directive (Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy) and the Wildlife Acts 1976 - 2012 as amended. Furthermore, this analysis was undertaken to help inform the upcoming decision-making process for siting ORE within this region. The final report was published in June 2023. The MPA Bill is expected to be progressed through the Houses of the Oireachtas during 2024.

There are no special protection areas (SPAs), special areas of conservation (SACs) or Ramsar sites within the ABWP2 array and cable corridor areas (see Figure 4.10 below) and the project is optimally sited with regard the recent MPA ESA in comparison to other proposed projects located within the region.

3. IRELAND MACRO ASSESSMENT

This section will examine the constraints to offshore wind (OSW) development throughout Ireland, with the aim of identifying the regions that are most suited for developers to propose new sites. Regions are examined through mapped data and commentary on perceived market-wide and local factors which affect the suitability to OSW development. Particular attention will be given to the east coast, with the aim of benchmarking the region around the ABWP2 project against other regions.

3.1 RESOURCE

3.1.1 WIND SPEED, DIRECTION & SEASONALITY

For the assessment of wind resources in the Irish Sea, the Global Wind Atlas 3.0 (GWA) has been used. The GWA provides an estimation of the wind resource that extends up to 200 km from land. The estimation is developed by downscaling ERA5 Reanalysis data using a 10-year Vortex mesoscale timeseries model to a resolution of approximately 3 km. This output is then further downscaled using a microscale model (that uses a similar process to that adopted in the WAsP linear flow model) to a 250 m resolution. Data are provided at 10 m, 50 m, 100 m, 150 m and 200 m elevations.

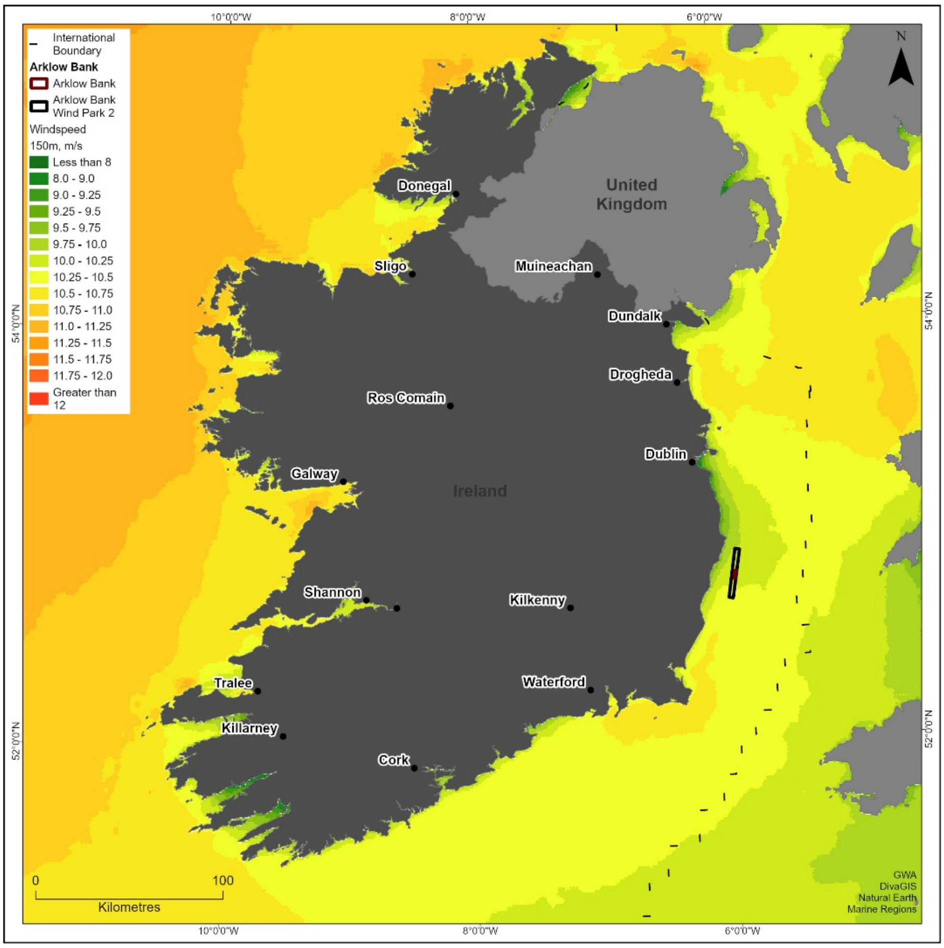
The GWA provides validation of the atlas output using publicly available wind datasets. However, none of these validations have been conducted in the Irish Sea, or in wider Ireland and UK regions. ERM's experience would indicate that the GWA dataset is likely to estimate a higher wind resource level than other wind data sources. However, the wind resource is sufficiently high that even if a significant overestimation of the GWA dataset was assumed, the resulting wind speed (>9.5 m/s) is robust for offshore wind development.

Wind speeds are very favourable throughout the Irish EEZ, with the highest average speeds seen off the west coast in the Atlantic Ocean. GWA data show that the average annual wind speed data at a height of 150 m above mean sea level (MSL) exceeds 11 m/s, with slightly lower speeds (mostly still exceeding 10.5 m/s) nearer the south-west and north-west coasts. Along the east coast, wind speeds in the range of 10-11 m/s are modelled throughout the majority of the EEZ, with a region of lower speeds hugging the central eastern coastline and in smaller areas along the south coast.

In terms of wind directions, the wind roses indicate a strongly prevailing westerly wind originating from the Atlantic Ocean along the west coast, which develops into a south-westerly wind when moving north along the coastline. The northern tip sees more mixed wind directions from all directions but the north-east, with the westerly direction still having the highest frequency. On the central east coast, there are two dominant wind directions including a southern wind from the Celtic Sea and into the Irish Sea as well as across Ireland from the west. Moving to the south-east coast, wind is mostly seen blowing from the Atlantic across the Celtic Sea, in a south-westerly orientation.

Wind speeds show seasonal variability with below average wind speeds from April to September. The lowest wind speed is modelled in June and July with wind speed indices of 0.8 or lower, whereas the highest speed indices of 1.2 are modelled in January.

FIGURE 3.1 IRELAND ANNUAL AVERAGE WIND SPEEDS (FIGURE PREPARED BY ERM)



3.1.2 EXTREME WIND EVENTS

Whilst wind speeds in Ireland favour the west coast, wind conditions around the whole country are well optimized for offshore wind development. The dominant influence on Ireland's climate is the Atlantic Ocean. According to The Irish Meteorological Service, a violent storm occurs approximately once a year, the most recent being Storm Debi in November 2023 where wind speeds of 33 m/s were recorded at Killowen. Storm Eunice occurred in February 2022 where wind speeds of 38 m/s were recorded at Roches Point. Hurricanes are rare but do occur every few decades, the most recent being in February 2014 where wind speeds of 44 m/s were recorded at Shannon Airport. From late summer through to Autumn there is a risk of former tropical depressions mixing in with the North Atlantic weather pattern depressions to produce severe storms. These are quite rare but are very significant weather events. The prevailing winds in Ireland are from the west which tends to receive more extreme weather events than in the east.

GWA data for V50 extreme winds, at a height of 150 m above MSL, shows a maximum 10-minute average wind speed across a 50-year period of 49-56 m/s throughout the entirety of the north and west coast of Ireland, with over 56 m/s highs occurring further offshore from central west and north coasts. This reduces slightly to 42-49 m/s highs along the south and east coasts, with small areas of 35-42 m/s V50 winds offshore County Waterford, eastern County Wexford and northern County Louth. Increased V50s of 49-56 m/s are seen further offshore the east coast in the Irish Sea, surrounding the Isle of Anglesey up to the Isle of Man.

Much of the region meets or exceeds the IEC Class I wind turbine generator (WTG) suitability when considering the average and extreme wind speeds.

In summary, the south and east coasts show lower 50-year high wind speeds, in particular along the south-east coastline of County Waterford and County Wexford. More extreme conditions are seen along the west and north coasts, in particular offshore County Mayo and County Donegal.

3.2 ENGINEERING

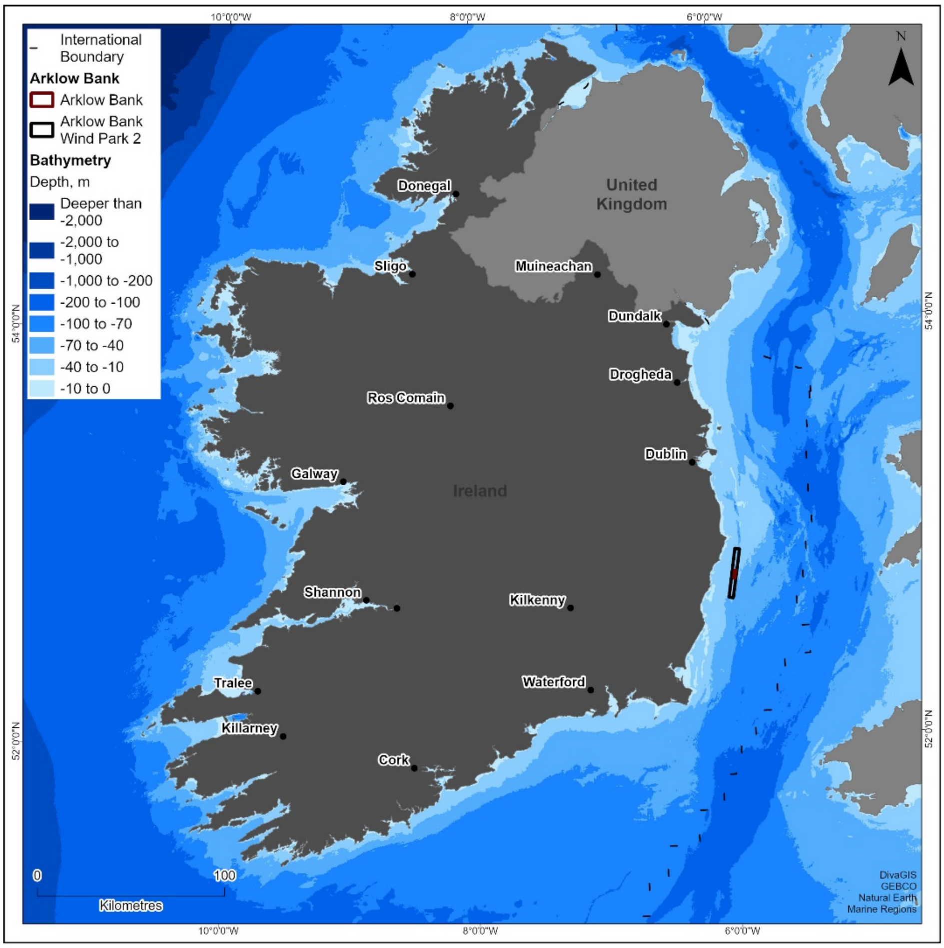
3.2.1 SEABED CONDITIONS

3.2.1.1 BATHYMETRY

Bathymetric data has been sourced from the General Bathymetric Chart of the Oceans (GEBCO) 2019. To differentiate between fixed and floating foundations, a crossover water depth of 70 m has been used.

Most fixed sites are proposed off the east coast in the Irish Sea, and most floating sites are proposed off the south and west coasts. Near to shore, the seabed surrounding the Irish coast is relatively shallow, between 0 – 40 m water depth. In general, the seabed off the west and southwest coast has a much steeper slope than in the east, making it more suited to floating foundations. The west and southwest coasts have variable water depths. The seabed surrounding the west and southwest coasts can deepen to 70 m close to shore. The east and southeast coasts have a more uniform water depth of 10 – 40 m, particularly between Wicklow and Dundalk, making it better suited to fixed-bottom foundations.

FIGURE 3.2 IRELAND BATHYMETRY (FIGURE PREPARED BY ERM)



3.2.1.2 SEABED LITHOLOGY

Seabed lithology and seabed substrate data has been obtained from the European Marine Observation and Data Network (EMODnet).

Bedrock geology conditions vary significantly around the Irish coast on a local and regional scale, in terms of bedrock type and age. To the east of Ireland, the geological conditions primarily consist of sandstone and mudstone, with some schist, granitoid, gneiss and some chalk in certain areas. South of Ireland, the conditions are primarily limestone and sandstone with patches of gneiss and granitoid. In the southwest of Ireland, sandstone and sand make up the primary geology, but also include patches of limestone and granitoid. The western region is a mixture of sandstone, limestone, metamorphic rock, granitoid and gneiss. In the north and northwest, metamorphic rock and gneiss are most prominent.

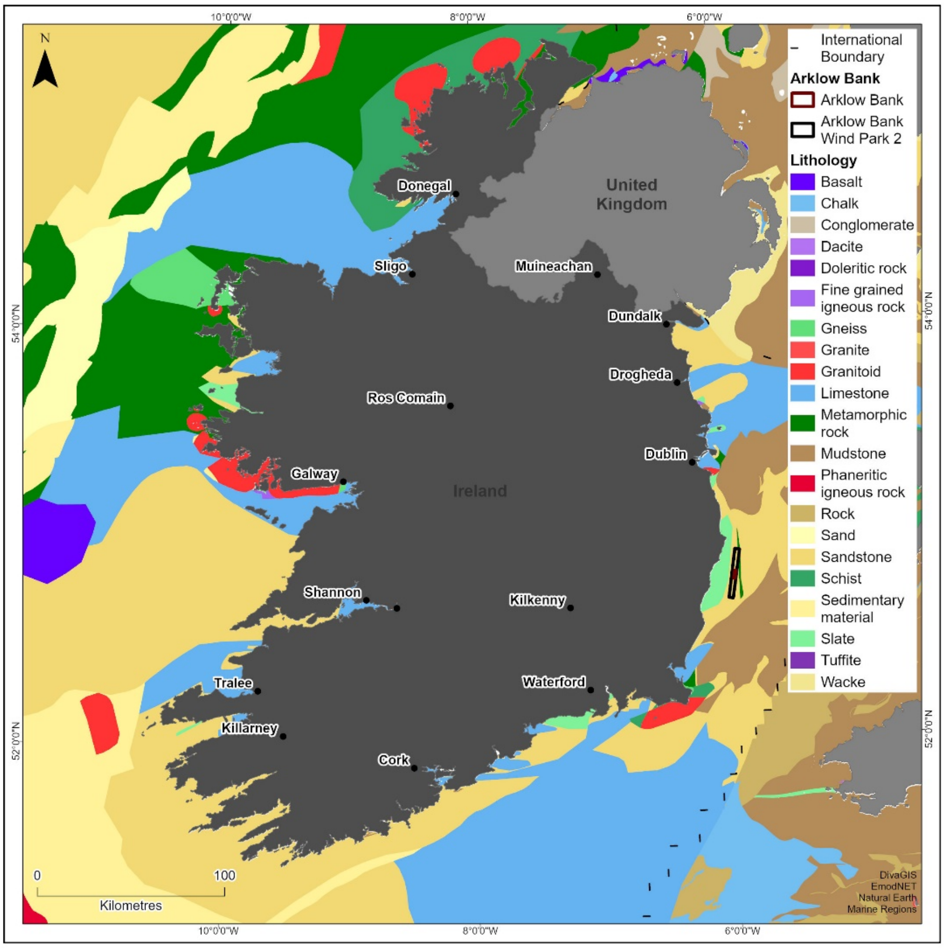
Mudstone, sandstone, limestone, metamorphic rock and granitoid have differing influence on site selection and/or foundation design due to the potential risks associated with drilling or driving foundations into the seabed. According to the typical composition of these rocks and the Mohs Hardness Scale, mudstone is generally soft, sandstone can range from soft to hard, limestone has medium hardness, metamorphic rock is hard, and granitoid is hard. Soft or hard rock will likely constrain foundation concept selection and installation methodology. For example, for soft lithology the monopile usually needs to be driven in using a hydraulic hammer, and for hard lithology, specialist drilling equipment will be needed.

Based on the geological characteristics around the coast of Ireland, it is likely that all regions could present geotechnically hard ground conditions, which could pose risks to foundation design and installation of piled foundations. In general, the geotechnically harder bedrocks are more prevalent along the west coast of Ireland and offshore wind projects have been successfully developed in areas off the northwest of England which have similar bedrock types. Conditions on the east coast are generally more favourable for foundation installation; however, this is subject to the characteristics and depth of the bedrock at each specific site.

Less common foundation technologies, such as suction-caissons or gravity base structures, could be considered to mitigate the risks of piling into hard bedrock, as these technologies are typically driven into the upper soil layers. It is noted that these technologies also have their own risks, however they have been used, successfully, on a number of projects.

It is also noted that there are a number of fault lines to the northwest and south of Ireland which should be treated as hard constraints when siting offshore wind projects.

FIGURE 3.3 IRELAND SEABED LITHOLOGY (FIGURE PREPARED BY ERM)



3.2.1.3 SEABED SUBSTRATES

Regarding surficial geology around Ireland, sands and coarse sediment (see

Figure 3.5 for details on EMODnet's Folk 7 substrate classifications) are present at most offshore locations which are not expected to prove problematic for foundation installation. However, rocks and boulders are found at various locations around Ireland, primarily along the southeast coast. Exposed rocks and boulders complicate foundation design and installation and can leave export cables exposed. These areas should be treated as constraints when siting offshore wind projects.

Further off the south coast there are significant areas of mud and muddy sand. For both floating and fixed-bottom offshore wind sites, areas with mud should be avoided, where possible, due to technical and engineering difficulties associated with anchoring floating foundations and stabilising fixed foundations. Areas with mud or sandy mud (pink and purple areas in legend) will require further investigation to assess their suitability for OSW development. These conditions can be mitigated with larger anchors with different fluke angles for floating foundations, or suction cups for fixed foundations. These areas are primarily seen towards the western and southern areas of the EEZ as well as in a large area stretching from Dublin to the Isle of Man in the Irish Sea. The substrate surrounding Galway Bay on the west coast shows presence of mud and sandy mud. Data gaps off parts of the west coast have been identified in the INFOMAR data archive with respect to longer-term offshore wind developments.

Areas of muddy sands (violet areas) are usually suitable; however, they could be formed of as much as 50% mud so would require in-depth site assessment. Areas of sand (yellow areas) or gravelly sand are preferred for OSW development.

FIGURE 3.4 IRELAND SEABED SUBSTRATES (FIGURE PREPARED BY ERM)

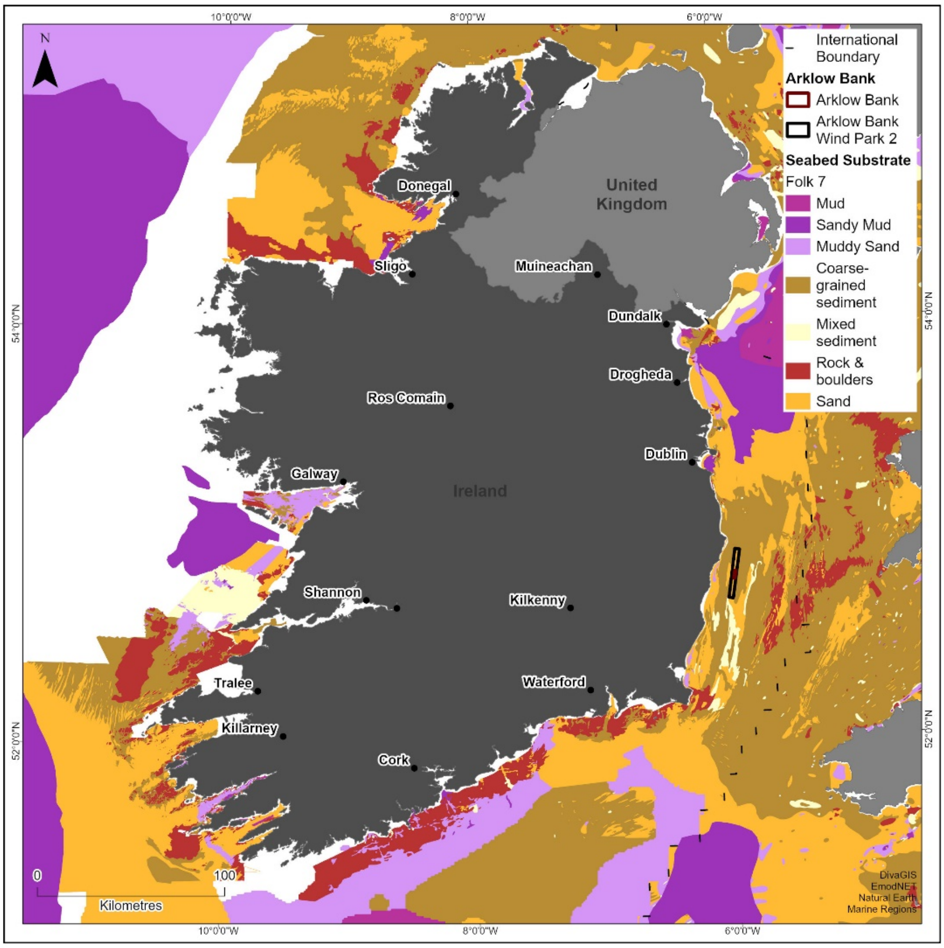
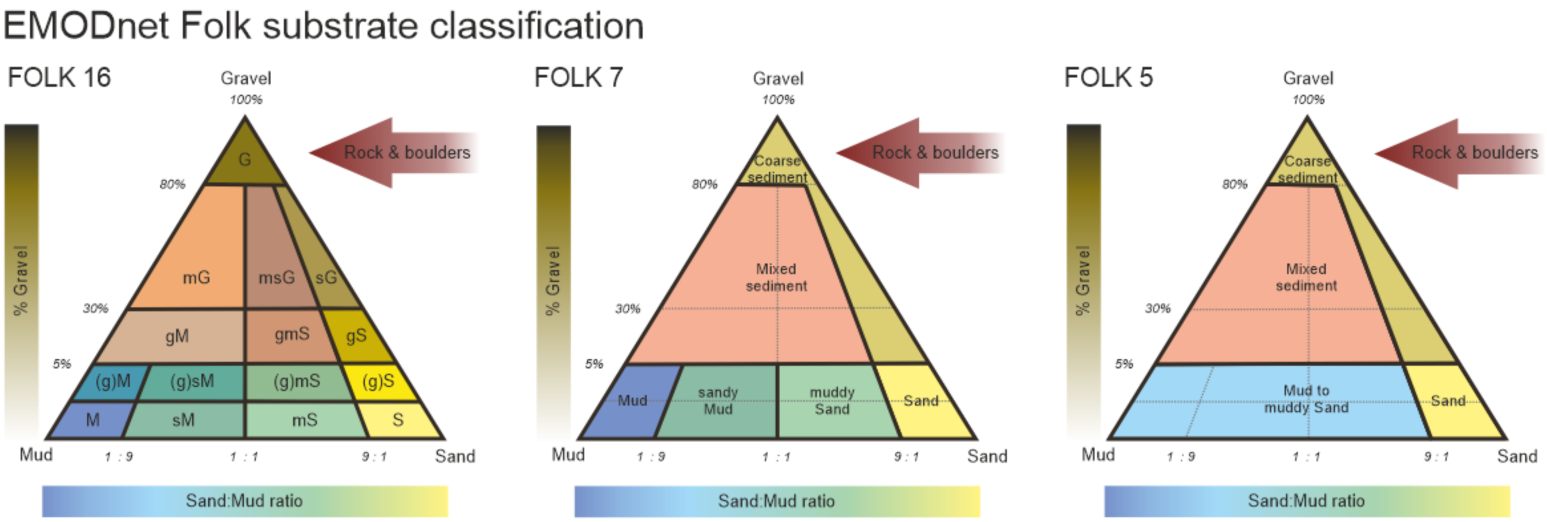


FIGURE 3.5 EMODNET SUBSTRATE CLASSIFICATIONS



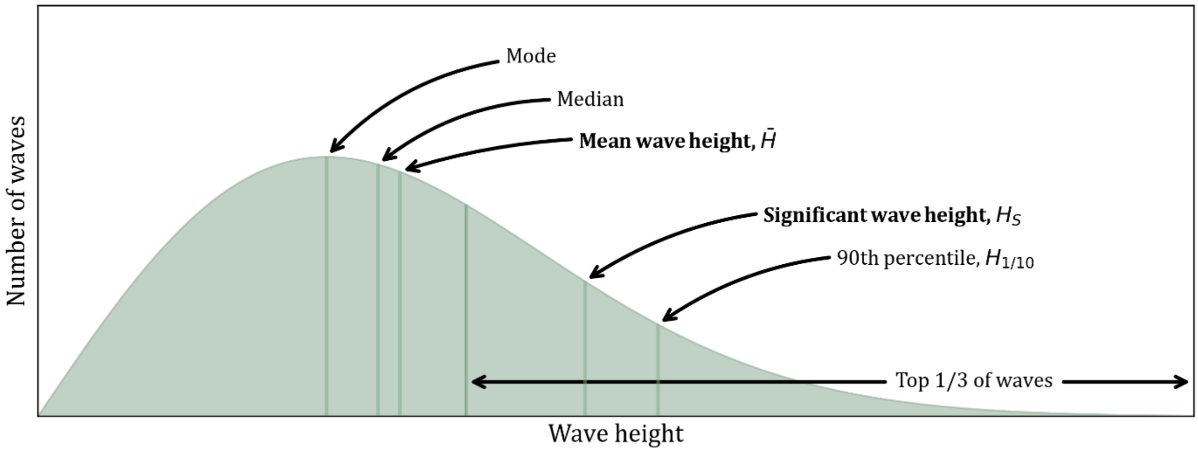
FOLK, 16 classes	FOLK, 7 classes	FOLK, 5 classes
Rock & Boulders	Rock & Boulders	Rock & Boulders
Gravel - G sandy Gravel - sG) gravelly Sand - gS	Coarse sediment	Coarse sediment *(Gravel >= 80% or (Gravel >= 5% and Sand >=90%)*
muddy Gravel - mG muddy sandy Gravel - msG gravelly Mud - gM gravelly muddy Sand - gmS	Mixed sediment	Mixed sediment *(Mud 95-10%; Sand < 90%; Gravel >= 5%)*
(gravelly) Mud - (g)M Mud - M	Mud *(Mud >= 90%; Sand < 10%; Gravel < 5%)*	Mud to muddy Sand *(Mud 100-10%; Sand < 90%; Gravel < 5%)*
(gravelly) sandy Mud – (g)sM sandy Mud - sM	sandy Mud *(Mud 50-90%; Sand 10-50%; Gravel < 5%)*	
(gravelly) muddy Sand – (g)mS muddy Sand - mS	muddy Sand *(Mud 10-50%; Sand 50-90%; Gravel <5%)*	
(gravelly) Sand – (g)S Sand	Sand *(Mud < 10%; Sand >= 90%; Gravel < 5%)*	Sand

3.2.2 METOCEAN CONDITIONS

3.2.2.1 WAVE HEIGHTS

For the evaluation of general wave conditions and heights, data were sourced from Marine Institute Ireland, which uses the ESBI Pelamis Wave Model (2005). The modelled data is freely available and was developed to evaluate potentially harvestable wave power using various wave energy converters. The mean wave height was used rather than the conventional use of significant wave height to account for limitations in data availability. It should be noted that the mean wave height is lower (but more frequently observed) than the significant wave height, as the significant wave height corresponds to the mean height of the largest third of waves in the wave height distribution of a given sea state (see Figure 3.6 below).

FIGURE 3.6 STATISTICAL WAVE DISTRIBUTIONS (SOURCE: US NOAA)



The east coast of Ireland has an annual mean wave height between 0.5 – 1.75 m from the coastline to the boundary of the EEZ. The calmest conditions occur closer to shore in the Irish Sea and along the border with Northern Ireland. In the south and southeast regions the annual mean wave height ranges from 0.75 – 2.5 m within 50 km from shore. Conditions near the coastline are comparable to the North Sea, Great Britain, where there has been significant experience in offshore wind construction and operation.

Along the west coast of Ireland, the mean wave height is highly variable compared to the east coast. In the southwest, mean wave heights within 50 km offshore range from 1.75 m to over 3 m. Beyond 50 km offshore, mean wave heights are in the range of 3 – 3.25 m. Mean significant wave heights beyond 2.5 m are generally considered extreme working conditions for fixed-bottom offshore wind installation so specialist vessels and longer construction periods may be required.

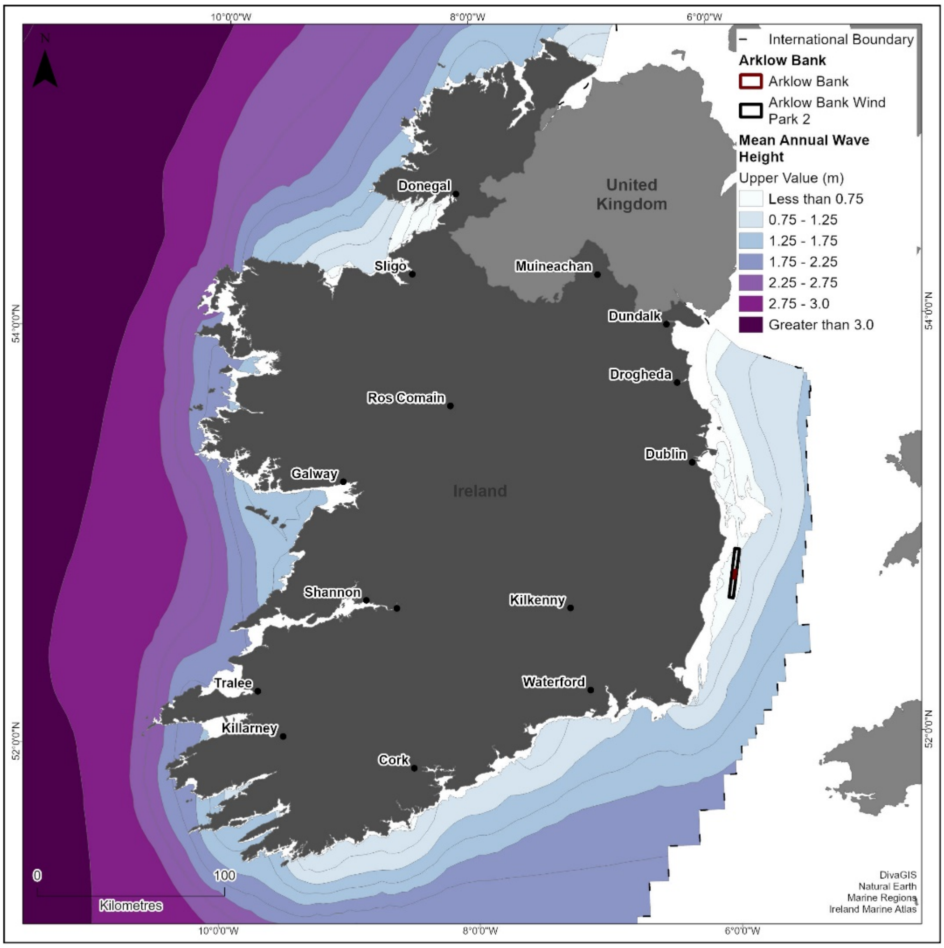
The central part of west Ireland has a mean wave height between 1.5 – 2.75 m near the coast. At 50 km offshore, this increases to over 3 m in areas. Most west coast regions beyond 50 km from shore have mean wave heights of over 3 m. The calmest conditions on the central west coast are found in the relatively sheltered waters within Galway Bay and in the surrounding areas, where mean wave heights are in the range 1.25 – 2 m. This region may see some areas suited to offshore wind development. However, confirmation of significant wave heights and site surveys would be required.

The northwestern region has mean wave heights as little as 0 – 0.25 m in the most inland waters of Donegal Bay, increasing to as much as 2 m along the shoreline in the more exposed areas. Mean wave heights of up to 2.75 m are seen 50 km from shore. In this region, mean wave heights reach 3 – 3.25 m around 150 km from the shore.

The north coast of Ireland has a mean wave height around 0.75 – 2 m at the coast and up to approximately 2.5 m at 50 km offshore. Beyond 50 km and within the Irish EEZ, significant wave height increases to approximately 3 m along the border with the UK, with calmer conditions seen when moving to the east along the border towards Northern Ireland.

Generally, the north, west and south coasts of the island of Ireland have higher wave height compared to those found in the east of Ireland. In the west and south-west, mean wave height exceeds 2.75 m at many locations relatively close to shore. As noted previously, the east coast of Ireland has comparable conditions with locations on the east coast of the UK where there is ample industry experience of offshore wind construction and operation.

FIGURE 3.7 IRELAND WAVE HEIGHT (FIGURE PREPARED BY ERM)



3.2.2.2 CURRENTS, TIDAL RANGES AND EXTREME WAVE HEIGHTS

The 100-year significant wave heights have been assessed using the 2005 report "Wave mapping in UK waters", which was prepared by PhysE Ltd for the Health and Safety Executive. The data indicates much more extreme conditions on the west coast compared to the east. 100 year extreme wave heights between 16 m and 18 m are expected near shore from Donegal to Kerry. These conditions are a major constraint for offshore wind construction and operation. The wave heights decrease from 15 m to 9 m towards the east coast which is still a constraint but less so than on the west coast.

According to the Geological Survey Ireland (see Figure 3.9), the modelled tidal ranges (mean high water springs – mean low water springs) are 3 – 4 m along the northwest coast, increasing to 4 – 5 m between Galway and North Kerry, decreasing back to 3 – 4 m along the south coast. On the east coast between Wexford and Wicklow the tidal ranges are 0 – 1 m, increasing to 2 – 3 m near Dublin, and 3 – 4 m north of Dublin. Mean tidal amplitude is lowest off the central east coast, southwest coast, and northwest coast at 0.74 – 1.24 m (see Figure 3.8).

Currents show a trend of being more extreme on the east coast compared to the west, see Figure 3.10. The peak velocity along the west and south coast is below 0.2 m/s for the most part, increasing to 1 – 1.5 m/s along the east coast between Wexford and Dublin. Higher tidal currents typically cause an increase of seabed mobility. However, this also depends on the surficial geology at a specific location. High seabed mobility can impact cable burial depths.

FIGURE 3.8 CURRENTS, TIDAL RANGES (FIGURE PREPARED BY ERM)

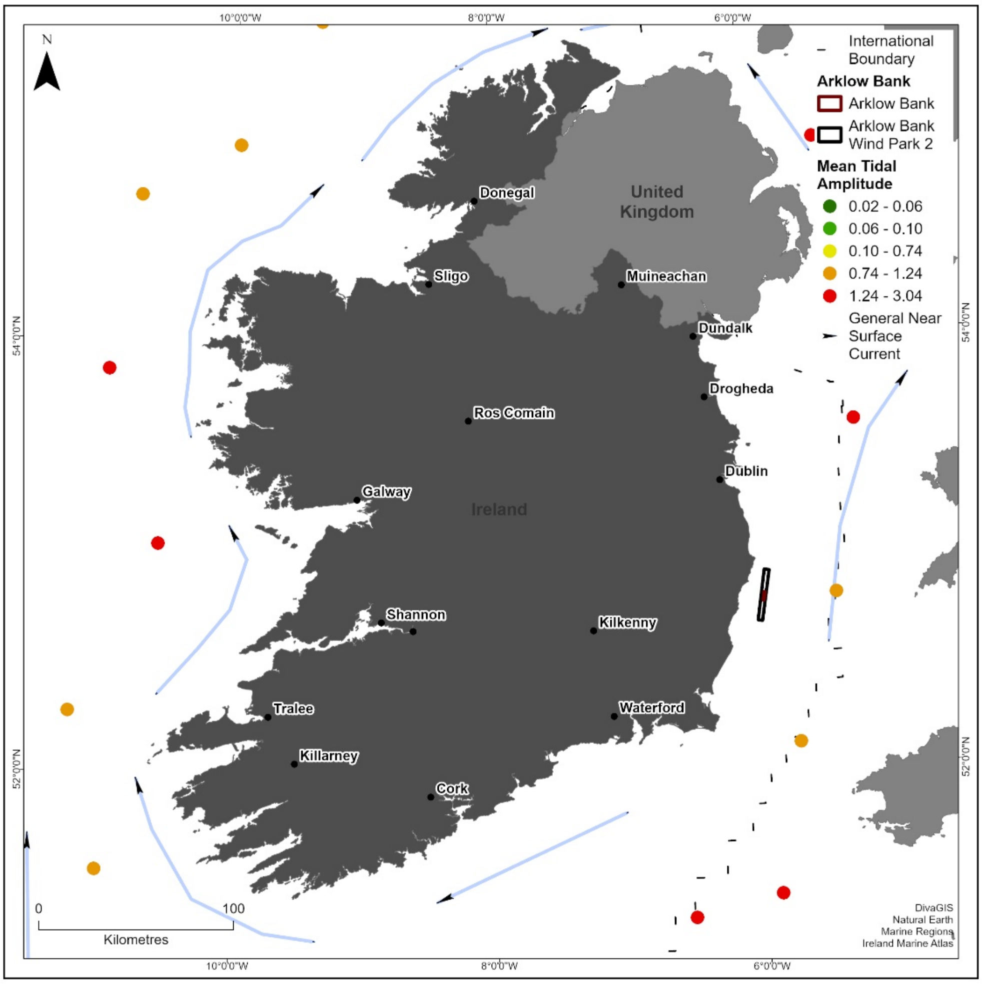


FIGURE 3.9 COASTAL TIDAL RANGES (SOURCE: GEOLOGICAL SURVEY IRELAND)

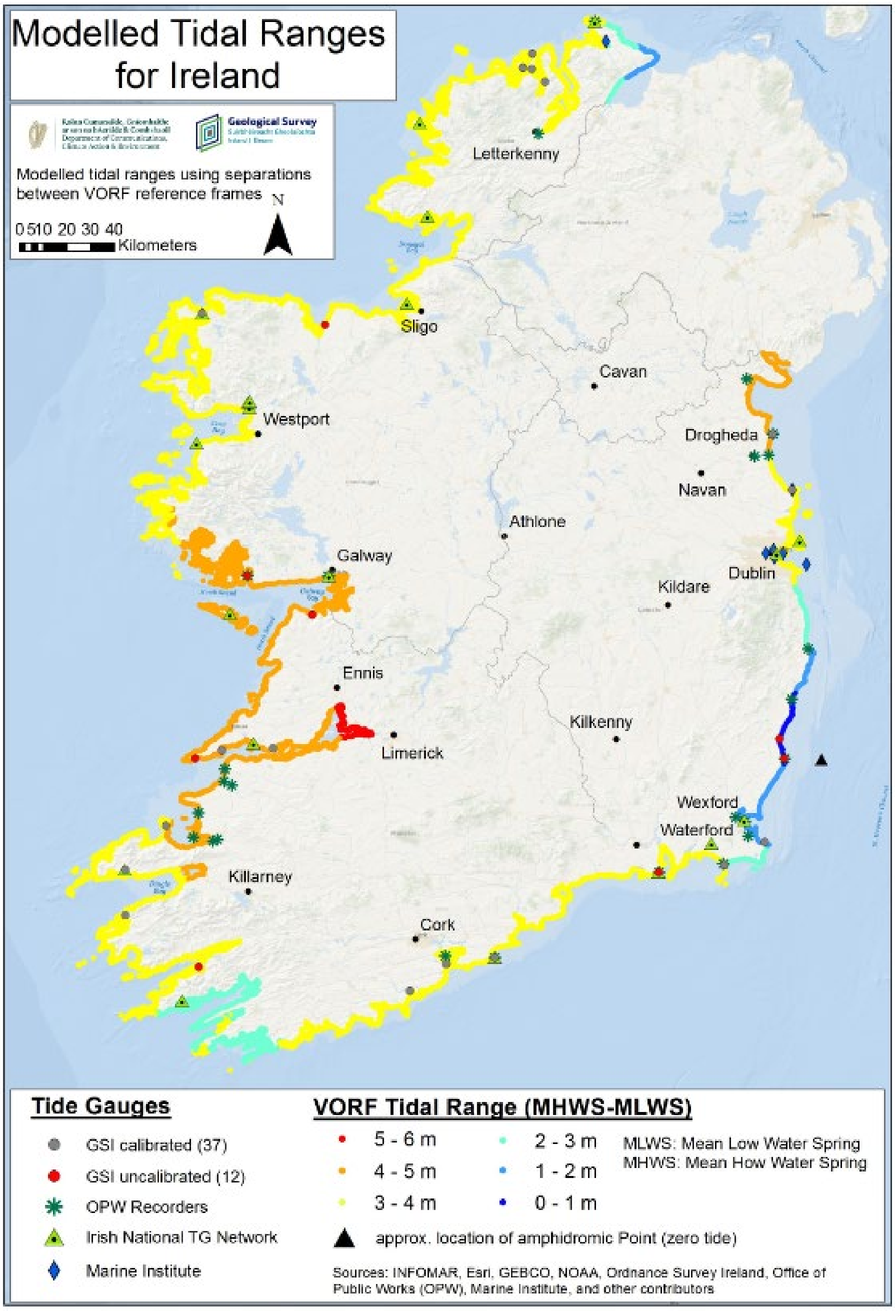
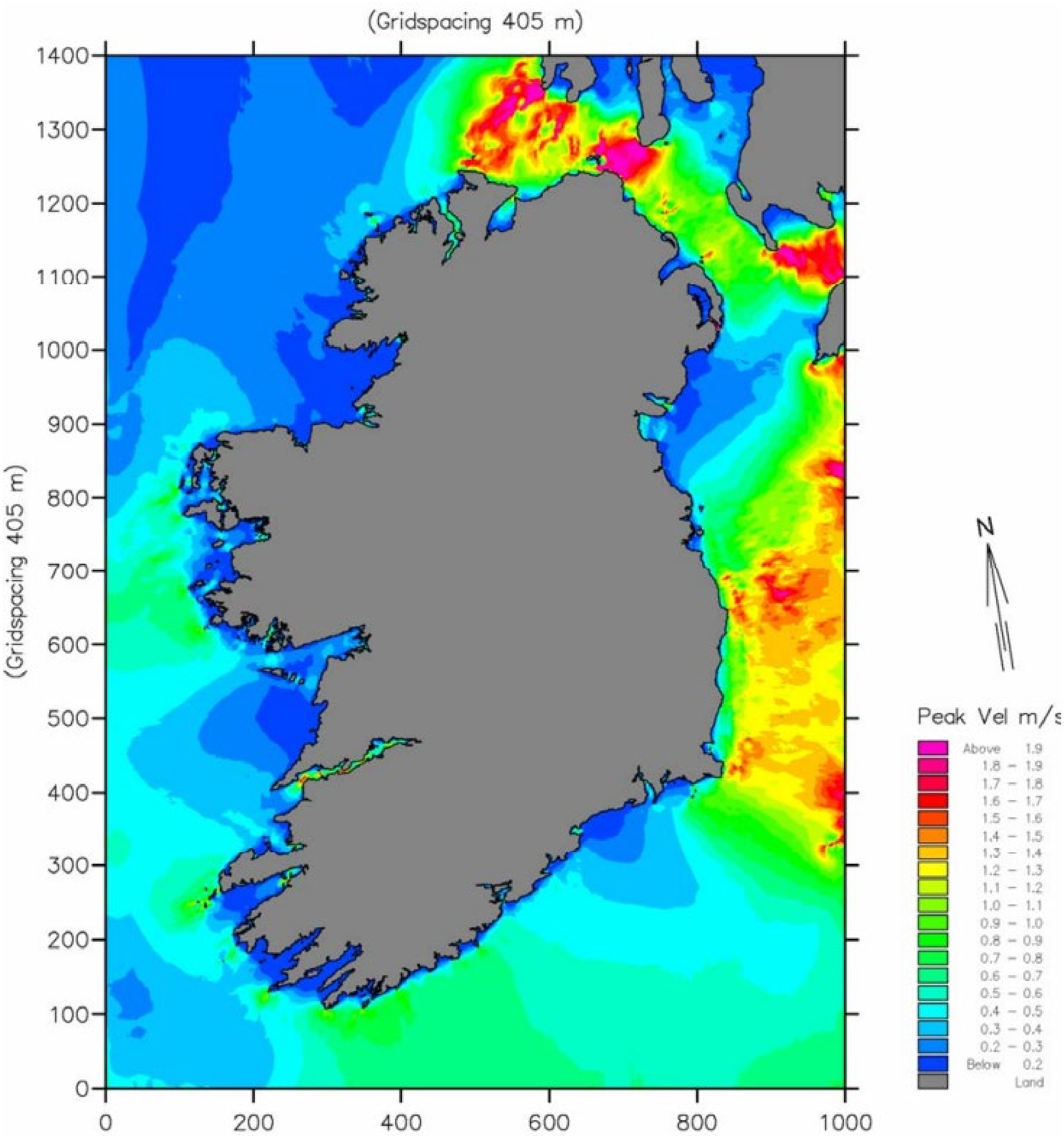


FIGURE 3.10 TIDAL CURRENTS (SOURCE: TIDAL CURRENT ENERGY RESOURCE ASSESSMENT IN IRELAND: CURRENT STATUS AND FUTURE UPDATE)

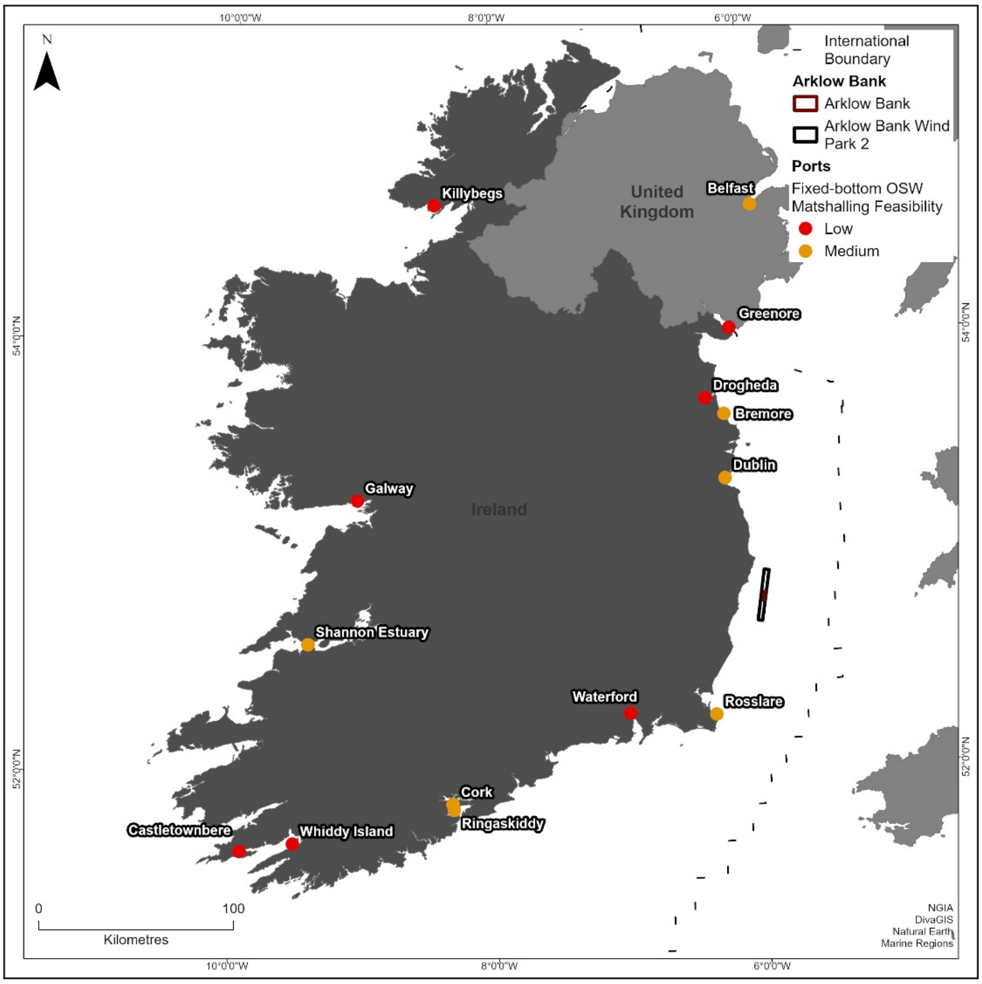


Depth Averaged Peak Spring Tidal Currents

3.3 PORTS

A high-level ports feasibility assessment has identified suitable Irish ports to support the construction and installation of bottom-fixed foundation.

FIGURE 3.11 ASSESSED PORT LOCATIONS (FIGURE PREPARED BY ERM)



The ports are assessed using nine criteria to best represent conditions needed to accommodate OSW marshalling (see Table 3.1). Note the distance to site criterion has not been applied in this section but is given in the table for completeness. The ports are rated as red, amber, or green to reflect suitable thresholds, where red is not suitable, amber is potentially suitable and green is suitable. These ratings reflect unsuitable, suited but with some mitigations, and well-suited ports in the red-amber-green ratings, respectively. The port assessment parameters are based on the current status of the port unless appropriate development plans with the required details are publicly available.

TABLE 3.1 PORT ASSESSMENT EVALUATION CRITERIA

Marshalling Port – Fixed-bottom OSW			
Parameter	**Red**	**Amber**	**Green**
Laydown area	<16 Ha	16-75 Ha	>75 Ha
Ground loading	<10 t/m^2	10-12 t/m^2	>12 t/m^2
Quayside depth	<10 m	10-12 m	>12m
Quayside length	<200 m	200-300 m	>300 m
Entrance width	<80 m	80-120 m	>120 m
Channel depth	<10 m	10-12 m	>12m
Air draught	<80 m	80-150 m	>150 m
Distance to site	>200 nm	130-200 nm	<130 nm

There were no green-rated ports identified in ERM's port assessment. The amber-rated ports, i.e., those that were identified as potentially suited to support OSW with some redevelopment or mitigations are Belfast, Bremore, Dublin, Rosslare, Cork, Ringaskiddy and the Shannon Estuary cluster. Out of these, Bremore initially appears the most suited (see section 3.3.1.4), although the port has not been developed to date. The port development plans include a dedicated ORE terminal, and outline intentions to make berths initially available for use between 2028 and 2030. Belfast port already has a dedicated OSW terminal (D1 terminal), which was developed to support the Duddon Sands wind farm. A further OSW terminal, the D3 terminal, is to be made available later in 2024. However, laydown area and channel depths in particular remain as constraining factors when considering WTG and foundation installation strategies. The ports of Rosslare and Cork are also undergoing OSW-dedicated upgrades, with Rosslare primarily targeting the fixed-bottom market and Cork the floating wind market arising in the Celtic Sea. Consequently, the strongest region in terms of suitable OSW ports appears to be the east coast at this stage. The south, west and north coasts have relatively few large ports with no OSW dedicated infrastructure.

While the port assessment presented in this report has assumed the latest available WTG models (and vessels required to support them) will be used, a major constraint that must also be considered for the offshore wind sector going forward is vessel availability. A shortage of wind turbine installation vessels (WTIVs), foundation installation vessels (FIVs), and Operations and Maintenance (O&M) vessels has been forecast from mid to late decade using ERM's Global Renewable Infrastructure Projects (GRIP) database, particularly for vessels capable of installing 15 MW+ turbines, and XL monopiles. Increasingly ambitious renewable energy targets in Europe and globally add pressure to the offshore wind sector to get projects built in the near term, resulting in increasing competitiveness to secure installation contracts. This could affect the results of this analysis if smaller WTGs and appropriate vessels are used instead.

3.3.1 EAST COAST

3.3.1.1 DROGHEDA

Drogheda is situated on the River Boyne, 4.5 miles from the sea. A commercial multi-model port of international and national regional importance also providing relief to Dublin port. Imports/exports include containers, hydrocarbons/LPG and general cargo. With the exception of the 4 ha Tom Roe terminal, access is gained under the Boyne Viaduct (height restriction 23 m). The north quayside is long and narrow with numerous warehouses, while the south quayside is more open to the east with some mixed uses to the west. Murflo jetty has an additional 4.5 ha of laydown area. South Terminal has 7 ha of laydown, and 1 ha of laydown area in the north terminal.

TABLE 3.2 DROGHEDA PORT ASSESSMENT PARAMETERS

Assessment Parameters		**Rating & Key Constraints**
Laydown area (ha)	8	• Laydown area • Quayside depth • Entrance width • Channel depth • Air draught
Ground loading (t/m^2)	Unknown	
Quayside depth (m)	1.6	
Quayside length (m)	550	
Entrance width (m)	60	
Channel depth (m)	1.6	
Air draught (m)	23	
Distance to site (nm)	60	

3.3.1.2 DUBLIN

The port of Dublin is situated at the mouth of the River Liffey. This is the largest port in Ireland for cargo handled, freight and passenger services. There are facilities to handle Ro-Ro (roll on-roll off), break bulk, liquid/dry bulk and transit cargoes. South terminal has 14 ha of laydown area and the north terminal has 31 ha. Both terminals have multiple quaysides with numerous warehouses and cargo. While the port may be suited to be repurposed for OSW, extensive dredging at the quayside and channel would be required. Through engagement with the port, it is understood that OSW will not be included in the port development strategy in the short or long term, making repurposing highly unlikely.

TABLE 3.3 DUBLIN PORT ASSESSMENT PARAMETERS

Assessment Parameters		**Rating & Key Constraints**
Laydown area (ha)	45	• Lack of interest in OSW • Quayside depth • Channel depth
Ground loading (t/m^2)	Unknown	
Quayside depth (m)	7.8	
Quayside length (m)	300	
Entrance width (m)	180	
Channel depth (m)	7.8	
Air draught (m)	N/A	
Distance to site (nm)	32	

3.3.1.3 ROSSLARE

Rosslare Europort is the nearest crossing point to the United Kingdom and Europe, and provides unrivalled marine access to the main centres. Current cargoes include Ro-Ro, agricultural products and fish. The port is undergoing a €200 million investment aimed at developing an ORE hub targeted at OSW, including a dedicated OSW quay and berth with up to 20 ha of laydown area, a 9 m deep access channel, 7.6 m quayside depths and other dedicated facilities. A crew transfer vessel (CTV) berth is also in development at the harbour. The works are planned for completion in 2026, with consent approval targeted for Q4 2024. Despite these upgrades, the port does not meet ERM's green criteria to support large-scale WTG installation. Further dredging could allow for the accommodation of large OSW vessels, and further dedicated laydown area would facilitate the handling and storage of more large components such as blades, foundations and towers. If engaging with the port regarding OSW marshalling support, inquiry into the possibility of quayside dredging to depths of at least 10 m, ideally 12+ m, and deepening of the access channel to the same depths is advised. While the quayside length is shorter than ideal, the OSW berth is located on open water making access restrictions minimal. As current vessels can exceed 250 m in length, it should be assumed that only one vessel at a time will be able to access the quay.

TABLE 3.4 ROSSLARE PORT ASSESSMENT PARAMETERS

Assessment Parameters		**Rating & Key Constraints**
Laydown area (ha)	24	• Quayside depths • Channel depths • Laydown area • Quayside lengths
Ground loading (t/m^2)	10	
Quayside depth (m)	7.6	
Quayside length (m)	260	
Entrance width (m)	150	
Channel depth (m)	9	
Air draught (m)	N/A	
Distance to site (nm)	35	

3.3.1.4 BREMORE

A new deepwater port targeted at ORE, including OSW staging and assembly, in development by Drogheda Port Company. Port will incorporate OSW facilities in its initial strategic focus on the OSW sector, and the port will be equipped with purpose-built infrastructure, including specialised quays for WTG assembly along with a green hydrogen plant using electricity from nearby OSW projects, providing both installation support and offtake potential. The project is set to present a detailed planning application by 2026/2027, following public consultation, with initial berths being functional in 2028-2030. Details are given for the dedicated ORE berth.

TABLE 3.5 BREMORE PORT ASSESSMENT PARAMETERS

Assessment Parameters		Rating & Key Constraints
Laydown area (ha)	60	• Port development timeline • Laydown area • Quayside depth • Channel depths
Ground loading (t/m^2)	25-60	
Quayside depth (m)	11	
Quayside length (m)	1000	
Entrance width (m)	300	
Channel depth (m)	11	
Air draught (m)	N/A	
Distance to site (nm)	50	

3.3.1.5 BELFAST

The port's D1 OSW terminal (21 ha) was developed in collaboration with Ørsted and Scottish Power Renewables to support the Duddon Sands project. Furthermore, a total greenfield area of 31 ha is under development to support OSW, spread across to sites near the D1 terminal in the deepwater channel and two to the west of the harbour. The channel depths are the main constraint going forward. The D3 terminal is the first to be made available in late 2024, with 18 ha of laydown area situated along the same quay as the D1 terminal. D1 and D3 terminal parameters jointly assessed.

TABLE 3.6 DUBLIN PORT ASSESSMENT PARAMETERS

Assessment Parameters		**Rating & Key Constraints**
Laydown area (ha)	39	• Laydown area • Quayside depth • Channel depths
Ground loading (t/m^2)	50	
Quayside depth (m)	10.2	
Quayside length (m)	350	
Entrance width (m)	320	
Channel depth (m)	3.1	
Air draught (m)	N/A	
Distance to site (nm)	140	

3.3.2 SOUTH COAST

3.3.2.1 CORK

Large port which has terminals at Cork City Quays, Tivoli, Ringaskiddy (assessed separately), Marino Point and Cobh, the port is also adjacent to Cork Dockyard. The Tivoli and City Quays terminals are further up the River Lee, which has shallow depths unsuitable to OSW construction vessels. Marino Point has an area of 25 ha currently in use as a chemical plant, with depths of around 10 m alongside a single jetty and similar channel depths. Cork Dockyard has an area of 9 ha and has nearby channel depths of around 15 m. The port is being developed for floating OSW projects in the Celtic Sea, with the upgrades considered in this study. Consent applications were initially scheduled for Q3 2023, with work completion targeted in 2027/2028. The port owner, Doyle Shipping Group, is currently undergoing consultation of the plans with stakeholders and the general public before submitting applications to An Bord Pleanála.

TABLE 3.7 CORK PORT ASSESSMENT PARAMETERS

Assessment Parameters		**Rating & Key Constraints**
Laydown area (ha)	34	• Port development timeline • Laydown areas • Quayside lengths • Quayside depths • Channel depths • Ground loading
Ground loading (t/m^2)	2-7	
Quayside depth (m)	11	
Quayside length (m)	300	
Entrance width (m)	230	
Channel depth (m)	10	
Air draught (m)	N/A	
Distance to site (nm)	125	

3.3.2.2 WHIDDY ISLAND

Subport within Bantry port. Currently used by Zenith Energy as a storage terminal for crude oil, gasoline and distillates. A 3.2 GW green energy facility is planned on the island, with an operational date of 2028 targeted. The storage area occupies 52 ha of land, with great potential for greenfield expansion further onto the island. The current setup utilises a single 60 m jetty, which is not suited to OSW. Should the port's focus shift to OSW, a new quayside and dredging would be required.

TABLE 3.8 WHIDDY ISLAND PORT ASSESSMENT PARAMETERS

Assessment Parameters		**Rating & Key Constraints**
Laydown area (ha)	52	• Port development timeline • Quayside depths • Quayside length
Ground loading (t/m^2)	Unknown	
Quayside depth (m)	7.8	
Quayside length (m)	60	
Entrance width (m)	110	
Channel depth (m)	23	
Air draught (m)	N/A	
Distance to site (nm)	200	

3.3.2.3 RINGASKIDDY

Rushbrooke shipyard to north (10 ha) is Ireland's only Freeport. Ringaskiddy is a subport of Cork. There is a large vehicle distribution centre and numerous warehouses and containers. Channel depth would need dredging for offshore wind. The Ringaskiddy Pier is the most suitable terminal for OSW.

TABLE 3.9 RINGASKIDDY PORT ASSESSMENT PARAMETERS

Assessment Parameters		Rating & Key Constraints
Laydown area (ha)	50	• Port development timeline • Laydown area • Channel depth • Ground loading
Ground loading (t/m^2)	5	
Quayside depth (m)	12.4	
Quayside length (m)	295	
Entrance width (m)	290	
Channel depth (m)	11	
Air draught (m)	N/A	
Distance to site (nm)	120	

3.3.3 WEST COAST

3.3.3.1 GALWAY

Galway is situated on the River Corrib in a sheltered position at the innermost eastern end of Galway Bay, on the west coast of Ireland. There are several laydown areas to the north and east. The docks are restricted to a 20 m width. There are several large car parks, warehouses, depots and a sailing club with a long pier and residential houses to the west.

TABLE 3.10GALWAY PORT ASSESSMENT PARAMETERS

Assessment Parameters		**Rating & Key Constraints**
Laydown area (ha)	16	• Port development timeline • Laydown area • Depths
Ground loading (t/m^2)	12	
Quayside depth (m)	3.4	
Quayside length (m)	110	
Entrance width (m)	155	
Channel depth (m)	3.4	
Air draught (m)	N/A	
Distance to site (nm)	330	

3.3.3.2 KILLYBEGS

Premier fishing port of Ireland and has one of the best natural harbours on this coast, with naturally deep waters. The port is increasingly being used as an offshore base due to the increasing volume of work associated with the oil and gas industry, as well as for onshore WTG component storage and logistics. However, the size of the port makes it unsuited to support larger OSW project construction.

TABLE 3.11 KILLYBEGS PORT ASSESSMENT PARAMETERS

Assessment Parameters		Rating & Key Constraints
Laydown area (ha)	8	• Port development timeline • Laydown area • Bearing capacity
Ground loading (t/m^2)	7	
Quayside depth (m)	11.7	
Quayside length (m)	300	
Entrance width (m)	300	
Channel depth (m)	20	
Air draught (m)	N/A	
Distance to site (nm)	300	

3.3.3.3 SHANNON ESTUARY

The Shannon Estuary port cluster is investing heavily in supporting floating OSW, and has subports at Foynes, Limerick Docklands, Aughinish, Tarbert and Shannon Airport Aviation Jetty. Moneypoint, which is owned by ESB, is also included in the Shannon Estuary cluster's floating OSW development plans. Moneypoint has been assessed in this study as it is the most suited subport to supporting OSW in its current state. The port has a natural deepwater terminal that serves the Moneypoint coal power station, due for decommissioning in 2025. The current coal storage area occupies 30 ha, but makes use of a 380 m long jetty which is not suited for component laydown. A further 20 ha may be available for brownfield development to the west of the power station. The port is mainly surrounded by fields, allowing for greenfield expansion which has been outlined in plans for the coming years/decades (available on the port website). Further marshalling support is likely to be made available from Foynes Port, which is investigating expansion onto Foynes Island opposite as part of the cluster's future OSW focus.

TABLE 3.12 SHANNON ESTUARY (MONEYPOINT) PORT ASSESSMENT PARAMETERS

Assessment Parameters		**Rating & Key Constraints**
Laydown area (ha)	30	• Laydown area (current)
Ground loading (t/m^2)	15	
Quayside depth (m)	23	
Quayside length (m)	380	
Entrance width (m)	N/A	
Channel depth (m)	20	
Air draught (m)	N/A	
Distance to site (nm)	300	

3.4 ENVIRONMENTAL CONSTRAINTS

3.4.1 PHYSICAL

3.4.1.1 UXO, WRECKS & ARCHAEOLOGY

Unexploded ordnance (UXO) poses a risk to offshore wind projects anywhere in the world. UXO consists of munitions of a range of sizes, types and ages, derived from:

- Aerial bombing.
- Naval and aerial warfare.
- Mine laying.
- Vessel and aircraft wrecks.
- Live firing for training.
- Deliberate disposal of stocks of munitions or explosives.

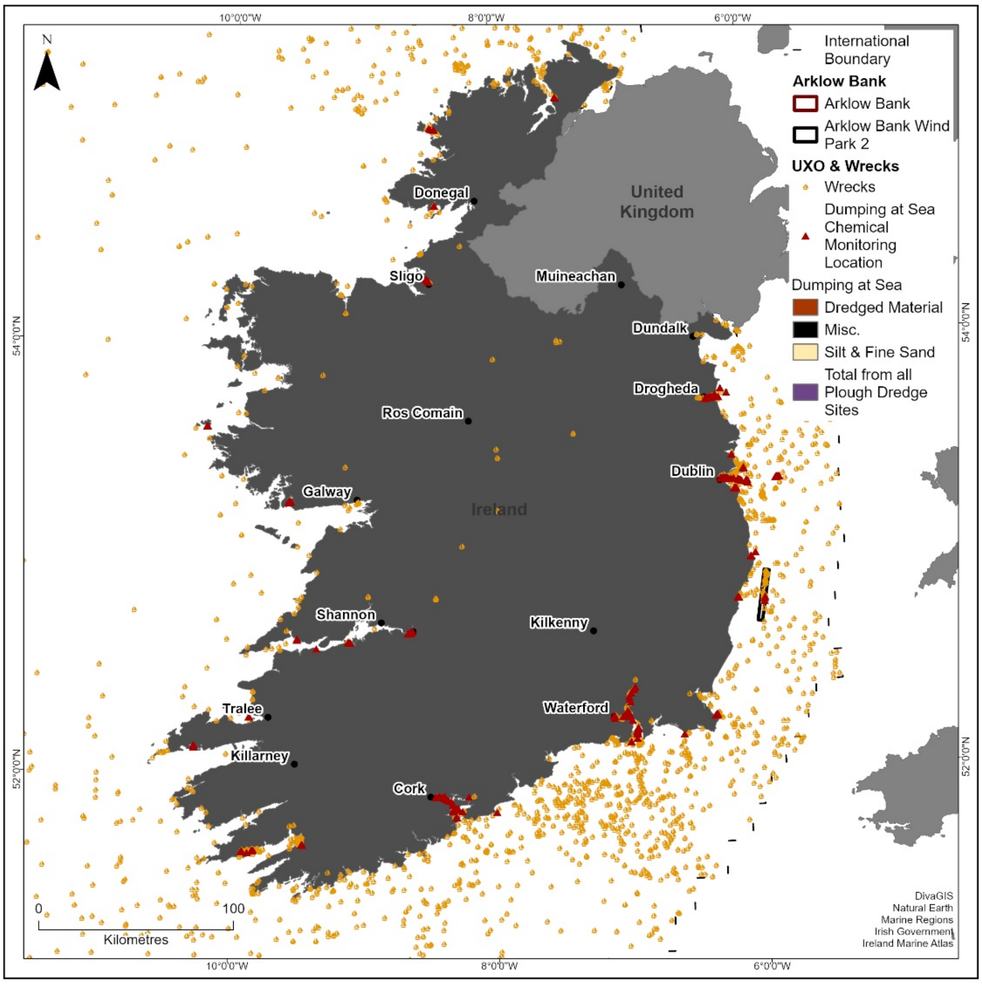
Given the lack of UXO data for Ireland, UXO survey campaigns and risk assessments should be conducted for all offshore wind sites to minimise risks.

UXO disposal grounds should be treated as a hard constraint and avoided during the selection of potential development areas.

The presence of archaeology is not considered a hard constraint to development. Risks can be mitigated by thorough surveys and appropriate micrositing of subsea infrastructure. The OREDP describes the different types of archaeology that is present within potential development areas. The eastern, southern, and northern coasts of the island of Ireland have many wrecks surrounding the coast, which must be considered in site selection. In addition, there are prehistoric landscapes consisting of sheltered bays in the west, drowned estuaries and inlets to the south and glacial lake shores to the east.

Figure 3.12 reveals a higher concentration of wrecks in the Irish Sea and Celtic Sea, offshore the east and south coasts. Clusters of chemical monitoring locations are also present along these two coastlines in particular, with concentrations seen offshore Drogheda, Dublin, Waterford and Cork. Overall, the south and east coasts appear more constrained when considering these constraints, as would be expected given the higher levels of vessel activity and major ports in these regions. Regardless, these are not expected to pose significant constraints to OSW development, as mitigations such as survey campaigns and micrositing are usually sufficient to allow for the development of ORE and other offshore infrastructure. Impacts on project development are usually limited to small increases in CAPEX.

FIGURE 3.12 IRELAND UXOS, WRECKS & ARCHAEOLOGY (FIGURE PREPARED BY ERM)



3.4.2 BIOLOGICAL

3.4.2.1 ENVIRONMENTALLY DESIGNATED AREAS

Special Protection Areas (SPAs) and Special Areas for Consideration (SAC) are prominent along Ireland's coastline, subject to varying restrictions based on their designation. Ireland dedicates over 597,000 hectares to designated SPAs, safeguarding rare and vulnerable species, migratory birds, and internationally significant wetlands. SPA regulations specifically prohibit pollution, habitat deterioration, and disturbance to birds within these areas. SACs, crucial for wildlife conservation and recognised at both European and Irish levels, number over 430, with just over 40% having formal designation.

In Ireland, Marine Protected Areas (MPAs) constitute a specific approach to area-based conservation, encompassing about 2.1% of the country's marine territory (approximately 10,420 km^2). The General Scheme of the MPA Bill was published in 2022. This includes the identification, designation and management of MPA sites. Based on the General Scheme published in 2022, the MPA Bill is currently in pre-legislative scrutiny and is expected to be progressed through the Houses of the Oireachtas during 2024. Given the lack of specific legislation offering legal backing for areas established under international conventions, Ireland has designated certain Special Areas of Conservation (SACs) as Oslo and Paris Conventions (OSPAR) MPAs for marine habitats. This aligns with Ireland's commitment under the OSPAR

Convention to establish MPAs for the protection of biodiversity. Marine habitats include sand dunes, machair, estuaries and inlets, and species include salmon, otter and bottlenose dolphin.

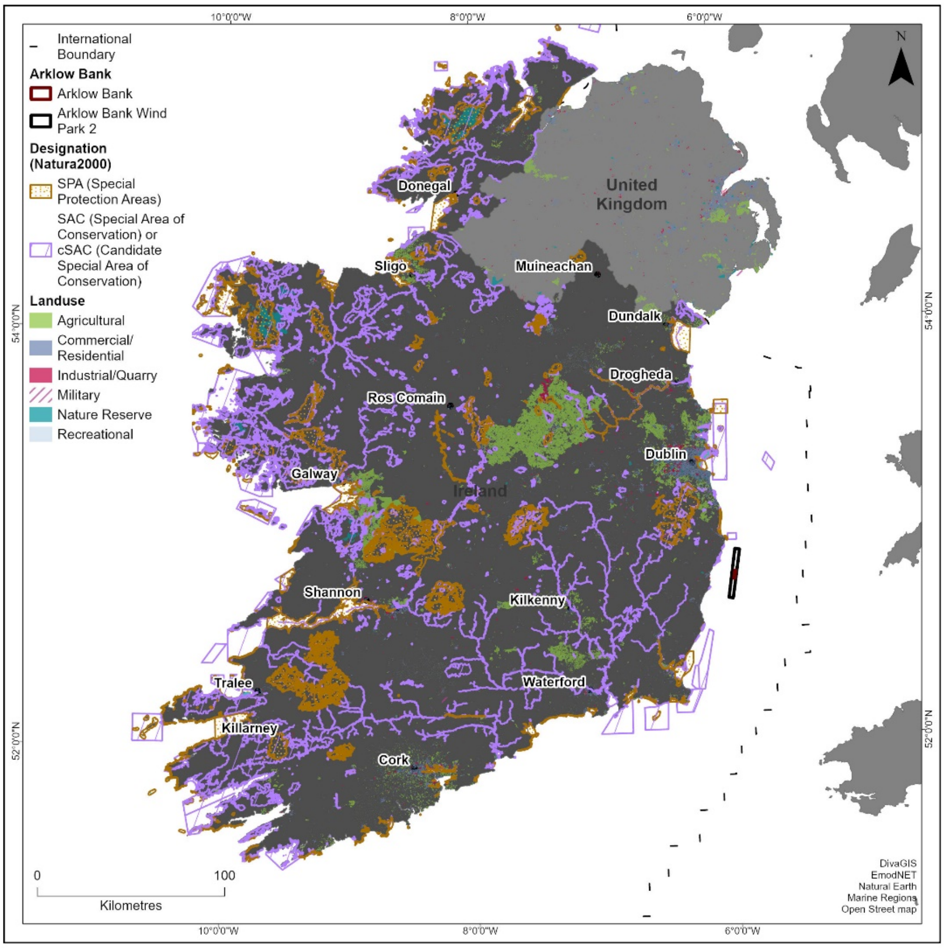
However, windfarms pose potential harm to birds, fisheries and marine mammal habitats through disturbance, displacement, acting as barriers, habitat loss, and collision risks. To mitigate these impacts, strategic planning is essential, involving the careful siting of turbines in less sensitive areas and thorough ecological assessments at every stage of development. Recognising the dynamic nature of wildlife movement within these areas underscores the need for flexibility in viewing protected boundaries, considering the shifting foraging ranges associated with SPAs.

The Natura 2000 network, established through the Birds and Habitats Directive, brings together SACs designated under the Habitats Directive and SPAs classified under the Birds Directive. Termed 'European sites' in Irish legislation, this network stands as the world's largest coordinated system of protected areas, extending from land to sea, covering the national jurisdiction limit of 200 nautical miles.

Ireland has identified 45 sites as Ramsar wetlands of international importance, 22 of which include marine and/or coastal elements, highlighting the interconnectedness of marine and terrestrial ecosystems. Noteworthy examples, such as North Bull Island in Dublin Bay, celebrated for its significant bird habitats, and the Carrowmore-Knocnarea SAC in County Sligo, recognized for its diverse botanical composition, underscore Ireland's commitment to preserving diverse environments. All Ramsar sites harmoniously intersect with regions within the Natura 2000 network. Some, like the Courtown Harbour and Dunes SAC, contribute to the OSPAR network of MPAs, while others, such as the Lower River Shannon SAC, hold national designation.

Additionally, the geographic distribution of SPAs and SACs reveals a higher concentration of environmentally protected areas on the western coast of Ireland compared to the eastern coast (Figure 3.13). The stretch from Sligo on the west coast to Kerry in Ireland's southwest encompasses over 80% of protected area designations, including SPAs and SACs such as West Connacht Coast, Castlemaine Harbour, the Connemara Bog Complex, and the Ballycroy National Park. This region poses a high risk for OSW due to the presence of geological features, coastal lagoons, reef habitats, Common Bottlenose Dolphins, and wetland birds. In contrast, Ireland's eastern coastlines around Arklow Bay and Courtown Harbour present low to minimal risk of environmental constraints from protected areas. Developing in this area may encounter fewer challenges; however, thorough assessments and considerations remain essential.

FIGURE 3.13 IRELAND ENVIRONMENTALLY DESIGNATED AREAS (FIGURE PREPARED BY ERM)



3.4.2.2 ORNITHOLOGY

There are 103 SPAs with marine components (i.e., seabird qualifying features) around the coast of Ireland (Figure 3.13; EEA, 2023). These designations provide protection to qualifying seabird populations, including, but not limited to, black-legged kittiwake (*Rissa tridactyla*), Atlantic puffin (*Fratercula arctica*), Manx shearwater (*Puffinus puffinus*), and northern gannet (*Morus bassanus*).

Classified SPA populations are protected under the EU Birds Directive (Directive 2009/147/EC) and under European Communities (Birds and Natural Habitats) Regulations 2011 (as amended) (S.I. No. 477/2011) Ireland. The level of legal protection assigned to classified populations and their supporting habitats makes this constraint considerably high and poses a potential development risk.

In addition to classified bird populations, regional seabird populations must also be considered. Ireland supports a range of seabird species (Rogan *et al.*, 2018), including gulls, which can be vulnerable to collision risk (e.g. great black-backed gull (*Larus marinus*)); auks, which are sensitive to displacement effects (e.g. common guillemot (*Uria aalge*)); and petrels and shearwaters (e.g. Manx shearwater), which can be disoriented by artificial light at night.

Rogan *et al.* (2018) described bird density estimates around the coasts of Ireland over a two-year period between 2015 and 2016. The researchers were unable to fully analyse bird density along inshore regions of the northwest, west, and south due to data gaps. However, overall seabird density was generally greatest in the northwest, southern and eastern regions. The data indicated areas of high bird density along the south and northwest coasts (Rogan *et al.*, 2018), suggesting that the inshore regions are likely to support greater densities than the offshore regions.

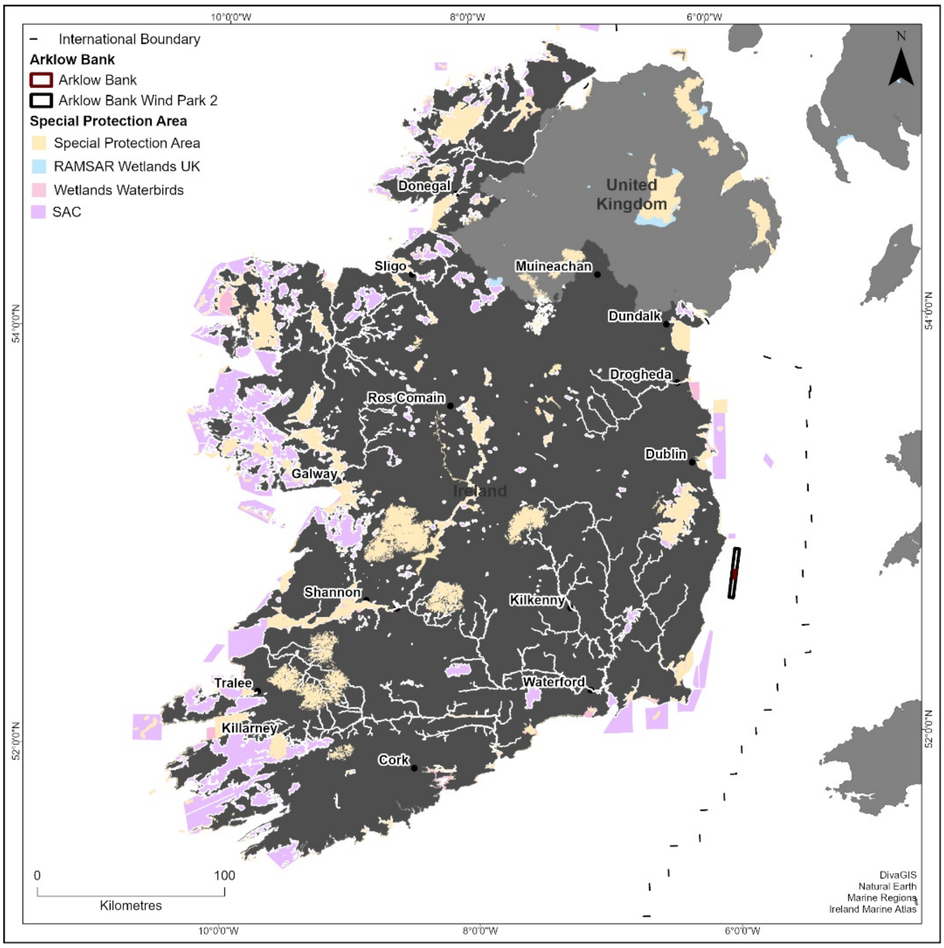
The northern gannet was recorded in high densities in all areas (Rogan *et al.*, 2018). Other bird species were also widespread including gulls (all species), northern fulmar (*Fulmarus glacialis*), and Manx shearwater. Summer densities were notably higher than winter across all regions.

The east coast of Ireland and the Irish Sea are particularly important to certain seabird species (Rogan *et al.*, 2018; Cummins *et al.*, 2019), due to presence of suitable nesting habitats, such as Lambay Island, and supporting habitat and prey availability, such as the Irish Sea Front (JNCC, 2016). High densities of seabirds were also recorded on the southern and western coasts, with similar species recorded in both locations, and a notable area of higher density of some species was recorded in the northwest (Rogan *et al.*, 2018). Species recorded in high density in each coastal region are listed in Table 3.13.

TABLE 3.13 SEABIRD SPECIES WITH HIGH DENSITIES IDENTIFIED IN EACH REGION OF IRELAND (ROGAN *ET AL.*, 2018)

East	South and West	Northwest
Black-legged kittiwake (*Rissa tridactyla*) Common gull (*Larus canus*) European herring gull (*Larus argentatus*) Common tern (*Sterna hirundo*) Arctic tern (*Sterna paradisaea*) Common guillemot (*Uria aalge*) Razorbill (*Alca torda*) Manx shearwater (*Puffinus puffinus*) Northern gannet (*Morus bassanus*) Great cormorant (*Phalacrocorax carbo*) European shag (*Gulosus aristotelis*)	Black-legged kittiwake Common tern Arctic tern Common guillemot Razorbill Northern fulmar (*Fulmarus glacialis*) European storm petrel (*Hydrobates pelagicus*) Leach's storm petrel (*Hydrobates leucorhous*) Northern gannet	Black-legged kittiwake Common tern Arctic tern Northern fulmar European storm petrel Leach's storm petrel Northern gannet

FIGURE 3.14 IRELAND ORNITHOLOGY (FIGURE PREPARED BY ERM)



3.4.2.3 MARINE MAMMALS & TURTLES

All cetaceans and marine turtles are listed as species of community interest in need of strict protection under Annex IV of the Habitats Directive (1992/43/EEC)[3]. SACs have also been established to protect harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, and both resident species of seal found (grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*) which are also listed under Annex II. SACs contain physical or biological factors essential to the life and reproduction of these species and are transposed into Irish legislation through the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended) (S.I. No. 477/2011) Ireland.

In Ireland, there are 3 SACs for harbour porpoise, 5 for bottlenose dolphin, 13 for harbour seal, and 10 for grey seal, with the majority located on the west coast (Figure 3.14).

At least 25 species of cetacean have been recorded in Irish waters (O'Brien *et al.*, 2009). Regional surveys around Ireland have shown that while some species are primarily distributed over the continental shelf and shelf edge (e.g., long-finned pilot whale *Globicephala melas*, beaked whale species), others have a coastal distribution (e.g., bottlenose dolphin, harbour porpoise) (Wall *et al.*, 2013; Rogan *et al.*, 2018). Species richness in coastal areas is highest in the summer season, in part because this overlaps with the breeding period for multiple marine

[3] Commission notice Guidance document on the strict protection of animal species of Community interest under the Habitats Directive - Publications Office of the EU (europa.eu)

mammal species (Wall *et al.*, 2013). Over the ObSERVE program two-year survey period, the most frequently sighted odontocetes were bottlenose dolphin, harbour porpoise, and common dolphin, whereas the most frequently sighted mysticete was minke whale *Balaenoptera acutorostrata* (Rogan *et al.*, 2018). Among species that have common seasonal or year-round coastal distributions, minke whale and bottlenose dolphin had the highest number of sightings in the southwest region, while harbour porpoise density was highest in the Irish Sea (Rogan *et al.*, 2018).

Grey seal are the most numerous pinniped species in Ireland. Grey seals are present year-round off all Irish coasts (Wall *et al.*, 2013), and congregate at estuarine or coastal haul-out sites to rest, breed, and moult. A survey of grey seal breeding areas in Ireland between 2009-2012 estimated the three highest breeding populations to be located on the west coast at the Inishkea group of breeding areas in Mayo (1,841-2,367 individuals), the Inishark and Inishgort breeding areas in Galway (1,456-1,872 individuals), and the Blasket Islands breeding area in Kerry (1,099-1,413 individuals) (Ó Cadhla *et al.*, 2013). Two of the three lowest population and lowest pup production breeding areas were on the east coast, at Lambay Island and Ireland's Eye in Dublin (270-347 individuals) and at Saltee Islands in Wexford (529-680 individuals) (Ó Cadhla *et al.*, 2013). The Irish population of harbour seal is considerably lower, with approximately 2905 individuals estimated in a 2007 aerial study (Cronin *et al.*, 2007). Harbour seal haul-out sites are present across the north and west coasts, with scattered smaller haul-out sites also recorded on the south and east coasts in counties Cork, Waterford, Wexford, Dublin, and Louth (Cronin, 2010).

Six of the seven species of marine turtles have been sighted in Irish waters (Botterell *et al.*, 2020), with records primarily occurring off the south and west coasts (likely influenced by higher fishing effort and higher observer numbers (Doyle, 2007). The only marine turtle considered a seasonal resident in Irish waters is the leatherback turtle *Dermochelys coriacea* (NPWS, 2019), which is present during the summer months (June to October) to forage on jellyfish (Witt *et al.*, 2007).

Offshore wind developments need to consider potential impacts on SACs and their qualifying features, which could affect the SAC due to its proximity to the protected site and the projects design considerations, such as the extent of the wind turbine array, size and number of turbines, and piling activity.

Key impact pathways for marine mammals include:

- Disturbance or injury from underwater noise associated with piling;
- Clearance of unexploded ordnance, or other noise producing activities;
- Collision risk from vessels;
- Pollution risks;
- Indirect effects on prey availability;
- Electromagnetic fields from cables; and
- Increased suspended sediments and deposition.

FIGURE 3.15 IRELAND MARINE MAMMAL DENSITY (FIGURE PREPARED BY ERM)

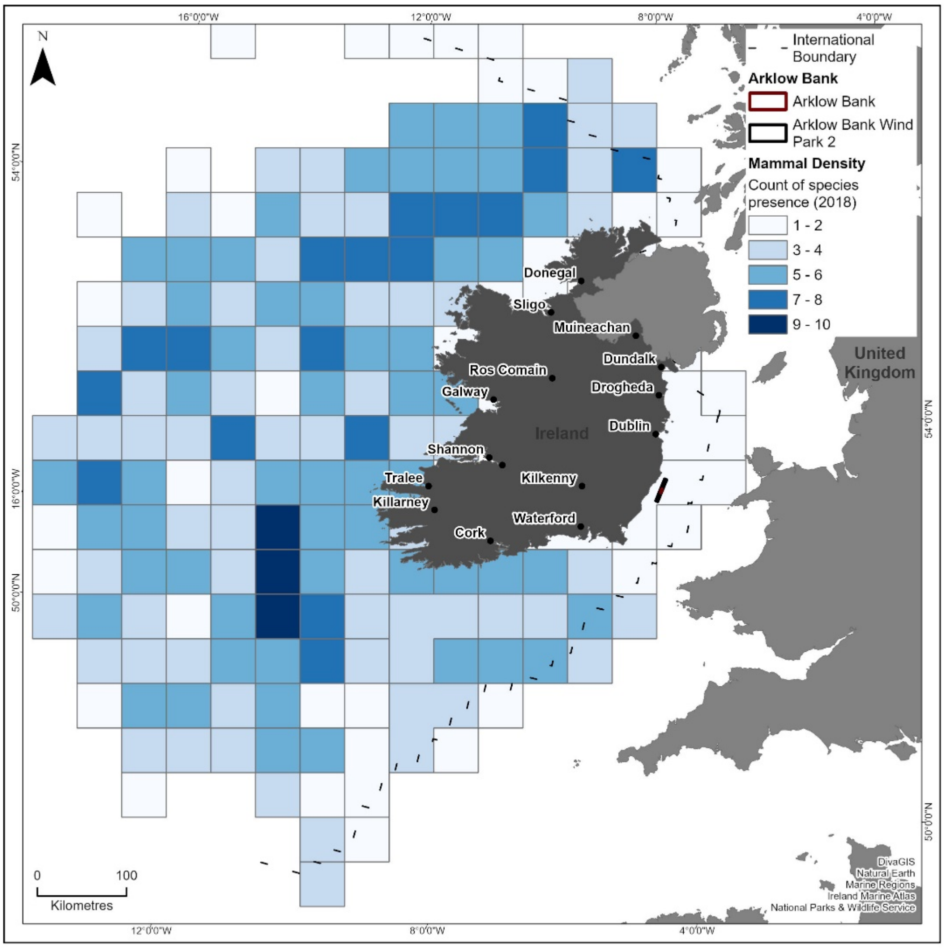
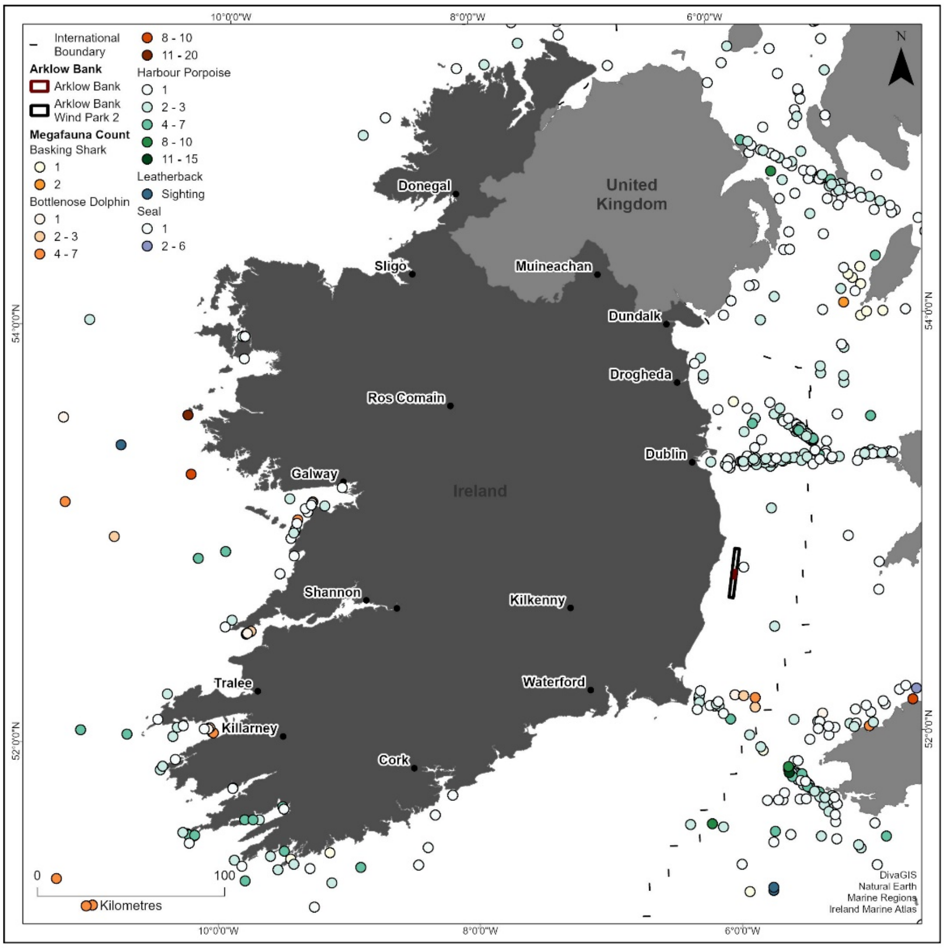


Figure 3.15 provides a proxy to the density of mammals within the waters surrounding Ireland. The figure is based on data from the Ireland Marine Atlas, which consists of individual grids of 50 km by 50 km squares for each of 18 total species of marine mammals. Squares are marked if the species in question has been spotted within them. All of these 18 grids were then combined, and the count of species sighted in each individual grid square was returned as shown.

The data for all 18 mammals derives from the Ireland Marine Atlas collected in 2018 and used in a 2019 report; with 117 blocks, the east coast and surrounding the Arklow Bank projects holds a much lower presence than the western counterpart, which links with the higher density of SAC's and SPA's on that coast and more sporadic sightings that do not follow ferry routes or transit vessels between Ireland and the UK, shown in Figure 3.16 below.

FIGURE 3.16 IRELAND MARINE MAMMALS, TURTLES & BASKING SHARKS (FIGURE PREPARED BY ERM)



3.4.2.4 BENTHIC ECOLOGY

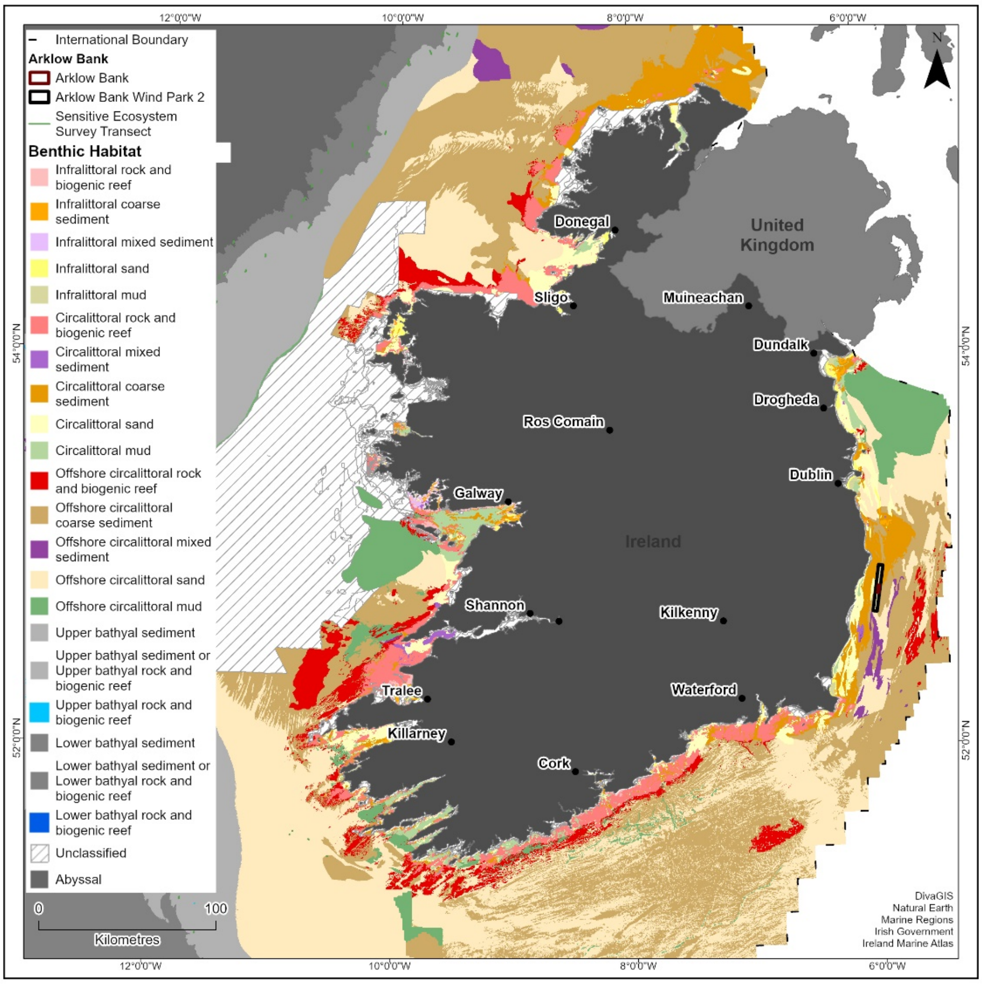
Many different benthic habitats occur around Ireland's coastal waters and are associated with sand, mud, coarse sediment, mixed sediment, rock, and biogenic reefs, as shown on the map in Figure 3.17. The map shows the distribution of, circalittoral, infralittoral, and bathyal sediment types which is related to different biological zones. Circalittoral zones are characterised by animal dominated communities, infralittoral zones are algae dominated, and bathyal sediments have a more diverse epifaunal community. The type of sediment will dictate the benthic habitat. Coarse grained sediment is indicative of a high energy environment with high oxygen levels where sediment is constantly being deposited or eroded. Mud is indicative of a low energy environment with low oxygen levels where fine-grained sediment settles. Biogenic reefs are made up of hard matter created by living organisms and provide an important habitat for a number of species. Different species will be adapted to different environments within the benthic zones.

Figure 3.17 shows that the northwest coast is mostly characterized by circalittoral coarse sediment with sections of sand, rock, and biogenic reef. The west coast has a large portion of circalittoral mud, intersected by coarse sediment, reefs, rock and sand towards the southwest. The south coast has a long strip of circalittoral biogenic reef and rock close to shore which transitions to coarse sediment and sand further from shore. The east coast varies between circalittoral coarse sediment and sand, with a large portion of mud in the northeast. Circalittoral rock and biogenic reef is present further from shore along the east coast.

Benthic ecology is not considered a hard constraint for offshore development, unless in a protected area. Risks of impacting sensitive habitats can be mitigated by micro-siting of turbine locations and subsea cables. Habitats containing sand are more favourable to the developer than rock or biogenic reef, which is generally avoided.

The OREDP identified the distribution of habitats and species on the OSPAR list for threatened and/or declining habitats or species (OREDP, 2014). In Ireland, these are primarily distributed across the southern and western coasts with a few sparsely located habitats on the east coast, notably intertidal mudflats, zostera beds and sea pens and burrowing megafauna.

FIGURE 3.17 IRELAND BENTHIC ECOLOGY (FIGURE PREPARED BY ERM)



3.4.2.5 FISH SPAWNING & NURSERY GROUNDS

According to the Marine Institute Ireland, spawning grounds are considered the locations where commercially important species of fish leave their eggs for fertilisation, and nursery grounds are habitats that promote the survival of young commercially important fish species. These species are important for fisheries and seafoods, in particular mackerel, cod, herring, haddock, blue whiting, and whiting.

The fish spawning grounds off the west coast of Ireland consist of nephrops and sprat, and the nursery grounds consist of herring, nephrops, and saithe, with a large nursing ground of haddock further offshore. The fish spawning grounds off the south coast consist of sprat, lemon sole, plaice, and nephrops, and the nursey grounds consist of lemon sole, nephrops, and whiting. The fish spawning grounds off the east coast consist of cod, lemon sole, nephrops, plaice, sprat, and whiting, and the nursery grounds consist of cod, haddock, herring, lemon sole, nephrops, plaice, and whiting. The most abundant species is sprat, followed by nephrops, lemon sole, and mackerel. Nursery and spawning grounds cover large areas of the west coast, where as on the east coast, they occur in more localised areas with a distinct gap offshore Wicklow, along the central east coast.

FIGURE 3.18 IRELAND FISH SPAWNING AND NURSERY GROUNDS: BLUE WHITING, COD, HADDOCK, HERRING (FIGURE PREPARED BY ERM)

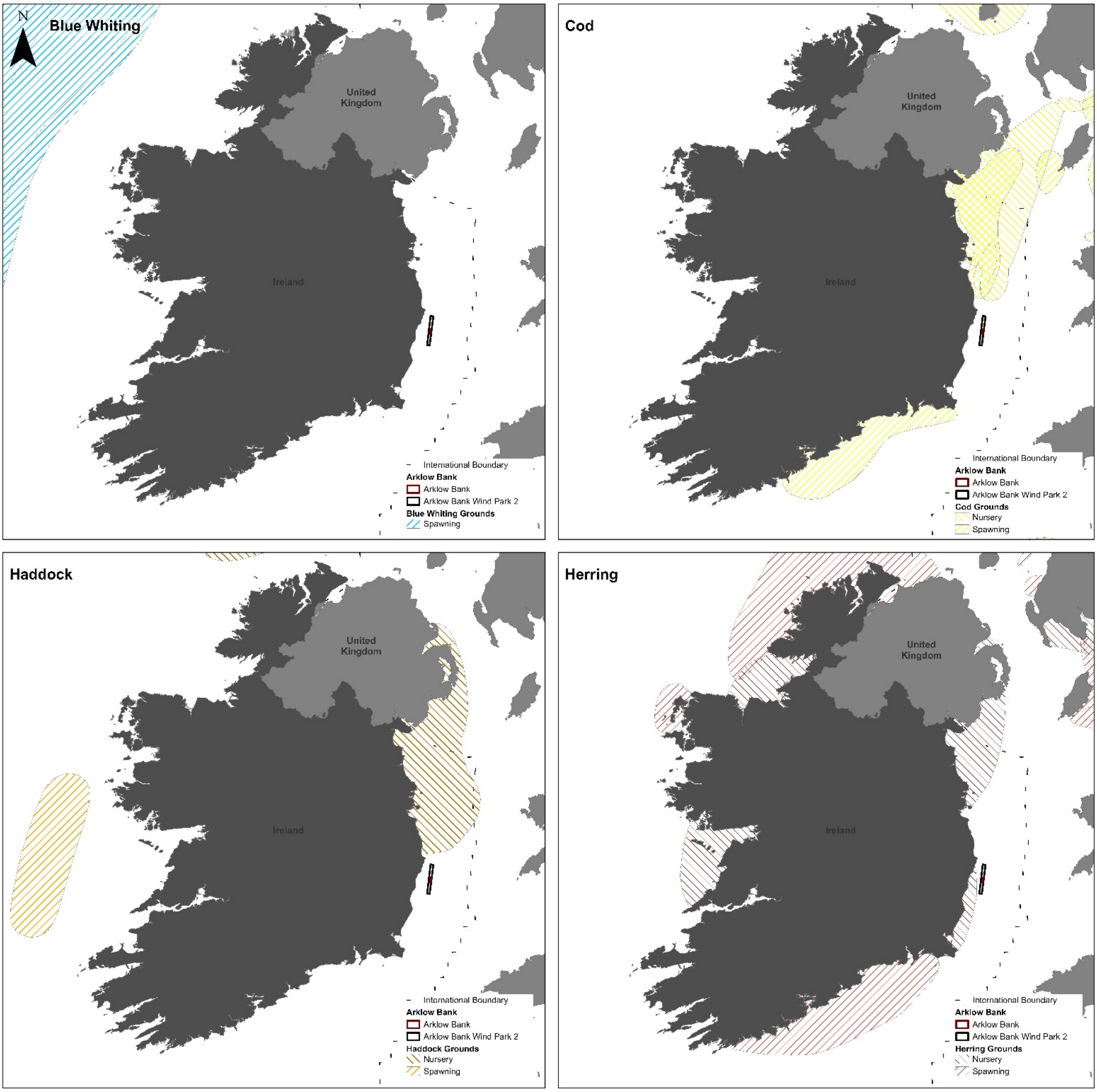


FIGURE 3.19 IRELAND FISH SPAWNING AND NURSERY GROUNDS: LEMON SOLE, MACKEREL, NEPHROPS, NORWAY POUT (FIGURE PREPARED BY ERM)

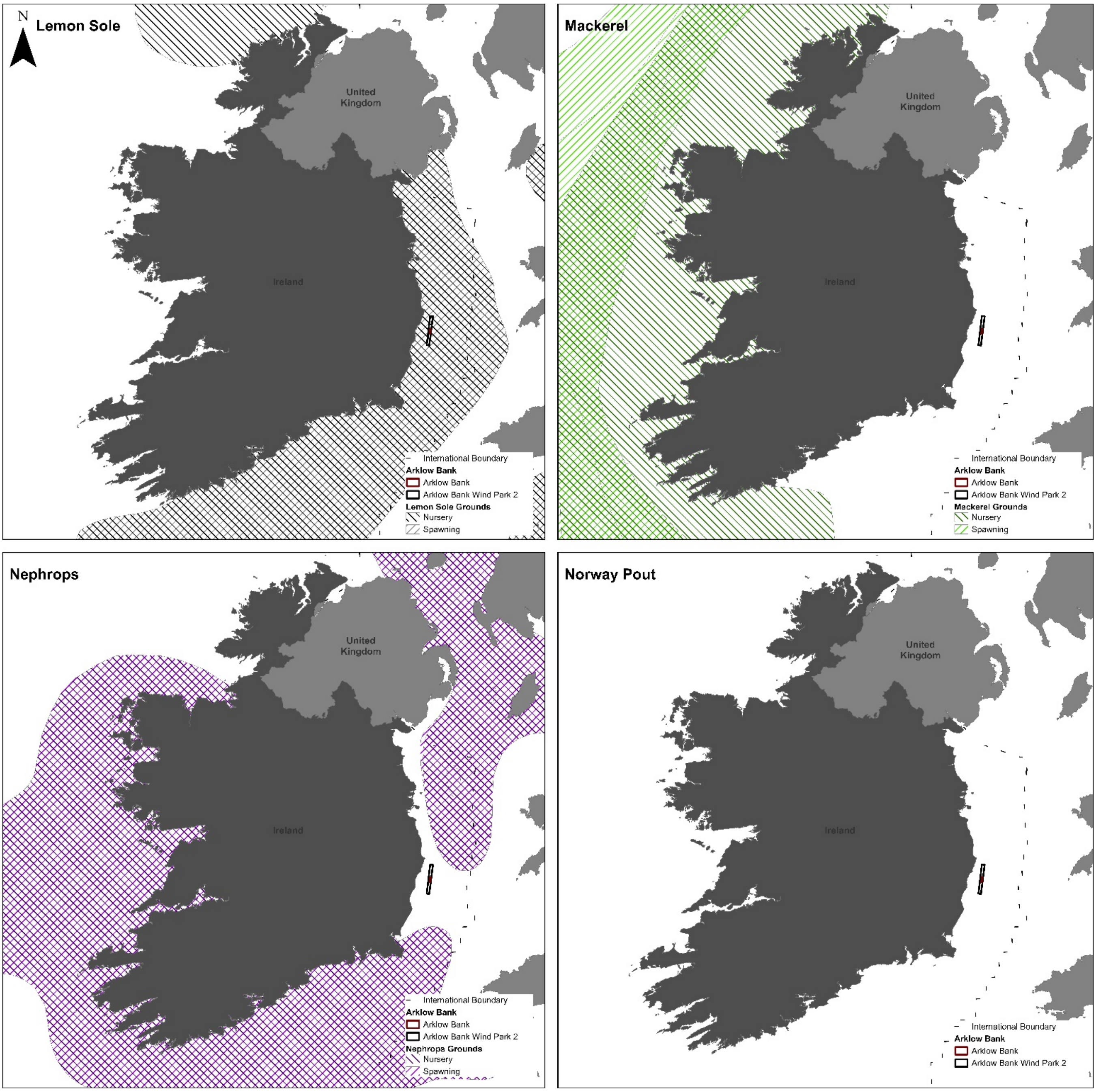
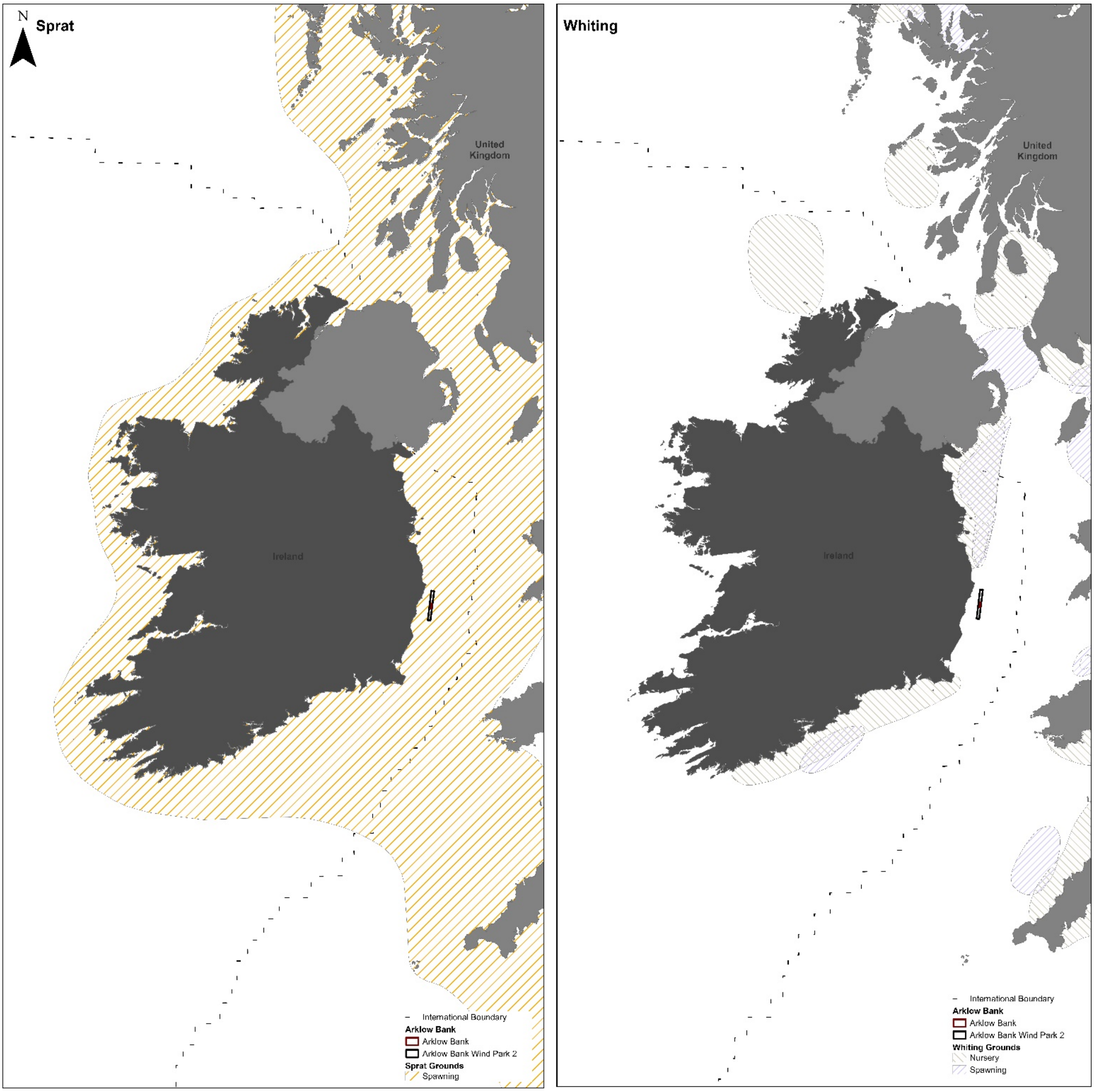


FIGURE 3.20 IRELAND FISH SPAWNING AND NURSERY GROUNDS: PLAICE, SAITHE, SAND EEL, SOLE (FIGURE PREPARED BY ERM)

FIGURE 3.21 IRELAND FISH SPAWNING AND NURSERY GROUNDS: SPRAT, WHITING (FIGURE PREPARED BY ERM)



3.4.3 HUMAN

3.4.3.1 SHIPPING & NAVIGATION

Major shipping routes are typically considered a hard constraint to offshore farms, and developers tend to avoid these areas where possible. Should an offshore wind site overlap with shipping routes, rerouting may be required. In some cases, a buffer zone may also be required to further minimize navigational hazards. Whilst it is feasible to create shipping transit routes through large enough OSW sites, a full navigation risk assessment and consultation with maritime users and the Maritime Area Regulatory Authority is advised. Re-routing commercial vessels, while possible, requires substantial capital and extensive consultation, making close proximity of WTGs to shipping lanes less favourable.

Under SOLAS (International Convention for the Safety of Life At Sea) Regulation 19, *"All ships of 300 gross tonnage and upwards engaged on international voyages and cargo ships of 500 gross tonnage and upwards not engaged on international voyages and passenger ships irrespective of size shall be fitted with an automatic identification system (AIS)".* All vessels over these size thresholds are hence included in the data mapped below, however smaller artisanal fishing vessels of less than 15 m and sailing boats may not be adequately reflected, among other small vessels. AIS transmissions contain information including the vessel's identity number, speed, course and position amongst other details. This information is transmitted automatically every 2-10 seconds.

In order to gauge shipping activity levels in Ireland, AIS data was sourced from EMODnet , which details the number of transmissions by location and vessel type. The density for cargo vessels is shown in Figure 3.22 with the objective of identifying volumes of shipping activity throughout the Irish EEZ and key shipping routes.

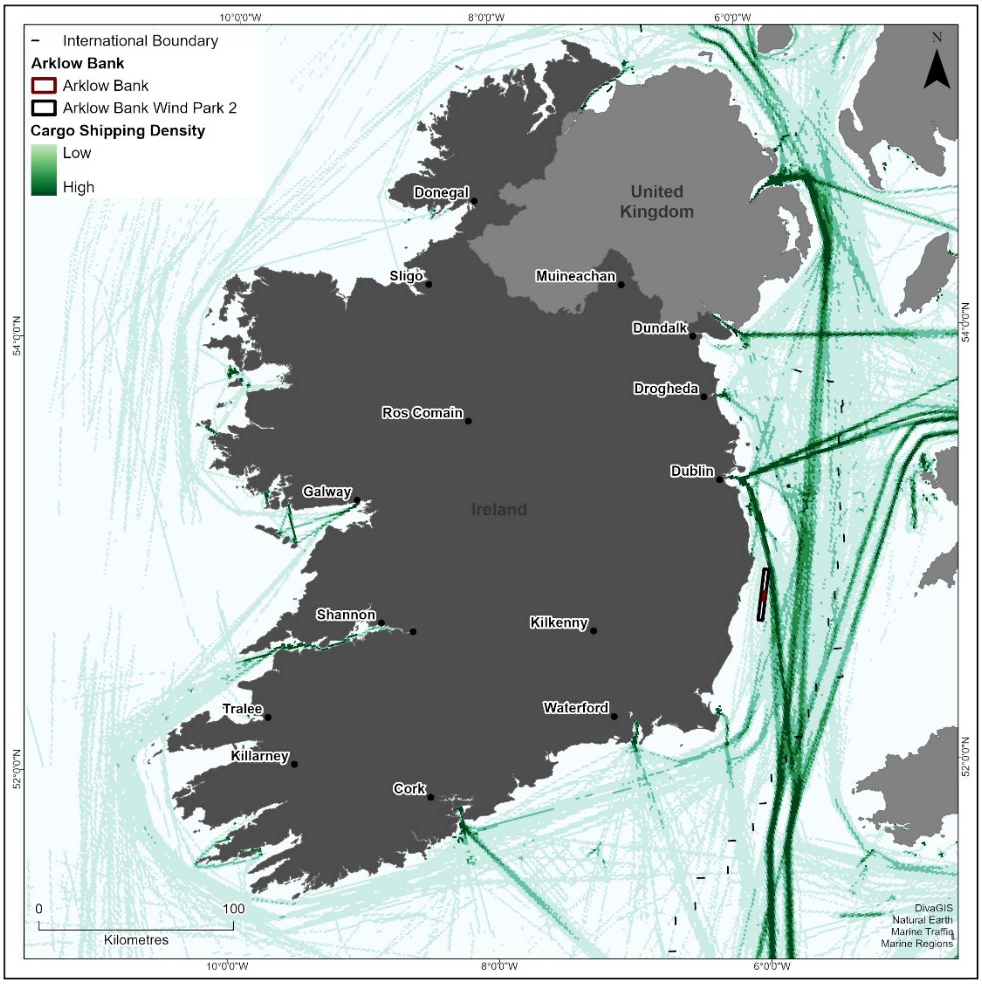
The data shows multiple shipping routes connecting Ireland to the UK, France, and Europe, with most activity concentrated on Ireland's east coast ports, including Dublin Port, Dun Laoghaire, and Waterford Port. Dublin, in particular, stands out as the most frequently broadcast destination, reflecting a high density of vessels and Ireland's active participation in regional and global trade networks. In 2022, 12,447 vessels arrived in Irish ports, with Dublin Port accounting for 59% of all vessel arrivals (Central Statistics Office, 2023). The extensive ferry network linking Ireland to the United Kingdom and continental Europe plays a crucial role in transporting passengers, vehicles, and goods.

The Irish Sea, located between the eastern coast of Ireland and the western coast of the United Kingdom, serves as a major maritime thoroughfare with significant vessel traffic. This traffic is driven by the strategic position of the Irish Sea as a crucial shipping route connecting Ireland to the UK and continental Europe. Commercial ports along Ireland's eastern coast, such as Dublin and Belfast, contribute significantly to this heightened traffic, facilitating the movement of goods, passengers, and cargo.

The extensive ferry network, playing a pivotal role in trade and tourism, features Roll-on/Roll-off (Ro-Ro) commercial ferries, including key operators like Cobelfret Ferries and Atlantic Container Line (ACL). The Irish coastline also attracts fishing vessels, with an average of three unique fishing vessels passing within the Shipping and Navigation Study Area daily. Consulting the EMODnet data and data available on the MarineTraffic data viewer, reveals abundant passenger vessel AIS tracks in routes between Dublin/Dun Laoghaire and Holyhead/Liverpool, and from Rosslare to South Wales and Southern England/continental Europe. High fishing vessel activity is seen near the border with Northern Ireland, offshore Drogheda and Dundalk.

Lower cargo vessel AIS transmission densities are observed along the north and west coasts, with some moderately busy routes seen along the coastline and in transit routes to fishing grounds offshore Galway and the south-west coast. Examination of the vessel types reveals fishing vessels as the highest contributor to the AIS transmission location densities in the region, with only minor cargo vessel densities in compact routes along the coastline. The south coast has greater overall cargo vessel densities, but lower than off the east coast. Higher vessel concentrations are generally seen near the coastline. Cargo vessel routes are the main contributor to coastal shipping activity, with moderate fishing vessel activity seen throughout the majority of the Irish Celtic Sea. While the west coast of Ireland experiences lower vessel traffic, influenced by its distance from major shipping routes and the presence of protected natural areas, it remains essential for trade and fishing activities.

FIGURE 3.22 IRELAND COMMERCIAL SHIPPING ACTIVITY (FIGURE PREPARED BY ERM)



3.4.3.2 FISHING

Commercial fishing is a key marine industry in Ireland, with Irish vessels landing 267,200 tonnes, worth nearly €450 million, into Irish ports in 2022. According to estimates by the Marine Institute, approximately 500 fishing vessels are typically active within the Irish EEZ each day and a large proportion of the seabed is trawled at least once per year. In terms of fishing ports Killybegs, on the northwestern coast, is the largest in terms of weight landed, with 187,012 tonnes (valued at €136 million) in 2022. This is followed by Castletownbere (27,323 tonnes, €107 million) and Dingle (7,062 tonnes, €22 million) which are both located in southwestern Ireland.

It is noted that between 2014 and 2018, 55% of fishing effort within the Irish EEZ was carried out by foreign vessels, though their activity was primarily focused in the western areas further offshore. Most of the fishing efforts closer to the Irish coastline were provided by Irish vessels. In the same time period, demersal otter trawls contributed 57% of the fishing period within the Irish EEZ with main fishing areas located to the south and west of the Irish EEZ, as well as in a localized area to the northeast of Dublin.

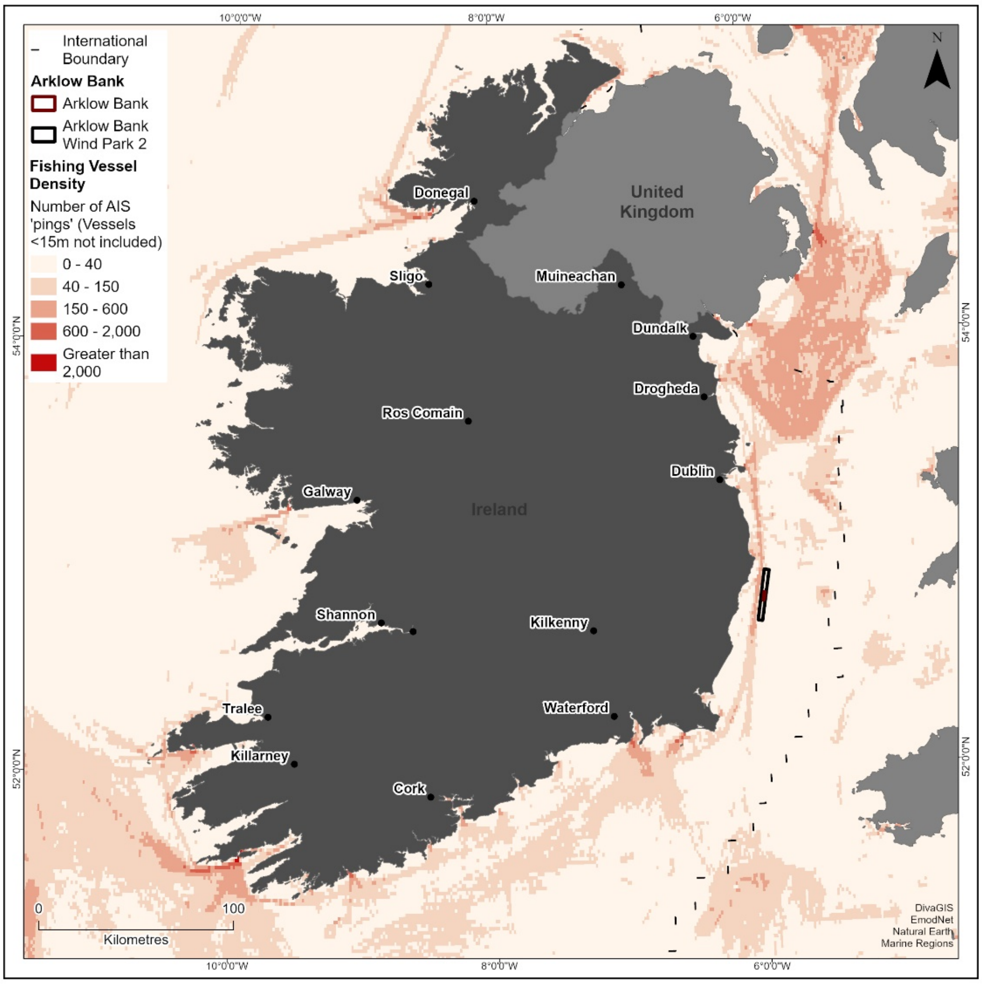
Marine recreational fishing is also a popular activity in Ireland, with over 150,000 people estimated to participate each year.

A number of aquaculture sites exist in addition to traditional fishing grounds. The aquaculture licence areas are covered in more detail below in Section 3.5.1.3.

It is common for fishing and wind farm development to co-exist, but it can be costly to develop in designated fishing areas and negotiations with fishing stakeholders can be lengthy.

Considering this and the data shown in Figure 3.23, the south coast is expected to have the greatest impacts of fishing on OSW development, due to the extensive presence of fishing grounds. These are seen as moderate-high fishing vessel densities in the figure. The north and west coasts are seen as presenting moderate overall risks to development, as is the case for the east coast. A large fishing ground is seen off the east coast along the border with Northern Ireland which is best avoided. However, it must be considered that small fishing vessels <15 m are generally not included in the AIS data and should be expected to a degree in all regions, particularly nearer the shoreline.

FIGURE 3.23 IRELAND FISHING ACTIVITY (FIGURE PREPARED BY ERM)



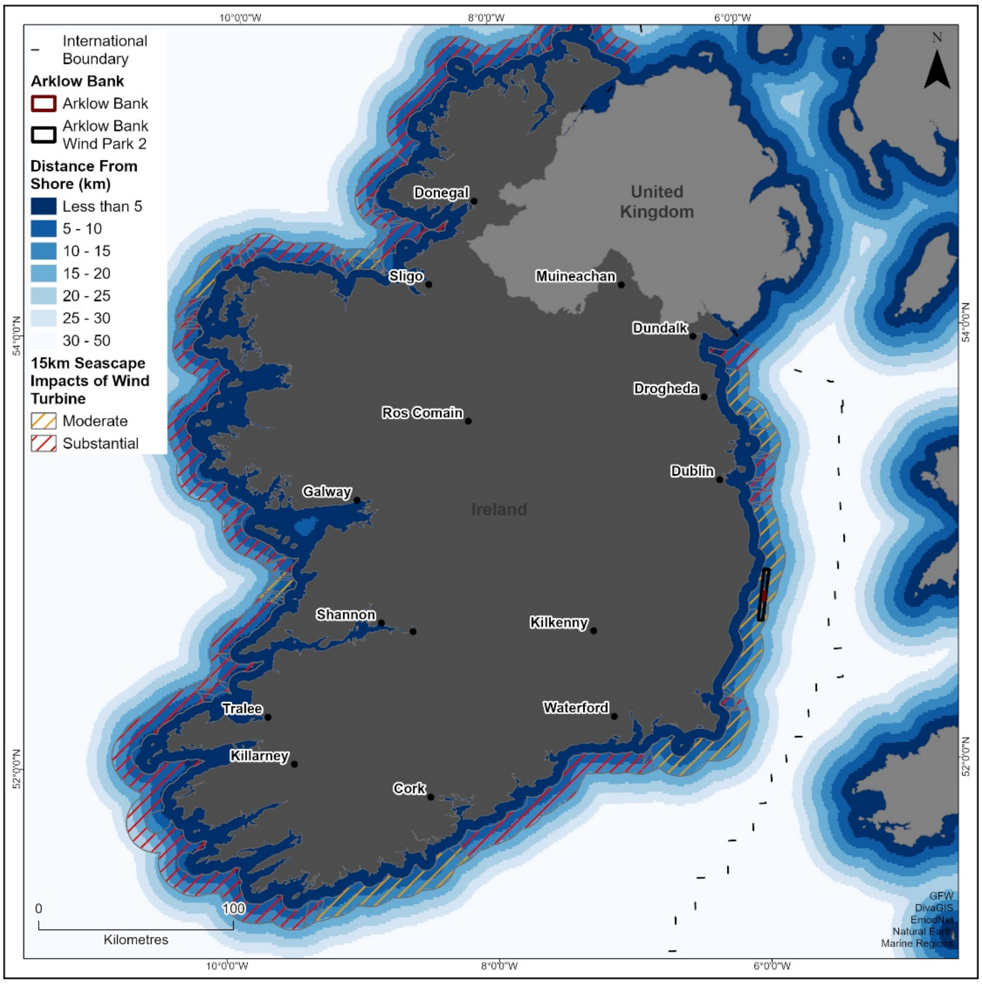
3.4.3.3 VISUAL & SEASCAPE

The west coast of Ireland is characterised by large limestone bays with low-lying hinterland and coastal wetlands, small bays and islands, estuaries, cliffs, peninsulas, coves, scenic beaches, and national parks. Water sports, surfing, and ferries for tourists are prominent around the west coast. These features will cause a major constraint for offshore wind development on the west coast and are reflected in the extensive areas mapped as having substantial seascape impacts as per the Ireland Marine Atlas.

The east coast has fewer seascape attractions but still has lots of scenic beaches, bays, estuaries, cliffs, and peninsulas, particularly near Dublin and Wexford. Tourism is of particular importance here, with numerous scenic walks and attractions in the region. Seascape impacts are more mixed across this region.

Consultations with local businesses and the public will be required for offshore wind development on the east coast. The visual impact can be mitigated with fewer or smaller turbines, or changing the turbine arrangement. There is one offshore wind farm on the east coast of Ireland which has been operational since 2004 and is visible from shore. This project is well perceived by the public. However, the visual impact will be greater with offshore wind projects in close proximity to each other. Several other offshore wind farms have been proposed close to shore on the east coast so early engagement with the public is necessary.

FIGURE 3.24 IRELAND VISUAL & SEASCAPE (FIGURE PREPARED BY ERM)



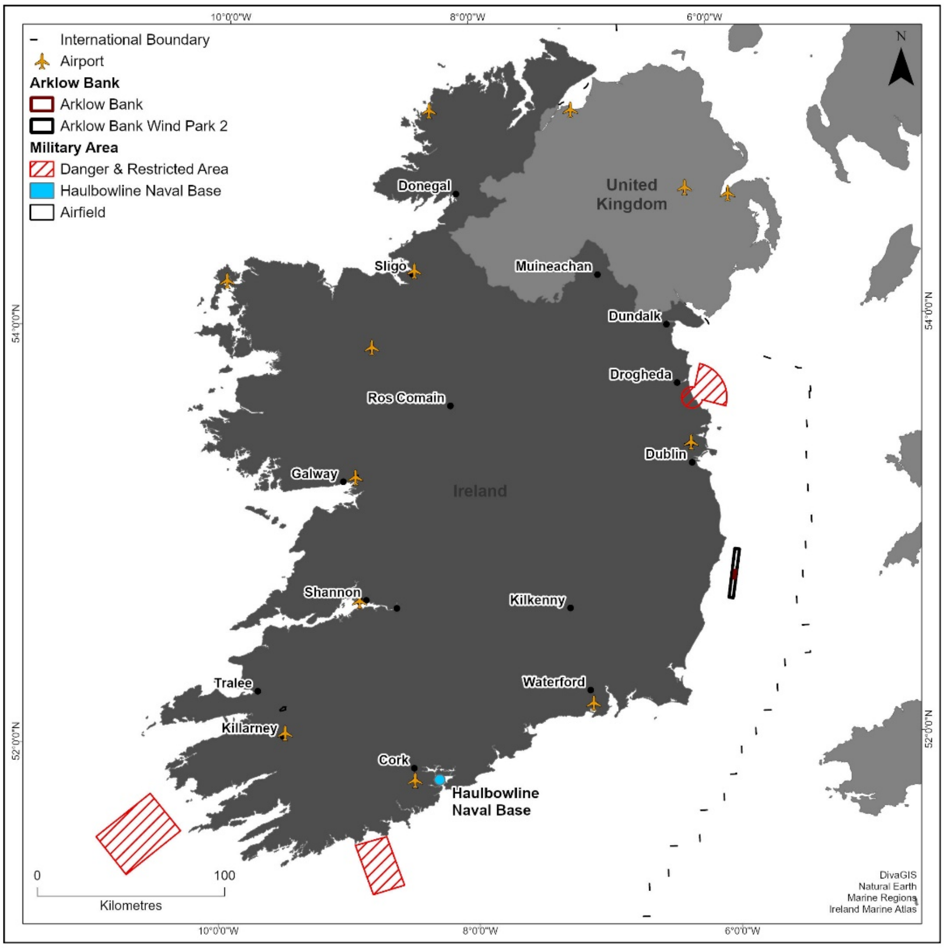
3.4.3.4 MILITARY & AVIATION

Figure 3.25 below shows key military and aviation areas in Ireland, which includes restricted areas, naval bases and airports. The Prohibited and Danger Areas have been designated by the Irish Aviation Authority (IAA) which is a commercial, semi-state company. The majority of such areas are above land but "EID1 Gormanston", "EID13 Sea/Coastal Area SSW of Cork" and "EID14 Sea Areas SW of Kerry" cover offshore regions. All three offshore sites are designated as Danger Areas due to the presence of a military firing range. Further, Ireland's Naval Service is headquartered on Haulbowline Island in Cork Harbour, off the southern coast. It is expected that any planned offshore wind projects in the vicinity of these areas will require extensive consultation with the IAA and the Department of Defence.

In 2022, the number of passengers handled by all Irish airports exceeded over 32.5 million, of which 99.9% were through the five main airports of Dublin, Cork, Shannon, Knock and Kerry. Over the same period, 236,346 flights arrived or departed from these five airports, of which 84% flew into or out of Dublin Airport. As seen in the map in Figure 3.25, there are eight airports in Ireland in close proximity to the shoreline: Dublin, Waterford, Cork, Shannon, Carnmore, Belmullet, Sligo and Donegal. The offshore wind development in the vicinity of these airfields would likely require consultation with the relevant airport authorities to understand the risk of potential interference of installed turbines with radar systems.

These military and aviation factors are not considered a hard constraint to development, however interference with airport and military radar can prove problematic to development and costly should mitigation be required to reduce potential impacts.

FIGURE 3.25 IRELAND MILITARY & AVIATION AREAS (FIGURE PREPARED BY ERM)



3.5 LAND USAGE

3.5.1 OFFSHORE LEASES

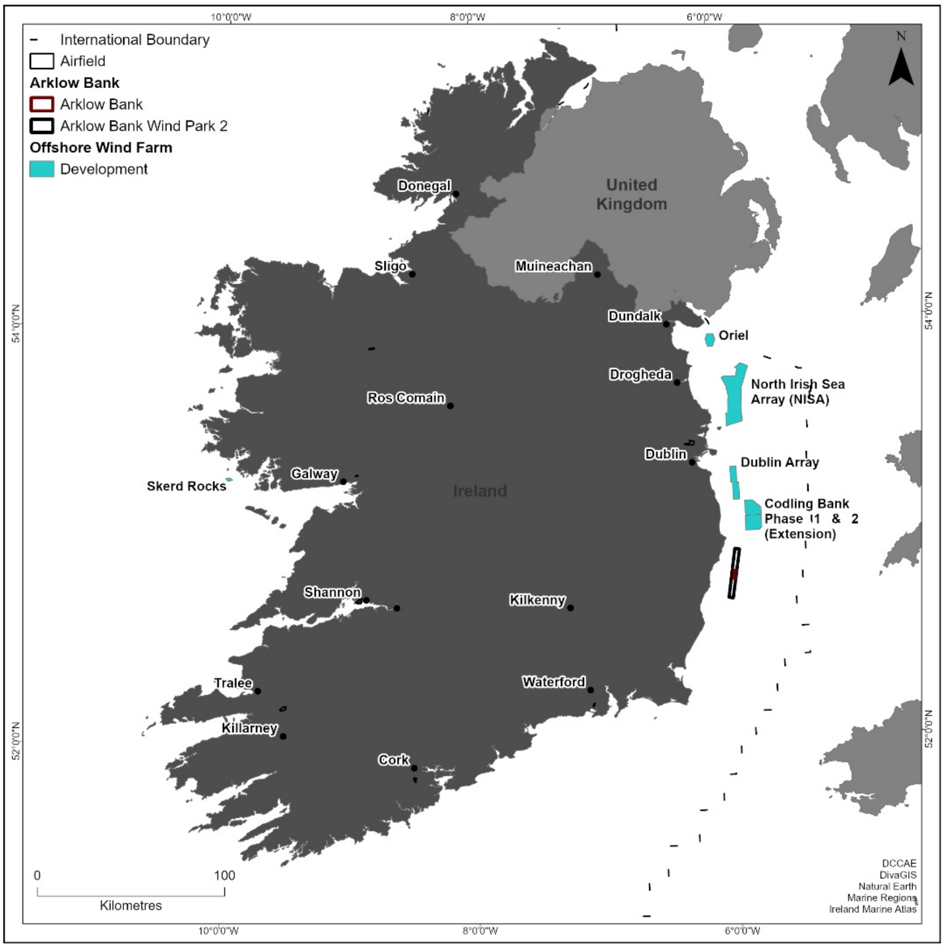
3.5.1.1 ORE INSTALLATIONS

The map in Figure 3.26 below indicates the locations of the announced Phase One offshore wind projects off the coast of Ireland including ABWP2, alongside Ireland's only operational offshore project, the 25 MW Arklow Bank.

In 2021, the Irish government published the MAP Act which superseded the Foreshore Acts and outlined a new maritime planning system for Ireland's EEZ which includes a State consent for offshore wind known as a MAC, which allows occupation of specified areas of the maritime area. Under special transition provisions under the MAP Act, ABWP2 was awarded a MAC by the Minister of Environment, Climate and Communications alongside five other Phase One projects. Five of these projects are located off the eastern coast, between the Northern Ireland border and Arklow, whilst one project is located off County Galway on the western coast. Of these Phase One projects, four projects totalling 3.1 GW secured a route to market in Ireland's first competitive offshore wind auction, the ORESS 1.

Beyond Phase One projects, Ireland is moving towards a plan-led approach to offshore wind energy development through the designation of sub national forward marine plans called Designated Maritime Area Plans (DMAPs). The first ORE DMAP is the South Coast DMAP Proposal, setting out a broad geographical area for future offshore wind energy development to take place within. This proposed area will be refined through environmental assessment and consultation (including statutory public consultation) and an initial offshore wind site of 900MW aligned to available grid capacity will be defined within the area and auctioned through the next ORESS, ORESS 2.1. All future offshore wind energy development will be plan led and take place in DMAPs.

FIGURE 3.26 IRELAND ORE INSTALLATIONS (FIGURE PREPARED BY ERM)

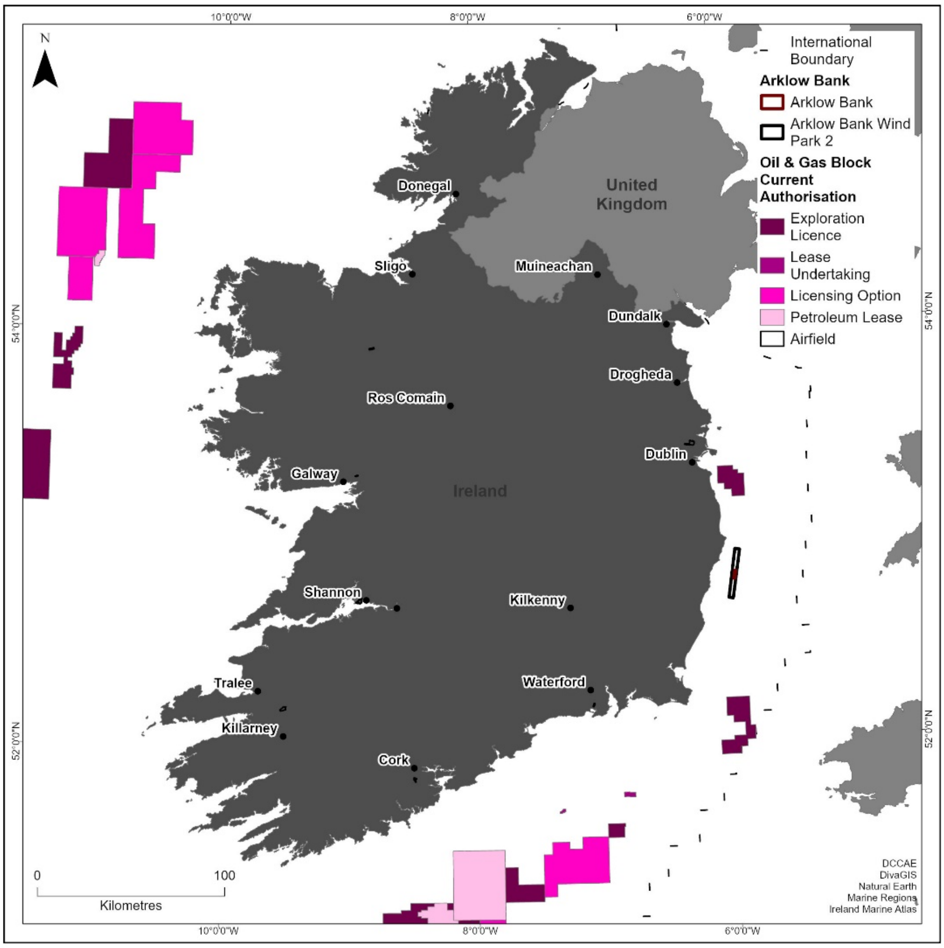


3.5.1.2 OIL & GAS LICENCES

All oil & gas (O&G) leases in Ireland must be authorised by the Minister for the Environment, Climate and Communications under the Petroleum and Other Minerals Development Act of 1960. As per the 30th June 2023 Acreage Report from the Department of the Environment, Climate and Communications (DECC), there are currently two active petroleum leases, four lease undertakings, eight petroleum exploration licences and two licensing options. Further, there are some expired licences, such as the Seven Heads Petroleum Lease, which is to undergo decommissioning operations. A majority of these O&G licences are for sites off the southern or western coast of Ireland, as seen in Figure 3.27. The Irish government committed to end the issuing of new licences for the exploration and extraction of both oil and gas, which was given statutory effect through the Climate Action and Low Carbon Development (Amendment) Act 2021.

In terms of offshore wind development, overlap with the active petroleum leases are considered a hard constraint and should be avoided, whilst careful consultation with licence holders would be expected to be required for exploration licence areas.

FIGURE 3.27 IRELAND OIL & GAS LICENCES (FIGURE PREPARED BY ERM)



3.5.1.3 OTHER OFFSHORE USERS

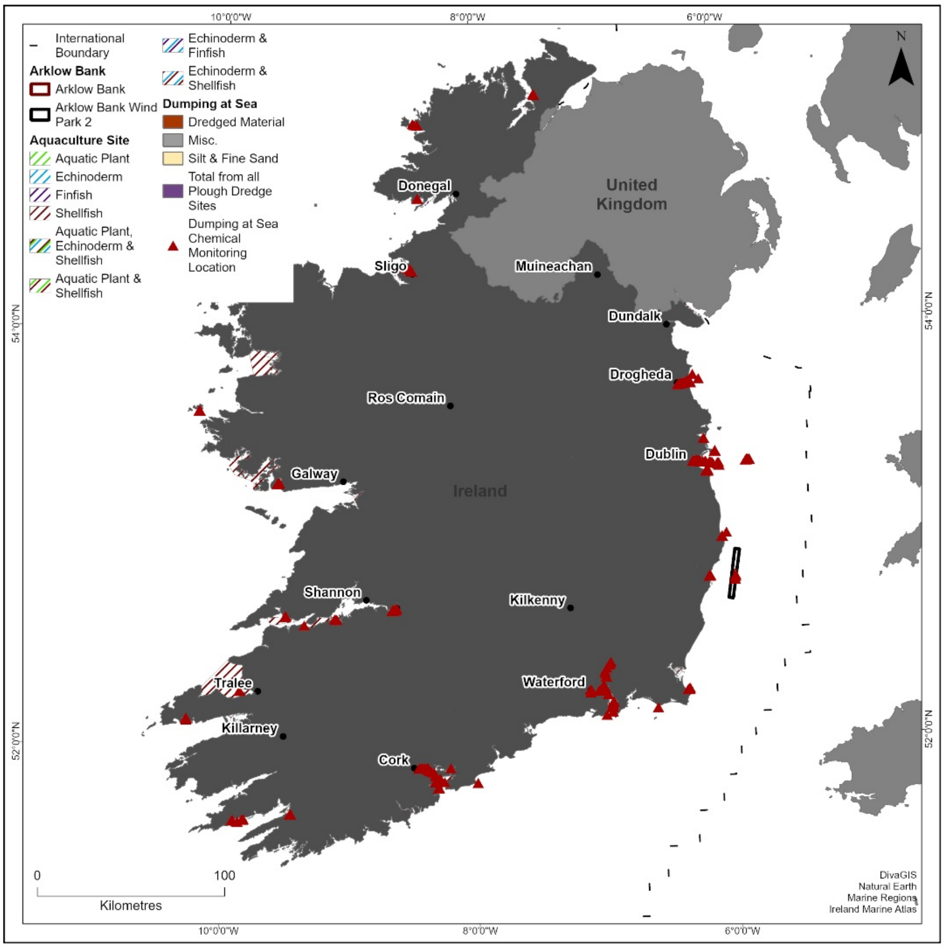
Aquaculture licences allow the holder to conduct aquaculture activities in a specified area and are administered by the Department of Agriculture, Food and the Marine (DAFM). Though all aquaculture activity in Ireland requires an agriculture licence, it is important to note that it does not represent a lease for a sea area. The main types of licences include: marine finfish, shellfish, aquatic plants / seaweeds, land-based. As seen in Figure 3.28 below, these aquaculture licence areas are nearly entirely within internal waters, such as the European Flat Oyster aquaculture sites in Brandon Bay and the Pacific Oyster site in Clew Bay.

Additionally, data shows the presence of several designated dumping grounds surrounding Ireland, in particular off the east coast. Data reveals areas designated for the dumping of dredged material, silt & fine sand, fish waste & shells, rock & mineral waste, sewage & chemical sludge, chemical manufacture waste and other materials. Of these classifications, sewage and chemical waste present the greatest constraint as they would provide the most high-risk conditions to onsite workers and the local environment. Several of these areas are seen in the northeastern EEZ, near the border with Northern Ireland, with clusters offshore Dundalk, Drogheda and Dublin. A particularly large sewage & chemical sludge dumping ground is seen around 20 km offshore to the south of Dublin, and a large chemical manufacture waste site is seen around 12 km off the coast near Cork. Both of these dumping sites are expected to be inactive, with their permits ending in 1992 and 1989 respectively, although the possibility of hazardous waste in and around them should still be considered. While there are other dumping grounds dotted around the entire coastline, although more sparsely throughout the south, west and north coasts, they are generally located closer to shore than is conventional for offshore wind farms, making overlap less likely. In all cases, surveys are recommended to identify and mitigate any potential hazards before proceeding with installation works.

Dumping of substances at sea from vessels, aircrafts or offshore installation in Irish waters requires a permit under the 1996 Dumping at Sea Act. The Environmental Protection Agency (EPA), an independent public body, is responsible for the Dumping at Sea (DaS) permit. The type of substances dumped include dredged material, fish waste & shells, chemical manufacture waste, sewage and chemical sludge. Most of the DaS licence areas are located close to shore, within the 12 nautical mile boundary or even within the internal waters. The dumping sites are generally concentrated in the vicinity of industrial areas on the Irish coast such as Cork Harbour, Dublin Bay and Waterford Harbour.

The Irish Marine Aggregate Initiative (IMAGIN) ran from 2005 to 2008 to develop a strategic framework for the extraction of marine aggregates (primarily sand and gravel) from areas in the southern Irish Sea. The study focused on geological and environmental assessments of four areas off the eastern coast of Ireland, between 20 and 60 metres in depth, as well as one site off the northern coast of Wales. The initiative was 66% funded under the Ireland/Wales Inter Regional (INTERREG) IIIA Community Initiative Programme 2000-2006, with the remainder being contributed by partner organizations and aggregate companies. The current status of these areas, or the existence of marine aggregate lease areas within Irish waters, is not clear.

FIGURE 3.28 IRELAND OTHER OFFSHORE USERS (FIGURE PREPARED BY ERM)



3.5.2 EASEMENTS/CROSSINGS

3.5.2.1 CABLES & PIPELINES

There have been a number of subsea cables and pipelines identified in Irish waters. These pipelines and cables are predominantly located on the east coast of Ireland and connected to Great Britain via the Irish Sea. Many of these subsea cables land in the vicinity of Dublin, including the Sirius South system owned by Virgin Media Business and the ESAT-2 system owned by BT Ireland. Some submarine cables also land on the western coast and connect to a wide variety of locations such as New York state, United States (AEC-1 owned by Aqua Comms), Iceland (IRIS owned by Farice) and Norway (Celtic Norse, still under development and owned by Eidsiva Energi, NTE and TrønderEnergi). The Greenlink interconnector, currently under construction and expected to be commissioned in late 2024, will have landfall at Baginbun Beach, located along the coast between Waterford and Wexford, and connects into the grid in Freshwater West, South Wales. The Celtic Interconnector, which started construction in November 2023 and is expected to be commissioned in 2026, will have landfall at Claycastle Beach, located near the border of County Waterford and County Cork, and connects into the French grid in Kerradenec.

In terms of subsea pipelines, there are interconnectors which connect the gas supply hub in western Scotland to the eastern coast of Ireland, landing at Gormanston and Loughshinny to the north of Dublin. The pipeline seen off the western coast of Ireland connects to the offshore

Corrib Gas Field. Further, there are pipelines running offshore from Cork towards the Kinsale and Seven Heads Gas Fields but both have now been decommissioned. These pipelines are operated by Gas Networks Ireland.

These subsea cables and pipelines are generally not considered a hard constraint for offshore wind development. Cable/pipeline crossing and proximity agreements are common practice in offshore industries and any interaction risks with in-service or out of service cables/pipelines should easily be managed and mitigated by a competent contractor.

3.6 INTERCONNECTION

The Irish transmission network is comprised of 110 kV, 220 kV and 400 kV infrastructure. Ireland's greatest source of renewable energy is wind, and the strongest and most reliable source of inland wind power is in the west of Ireland. However, most of Ireland's electricity is used on the east coast.

The grid is facing congestion challenges due to an aging infrastructure and a combination of more renewables and electrification. The increased demand from electrification and added data centre loads have accelerated over several years and electricity consumption is expected to increase by 37 percent from 2022 to 2031. It has been difficult to attract investments in new thermal production capacity despite high energy prices in recent times which would usually attract investments. Consequently, Ireland and the TSO EirGrid are focusing on renewables and building more green infrastructure to ensure that Ireland has an adequate electricity system to accommodate for massive grid connection of renewables in the years to come.

The Ireland and Northern Ireland power system is a synchronous system with limited HVDC interconnection to Great Britain. The number of interconnectors will increase before 2030 and are expected to improve grid stability and reduce future threat of congestion. The planned interconnectors are:

- The 2nd North-South Interconnector, a HVAC interconnection between Ireland and Northern Ireland
- Celtic Interconnector, a HVDC interconnection between Ireland at Knockraha station and the northern transmission network of France
- Greenlink, a HVDC interconnection between Ireland at Great Island station and a transmission station in western Wales.

The main challenge for the transmission system is the data centre concentration in the Dublin region. Energy consumption by Irish data centres increased by 31% in 2022, with data centre usage now accounting for 18% of the total energy consumed in Ireland. EirGrid has confirmed that it will not connect new data centres in Dublin for 'the foreseeable future' and possibly until 2028. Alternative locations for new data centres are promoted in the Midlands close to transmission lines but outside the current energy consumption centres and closer to the renewable energy hubs.

The development of the transmission network is characterised by the displacement of thermal generation for wind generation in the Dublin region, resulting in increased power-transfer capacity to enable supply from onshore renewables from the West and South-West, and from the planned offshore wind farms in the Irish Sea. The installation of offshore wind in the Irish Sea will reduce the need for large transfers of power into the Dublin region from the West.

The technical report "Shaping Our Electricity Future Roadmap" made available by EirGrid (Ireland TSO) and SONI (Northern Ireland TSO) developed and evaluated four strategic network approaches to reflect alternative ways of achieving the Renewable Ambition in both Ireland and North Ireland. The approaches are designed to evaluate the consequences and factors to be considered when developing the grid according to a particular theme that is as much a reflection of the technology available as the broader stakeholder environment. The strategic approaches are:

- Generation-Led

- Developer-Led
- Technology-Led
- Demand-Led

Detailed network planning studies have been undertaken for each of these approaches to formally work out what potential projects would be needed. All four approaches recommend reinforcement of the East coast 220 kV line minimising the risk of congestions related to bottlenecks in the transmission grid between the ABWP2 project's grid connection point and the Dublin region consumption centre.

The area of the south coast has been identified as suitable for large wind power developments with onshore connection points available near potential offshore development locations. However, from a transmission grid perspective, the ABWP2 project and the other projects in the Irish Sea have an optimal location close to the Dublin region load centre resulting in limited cost for grid reinforcements compared to the planned renewable energy hubs on the south coast.

The ABWP2 project will be connected to the East coast 220 kV line. According to the "Shaping Our Electricity Future Roadmap" the line is rated as having a marginal risk of overloading (circuit loaded up to 101% thermal rating for 1% of the year). The transmission network configuration used in the analysis is based on the network as it is today, but with approved reinforcements from the EirGrid Transmission Development Plan included. With the ABWP2 project included in the EirGrid Transmission Development Plan, the connection point is expected to have the needed capacity after the planned grid reinforcements.

In terms of Ireland as a whole, the transmission network analysis carried out in EirGrid's study concludes the (current) transmission system has insufficient capacity to facilitate the integration of the volume of renewables outlined in the increased Renewables Ambition. Figure 3.30 shows the grid overloading risks, with light yellow lines having a marginal risk, red lines a heavy risk and brown lines an extreme risk. Overall, ERM expects OSW development along the east and south-east coasts to be more cost effective from the point of view of necessary grid reinforcements, minimising the need to transfer power to demand centres from the west coast as is done at present. Developments along the south-west coast will be well placed to meet the demand in and around Cork but will likely also necessitate long distance transmission to the east/north-east. Large-scale OSW development along the west coast is expected to be severely constrained by local offtake opportunities and available grid capacity for transferring power across the country. Multiple power plants already make use of the west-east 400 kV transmission lines. Figure 3.29 shows the north coast's transmission is almost entirely 38 kV, making major upgrades required for any OSW farms developed in the region.

FIGURE 3.29 IRELAND TRANSMISSION GRID (FIGURE PREPARED BY ERM)

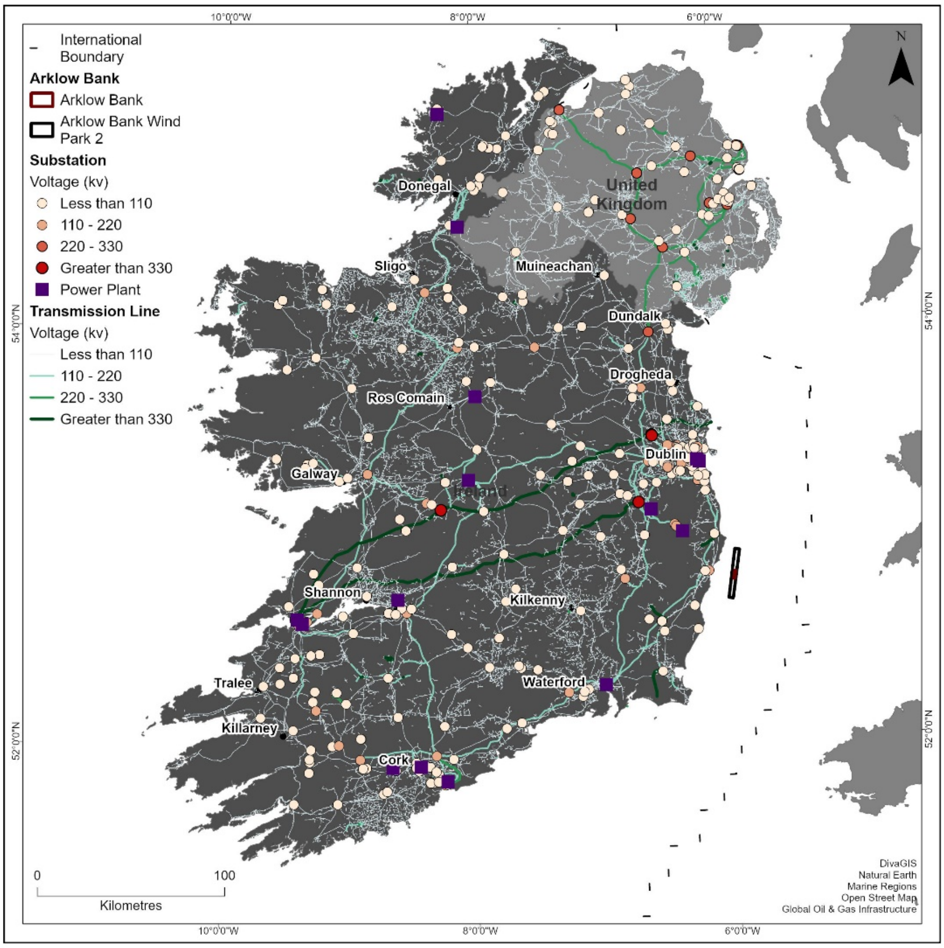
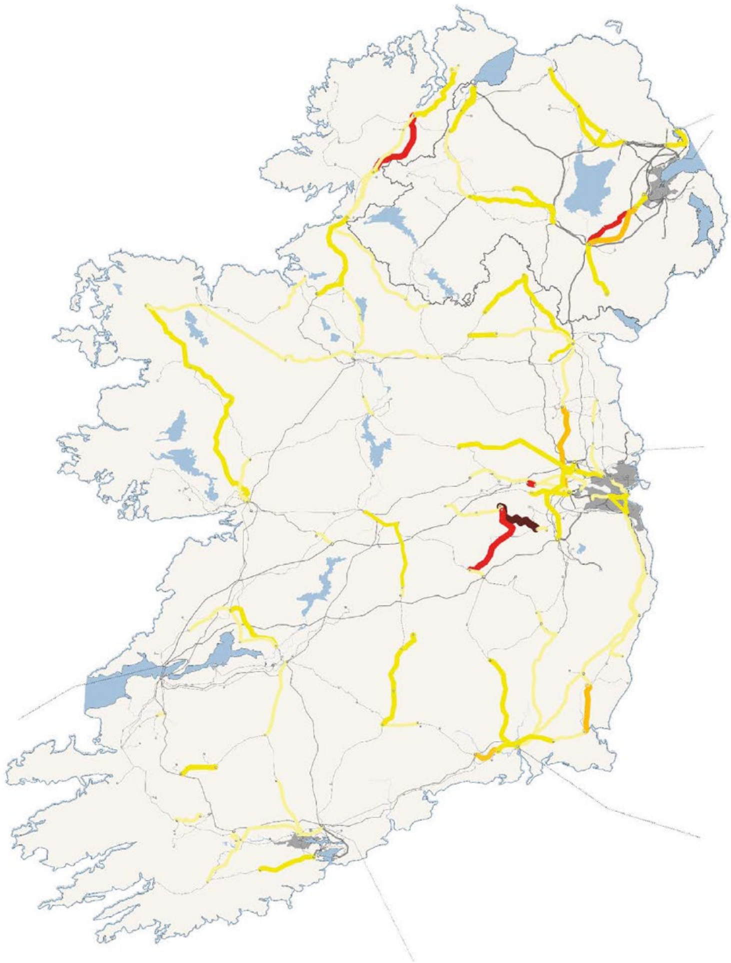


FIGURE 3.30 TRANSMISSION SYSTEM OVERLOADING RISKS (SOURCE: EIRGRID, SONI, 2023)



3.7 HARD CONSTRAINTS HEAT MAP

ERM has developed a hard constraints heat map in GIS to identify potentially suitable areas for offshore wind sites in the seas around Ireland (Figure 3.31). The hard constraints are coded black and include:

- Water depths of 10-2,000 m: 10 m depths are considered a minimum access requirement for large OSW vessels, while floating foundation OSW is considered feasible up to depths of 2,000 m at this stage. See further details in section 3.2.1.1.
- Areas of rock & boulders on the seabed. See further details in section 3.2.1.3.
- Mean wave heights of 2.5 m and above. See further details in section 3.2.2.1.
- Environmentally designated areas: SPAs/SACs. See further details in section 3.4.2.1.
- High-traffic shipping lanes. See further details in section 3.4.3.1.
- Military areas. See further details in section 3.4.3.4.

The remaining colours (green to red) indicate wind speeds. The entire EEZ can effectively be considered well suited to OSW on the basis of wind resource.

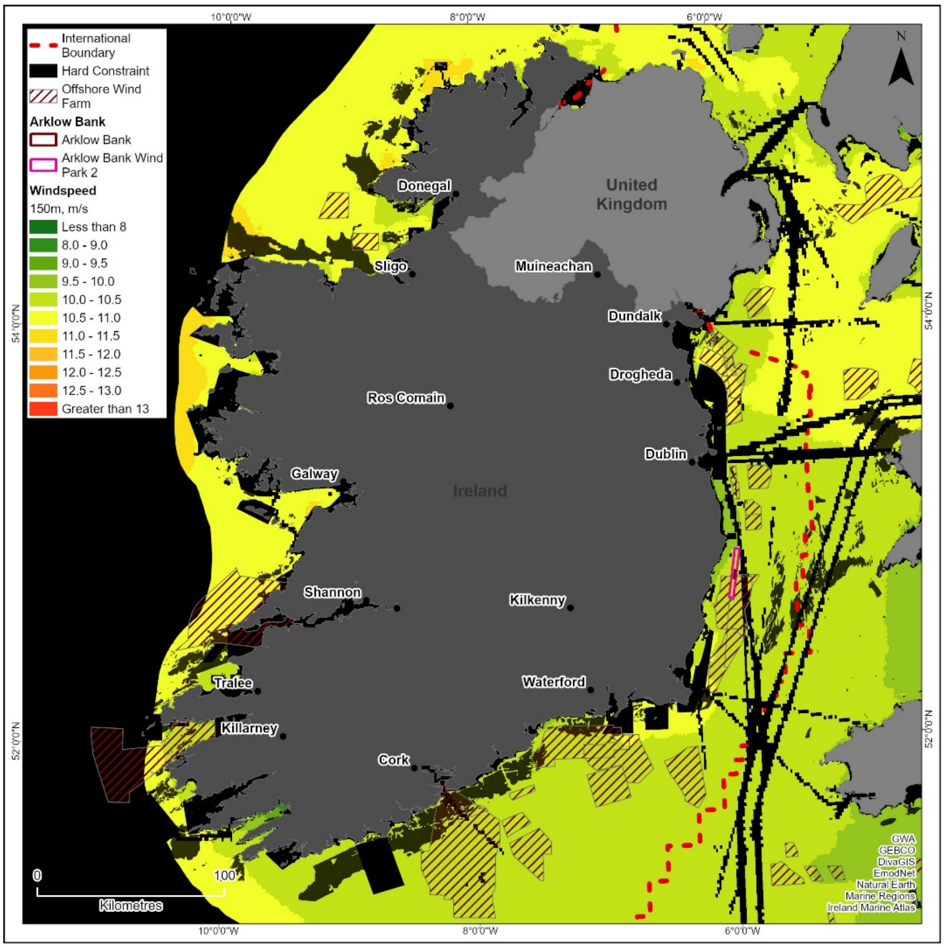
Overall, the west coast shows vast areas with no technical potential due to the extreme mean wave heights seen relatively near the shoreline. The largest areas along the coast are located off the central coast, in and around Galway Bay with some areas of technical potential to the north and south of the bay, and off the north-west coast from the north coast of Mayo to the border with Northern Ireland. A significant area of technical potential is also seen in and around Donegal Bay.

The technical potential off the south coast is limited from the west also by the mean wave heights hard constraint, which quickly exceed 2.5 m when moving offshore. The majority of the southern coastline’s seabed is covered by rocks & boulders, which further restrict the technical potential area (see Figure 3.4 in section 3.2.1.3).

In contrast, the east coast is relatively unconstrained. The largest blacked out area is owed to a large military danger area offshore Drogheda which lies adjacent to the Rockabill to Dalkey Island SAC, located off the coast of Dublin and slightly to the north. Most other blacked out areas are owed to environmentally designated areas, although they are all smaller in size. While there are several shipping routes throughout the Irish Sea, these occupy relatively little area within the Irish EEZ. There are multiple OSW farms in development throughout the region, constraining availability of new sites to interested developers, although this is not a constraint to the ABWP2 site.

It should be noted that within the areas of technical potential, some regions are more suited to OSW development than others. While there are areas which see mean wave heights below the cutoff along the north, west and south coasts, much of the technical potential area in these regions see wave heights only slightly below this value, which will still pose challenges during project development due to reduced weather windows and more extreme working conditions. More extreme metocean conditions are generally seen off the west coast, such as extreme wind speeds, more frequent storms and greater tidal ranges. Additionally, proximity to suitable OSW ports is much more limited along the west coast in particular, in contrast to the inclusion of OSW facilities in port development plans at Cork, Rosslare and the upcoming Bremore port. Shannon Estuary presents the best support opportunity for floating OSW in particular along the west coast.

FIGURE 3.31 IRELAND HARD CONSTRAINTS HEAT MAP (FIGURE PREPARED BY ERM)



4. ARKLOW BANK WIND PARK 2 CONSTRAINTS

4.1 RESOURCE

4.1.1 WIND SPEED, DIRECTION & SEASONALITY

Referring to GWA data, which represents the ten-year period from 2008 to the end of 2017, Arklow Bank lies near the region of lower wind speeds mentioned in section 3.1.1. However, the wind speeds within the site are still favourable for offshore wind, with mean wind speeds at 150 m above MSL in excess of 10 m/s. The site wind rose indicates prevailing wind from the 210° (south-westerly) direction, albeit with a moderate wind frequency from the west to south and a low wind frequency from the north. There is very low wind frequency from the east between the 45° to 165° directions. The monthly wind speed variability distribution (Figure 4.2) shows above average wind speeds during the months of October to February and below average wind speeds during the months of March to September. Wind speed indices of less than 0.9 are seen from June to August and indices of over 1.1 from November to February, with the lowest index of 0.84 in July and the highest of 1.18 in November. When comparing this to Ireland as a whole, the winds within the ABWP2 site boundaries vary less across the seasons, with minimally lower wind speeds which are still very favourable for OSW development.

FIGURE 4.1 ARKLOW BANK ANNUAL AVERAGE WIND SPEEDS (FIGURE PREPARED BY ERM)

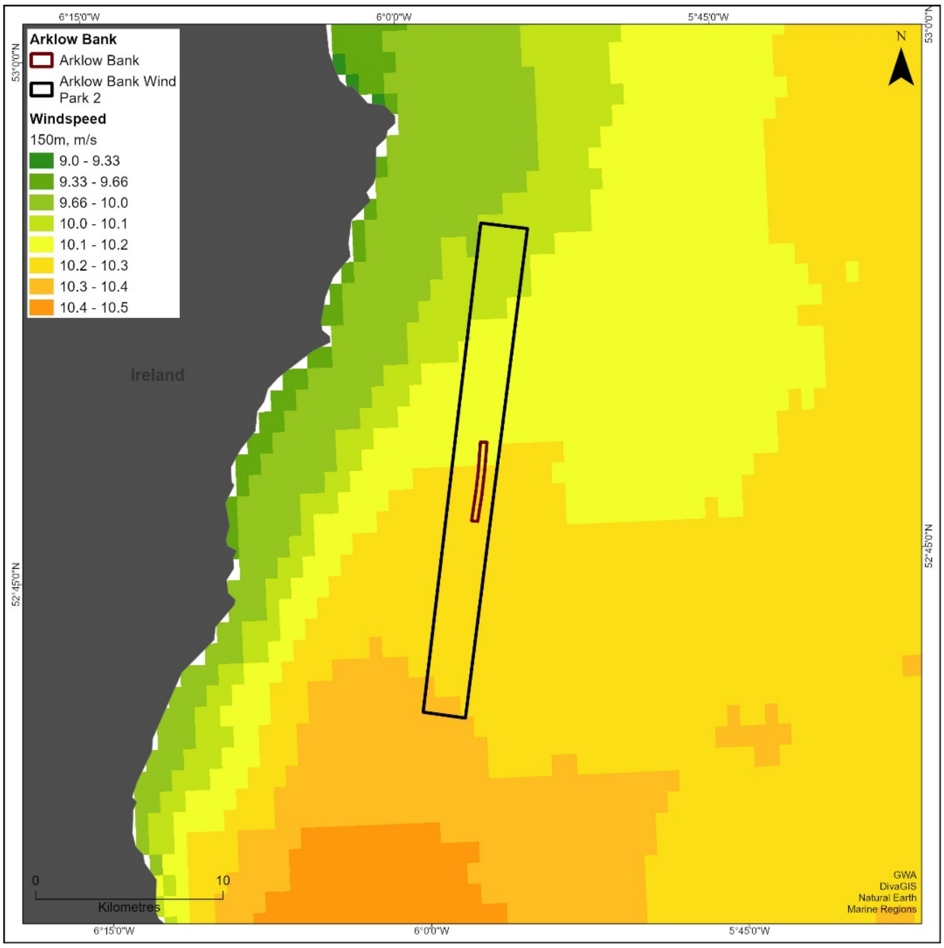
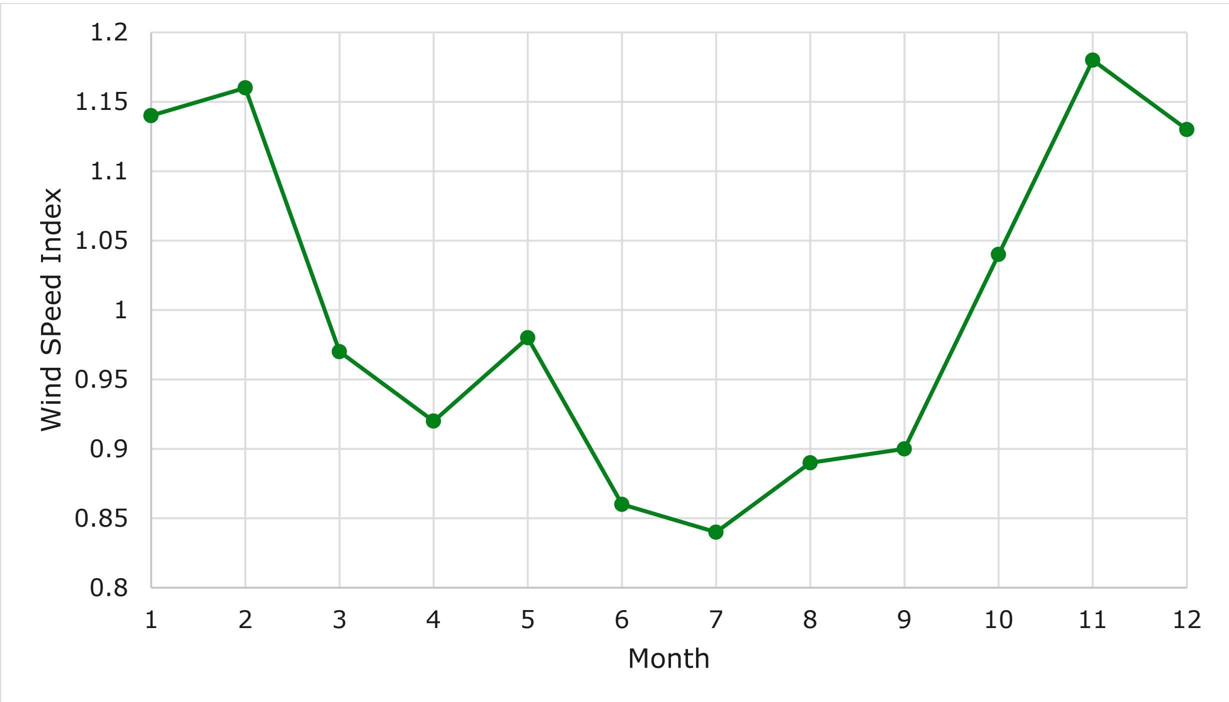


FIGURE 4.2 ARKLOW BANK WIND SPEED INDEX MONTHLY VARIABILITY (SOURCE: GLOBAL WIND ATLAS)



4.1.2 EXTREME WIND EVENTS

As discussed in section 3.1.2, storms have a tendency of arising from Atlantic Ocean, south-west of Ireland. The east coast is more sheltered from these storms, making them slightly less common and extreme along the coastline. This is backed up by GWA V50 data, which shows a 50-year extreme 10-minute average wind speed at 150 m above MSL of 42-49 m/s within the ABWP2 site, while the west coast experiences at least 49-56 m/s as a baseline. Together, the average and extreme wind speeds are at the upper limit of the IEC Class I turbine suitability, however WTGs have been deployed in the North Sea in more severe conditions.

For comparison, much of the North Sea sees similar conditions, with more extreme 50-year highs seen offshore north and west Scotland, along the central west coast of Denmark and near most of the coast of Norway.

4.2 ENGINEERING

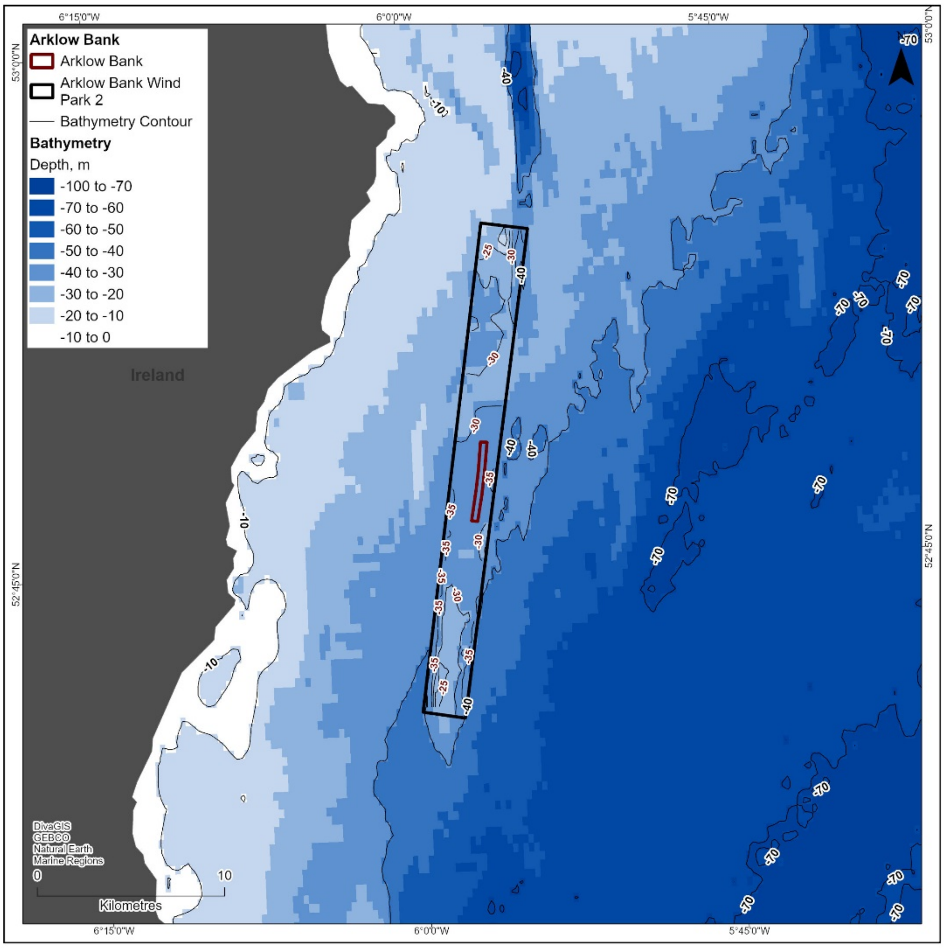
4.2.1 SEABED CONDITIONS

4.2.1.1 BATHYMETRY

ABWP2 is located on a sandbank which has water depths mostly between 25 m and 40 m, suitable for fixed-bottom foundations. High-resolution bathymetric data gathered as part of the INFOMAR programme picks up water depths of between 0 m and 52 m within the ABWP2 boundary, which will impact the wind farm layout and construction methods. The sandbank is orientated in a north-south direction, and water depths range from 0.6 m to 25 m. The varied nature of the seabed will require different types of construction and WTG installation vessels capable in either shallow or deep waters.

The water depth on the southeast of the ABWP2 site rapidly increases to >70 m deep, which ERM considers as approaching the current limit of feasibility for fixed-bottom foundation technologies. This figure is expected to increase in the near future. The seabed west of Arklow Bank varies between 22 and 35 m. At 1 km from shore the water depth is approximately 10 m, increasing to 40 m at 15 km from shore.

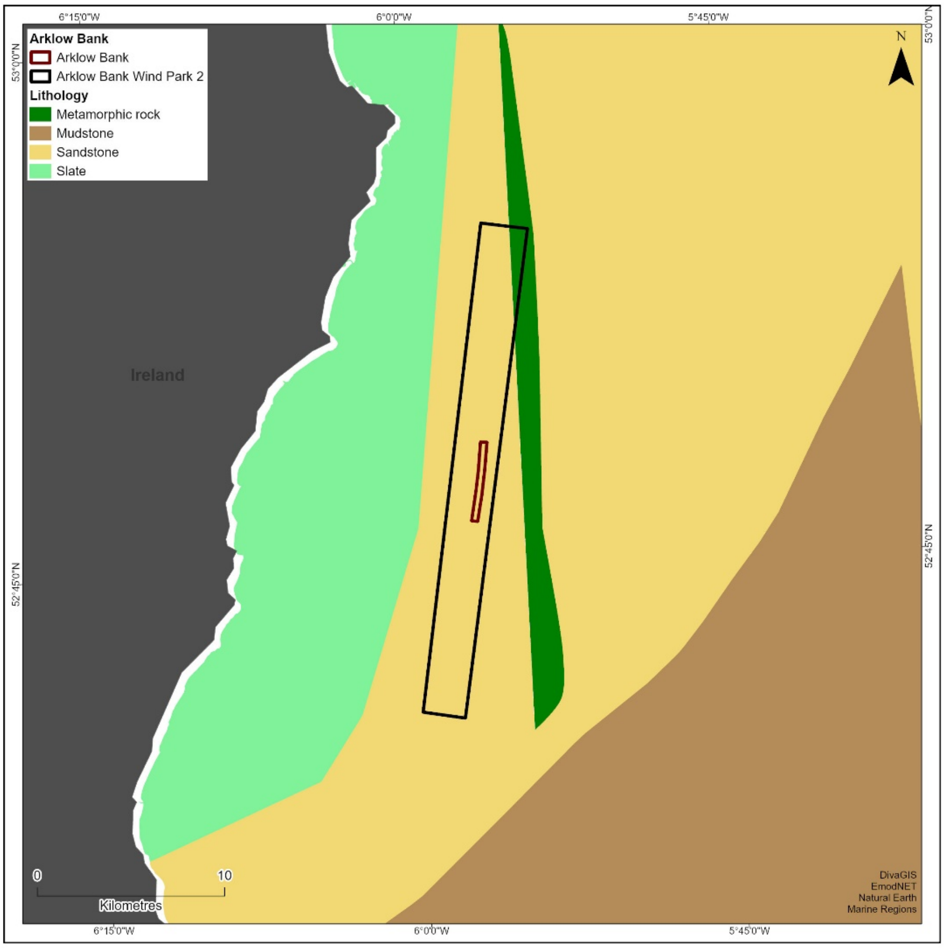
FIGURE 4.3 ARKLOW BANK BATHYMETRY (FIGURE PREPARED BY ERM)



4.2.1.2 SEABED LITHOLOGY

The lithology within the Arklow Bank Wind Park 2 site is primarily sandstone with some metamorphic rock in the northeast corner. Sandstones are well suited for all fixed-bottom offshore wind foundations. Between Arklow Bank Wind Park 2 and shore, the lithology is primarily slate which will affect cable routes and installation methods. In shallow waters, cables must be protected from anchors and fishing gear, so a range of protection methods have been proposed for the project (see section 4.6.2 for details). For cable burial, sand and clay sea floors are generally relatively easy to trench with increasing difficulty as the soil becomes harder. Slate is a hard and brittle type of rock which makes cable burial challenging. A Cable Burial Risk Assessment (CBRA) and Burial Assessment Summary (BAS) must be performed to investigate the needed burial depth both on-bank and off-bank to provide adequate protection of the cables taking seabed conditions, marine traffic, environmental and other aspects into consideration.

FIGURE 4.4 ARKLOW BANK SEABED LITHOLOGY (FIGURE PREPARED BY ERM)

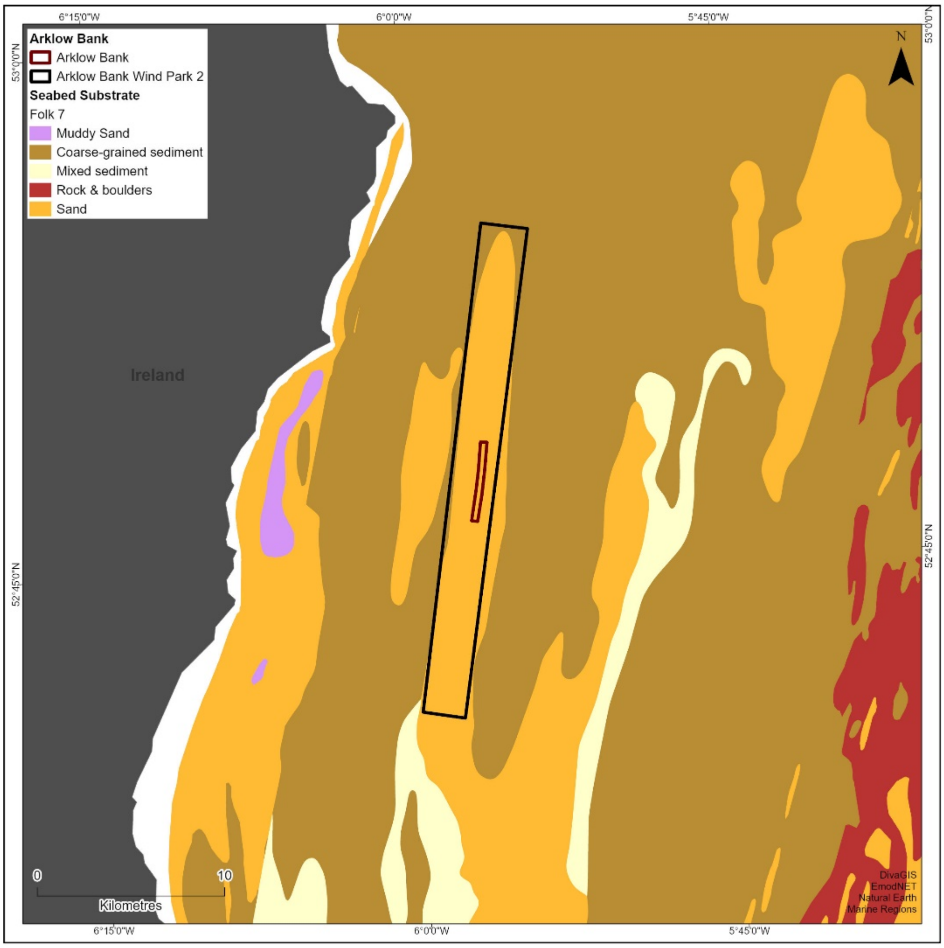


4.2.1.3 SEABED SUBSTRATES

The seabed substrate within the Arklow Bank Wind Park 2 site is primarily coarse-grained sediment with some mixed sediment in the northern corners. Coarse sediment may indicate high-energy wave action and strong tidal currents.

Between Arklow Bank Wind Park 2 and shore, the seabed substrate is primarily mixed sediment and coarse-grained sediment, with some muddy sand near shore. In shallow waters, cables must be protected from anchors and fishing gear and the primary protection method is to bury the cable below the seabed (see section 4.6.2 for details). In general, soft soils are relatively easy to trench with increasing difficulty as the soil becomes harder. A high-energy environment increases seabed mobility which can impact cable burial depths. A Cable Burial Risk Assessment (CBRA) and Burial Assessment Summary (BAS) must be performed to investigate the needed burial depth both on-bank and off-bank to provide adequate protection of the cables taking seabed conditions, marine traffic, environmental and other aspects into consideration.

FIGURE 4.5 ARKLOW BANK SEABED SUBSTRATES (FIGURE PREPARED BY ERM)



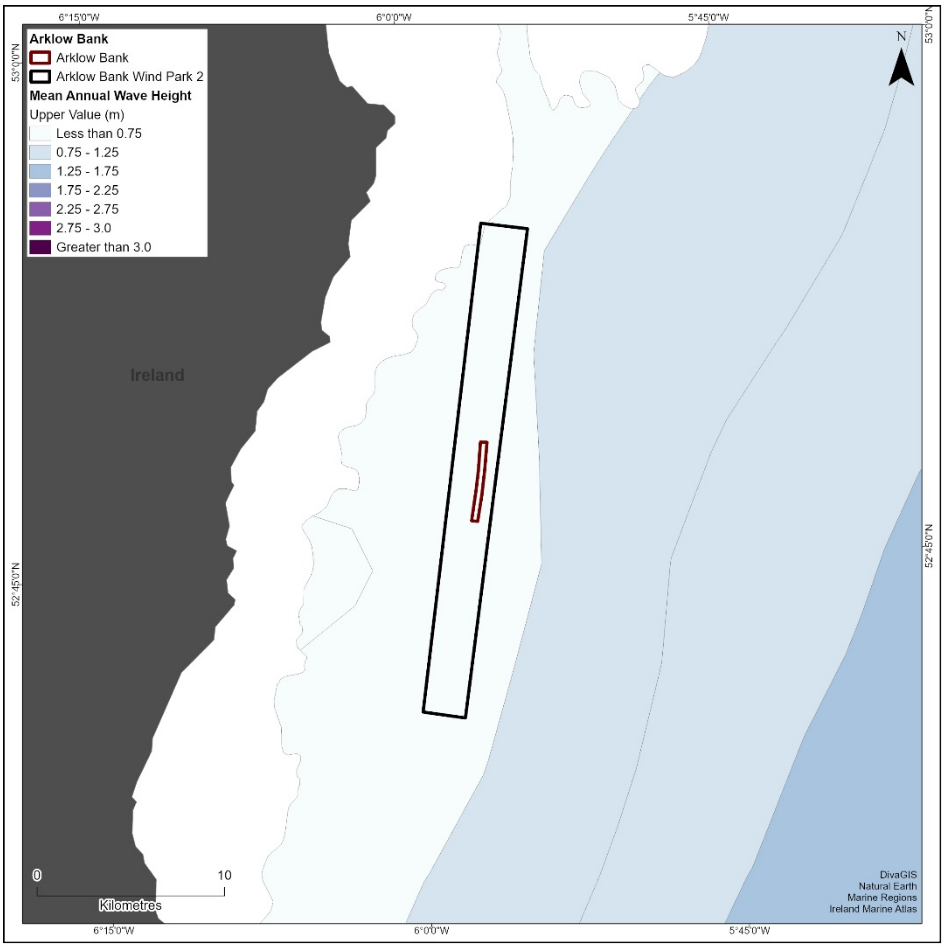
4.2.2 METOCEAN CONDITIONS

4.2.2.1 WAVE HEIGHTS

The entirety of the Arklow Bank Wind Park 2 site lies within the 0.5 – 0.75 m mean wave height range as per the ESBI Pelamis Wave Model data. Mean wave heights of 0.75 – 1 m are seen within as little as 1 km from the north-eastern site boundary and around 3 km from the south-eastern boundary. A small pocket of 0.25 – 0.5 m mean wave heights is present around 4 km from the south-western boundary.

These conditions are relatively calm and should not pose a significant risk to project development. These mean wave heights are lower than those seen offshore almost all of the south, west and north coasts, with comparable conditions only seen in large areas elsewhere in the Irish Sea. The North Sea has higher mean wave heights throughout, including at most operational OSW farms.

FIGURE 4.6 ARKLOW BANK WAVE HEIGHTS (FIGURE PREPARED BY ERM)



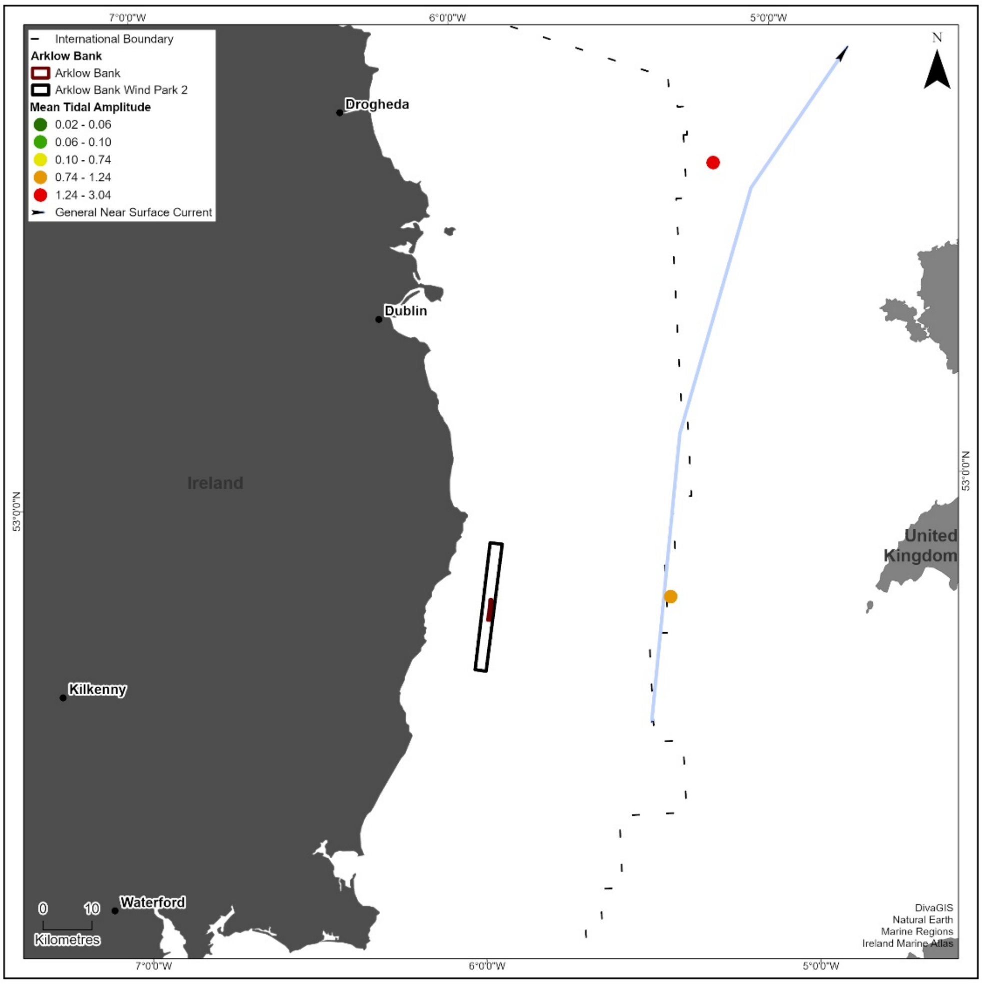
4.2.2.2 CURRENTS, TIDAL RANGES AND EXTREME WAVE HEIGHTS

The data shown in the 2005 report "Wave mapping in UK waters indicates a 100-year significant wave height contour of 11 m in St George's Channel, between the south-east tip of Ireland and south-west Wales, a 10 m contour slightly further north and a 9 m contour in Cardigan Bay. An 8 m contour is seen north of the ABWP2 site offshore Dublin. It should be noted that this data was created as a guide rather than for site specific assessments, however relating it to the location of the site can give an approximate indication of conditions. A conservative approach may assume 9-10 m 100-year significant wave heights within the site, although this is likely to be lower given the site's proximity to shore. Similar conditions are seen off the north-east coast of England, with more extreme wave heights seen off the west coast of Denmark. It is therefore assumed that these wave heights will not pose a major constraint to offshore wind development at the site.

In terms of currents, a single near surface current is present further offshore in the Irish Sea, originating from the Celtic Sea and flowing north towards the Isle of Man. The peak current velocity in proximity to the site can reach as high as 1.5 m/s according to the Geological Survey Ireland (Figure 3.10). This will likely affect seabed mobility at the site which requires consideration in seabed infrastructure designs, e.g., foundations and cable burying. As there are areas of sand within the site, this may have a considerable effect on the engineering design of the ABWP2 substructures.

Tidal ranges are moderate along the coastline near Arklow Bank, with as little as 0-1 m ranges seen along the coast in Figure 3.9. The ABWP2 site lies near the zero tide point in the Irish Sea, making expected impacts from tides very limited at the ABWP2 site.

FIGURE 4.7 ARKLOW BANK CURRENTS, TIDAL RANGES (FIGURE PREPARED BY ERM)

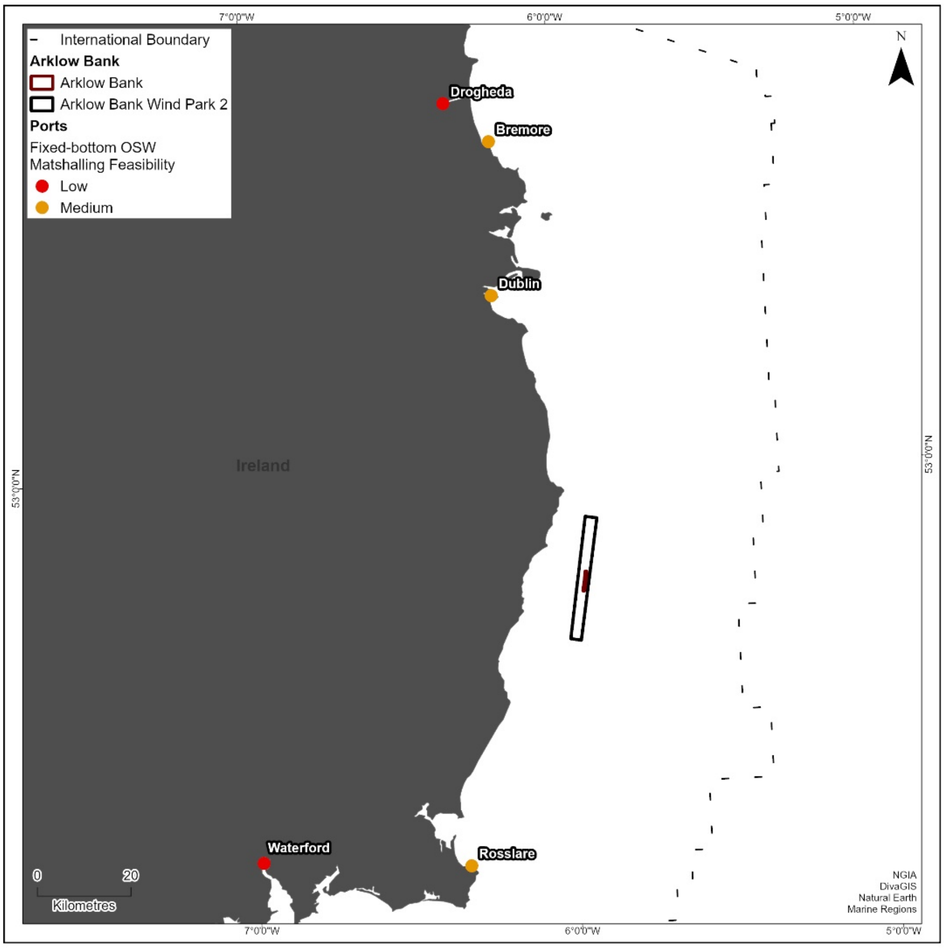


4.3 PORTS

Of the thirteen analysed ports, six appear to be suited to support OSW installation at the ABWP2 site with some port-side mitigations at this stage: the ports of Belfast, Dublin, Ringaskiddy, Cork, Bremore and Rosslare. Note that the Shannon Estuary cluster is excluded from the seven ports given in section 3.3 due to the distance of 300 nm to the ABWP2 site, which would result in a transit time in excess of three days.

As discussed in section 3.3, Bremore appears to be the most suitable port to support fixed-bottom OSW in Ireland and will be located 50 nm from the ABWP2 site once construction is finalised. However, with berths expected to be made available in 2028-2030, the port development timeline may not match up with that of the ABWP2 project. Engagement with the port owner is recommended to clarify availability to support ABWP2. As an alternative, Rosslare may be viable as a backup. The port of Rosslare supported the installation of the Arklow Bank Wind Park 1 (ABWP1) WTGs and has included a 20 ha OSW quay in its development plans, with a target completion date of 2026. However, the development plans do not appear to accommodate the large vessels and laydown areas required for the handling and storage of 15+ MW WTG and foundation components.

FIGURE 4.8 ARKLOW BANK NEARBY PORTS (FIGURE PREPARED BY ERM)



4.4 ENVIRONMENTAL CONSTRAINTS

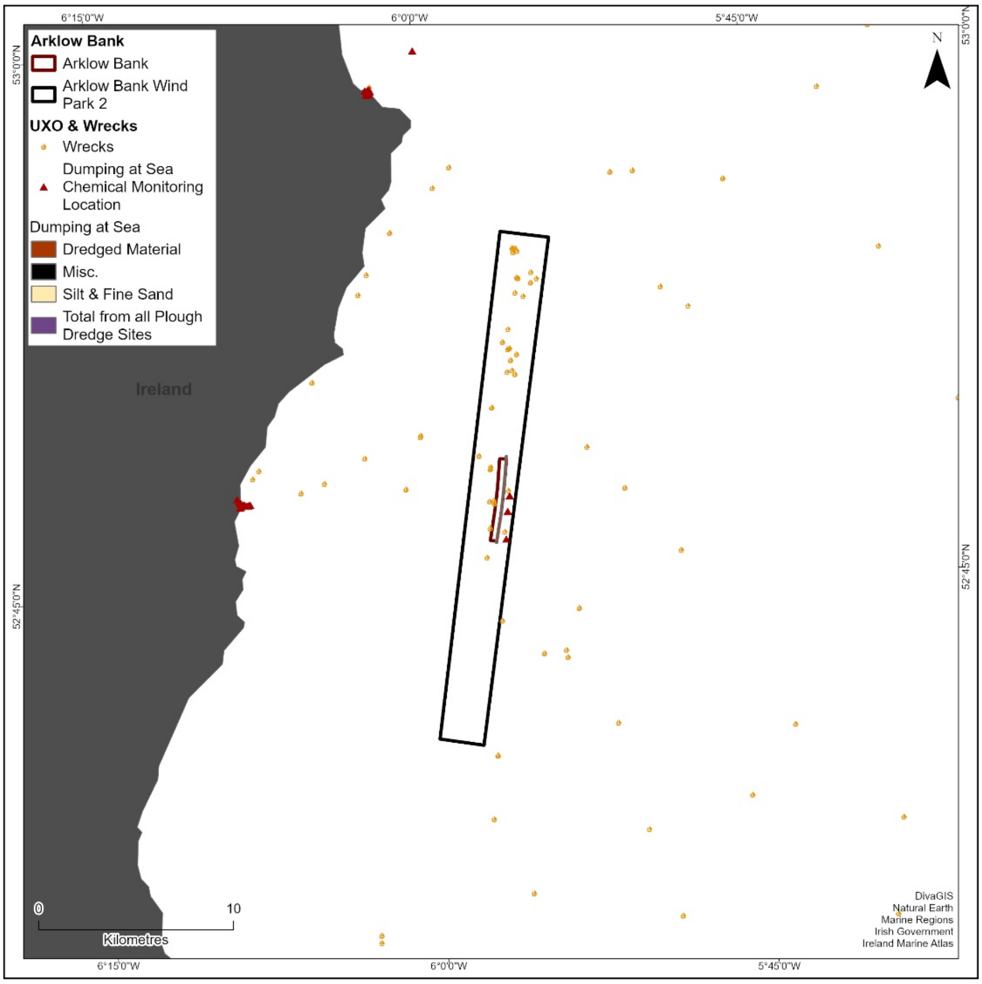
4.4.1 PHYSICAL

4.4.1.1 UXOS, WRECKS & ARCHEAOLOGY

There is no documented UXO presence within or near the site in the data examined. UXO surveys are standard practice and should be carried out if not having been done already to ensure safety. GIS data from Ireland Marine Atlas shows a dredged material dumping license held by Arklow Energy Limited and valid until May 2025 within the ABWP2 site and along the ABWP1 site boundary. It is assumed that this is related to the foundation construction of the first phase and is not of concern to the ABWP2 project. Similarly, there are three locations along the eastern boundary listed as dumping at sea chemical monitoring locations; these are listed as clean sand dumping grounds with no visible signs of animal life. All dumping sites are under permits held by Arklow Energy Limited and can be assumed to be related to the first phase project.

There are several known wrecks within the ABWP2 boundaries, mostly arising from the geophysical surveys already carried out on site. Clusters to the north of the site may pose more of a constraint to project development. Mitigations include careful micrositing of WTG foundations, cables and other seabed infrastructure, and the formation of exclusion zones. The avoidance of wrecks requires consideration during the installation phase in particular.

FIGURE 4.9 ARKLOW BANK UXOS, WRECKS & ARCHAEOLOGY (FIGURE PREPARED BY ERM)



4.4.2 BIOLOGICAL

4.4.2.1 ENVIRONMENTALLY DESIGNATED AREAS

There are eighteen SPAs off the eastern coast of Ireland in the Irish Sea, including the Wicklow Head SPA, the Cahore Marshes SPA, and The Murrough SPA (shown in Figure 4.10). These areas are protected due to the presence of species including seabirds such as Kittiwake and Little Tern, waterfowl like Wigeon and Teal, as well as shorebirds including Golden Plover and Lapwing.

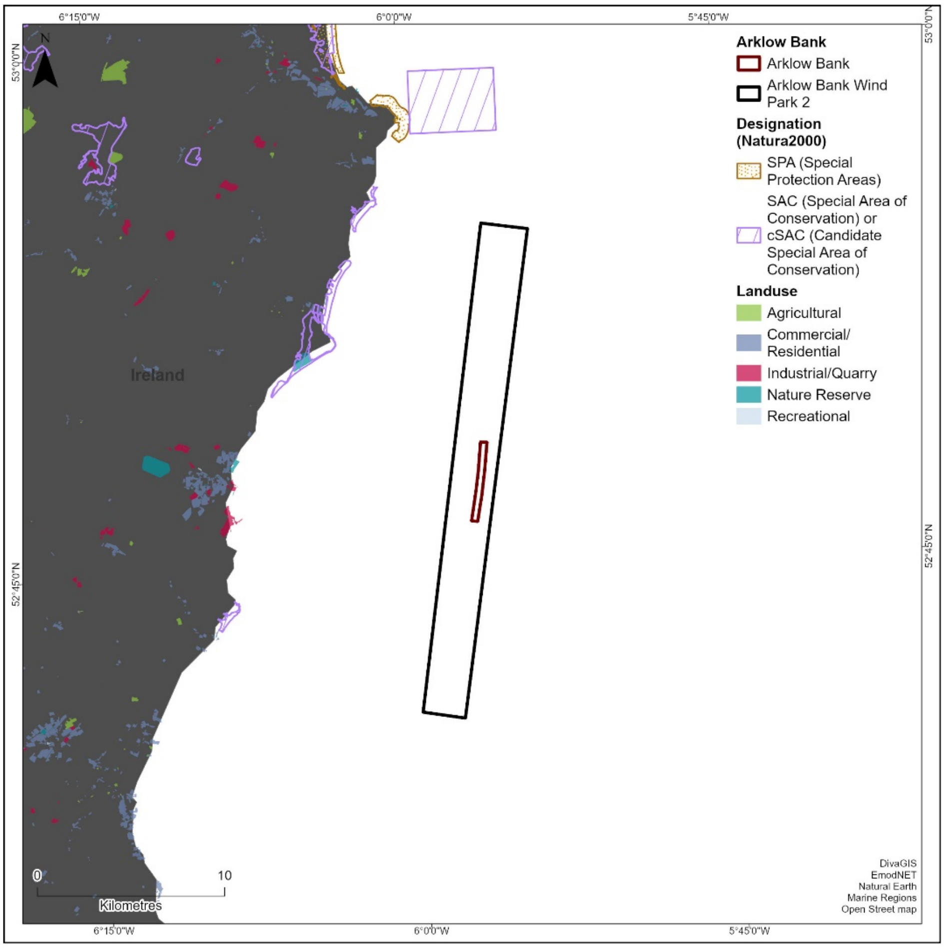
As presented in Figure 4.10, both Arklow Bank and Arklow Bank Wind Park 2 are located in an area with no presence of Environmentally Designated Areas. However, there are SACs close to Arklow, which include Wicklow Reef, Kilpatrick Sandhills, Buckroney-Brittas Dunes and Fen, and Magherabeg Dunes, all of which play a crucial role in protecting diverse and sensitive habitats crucial for biodiversity. These habitats range from annual vegetation of drift lines to embryonic shifting dunes. Kilpatrick Sandhills SAC, for instance, safeguards shifting dunes with *Ammophila arenaria* and humid dune slacks. Magherabeg Dunes SAC plays a vital role in conserving habitats like petrifying springs with tufa formation.

The Murrough Wetlands and the area around Arklow are home to many species of wildlife, including waterbirds, rare plant species, breeding seabirds, marine mammals and fish species.

Figure 4.10 also presents the Buckroney Sand Dunes Nature Reserve located 8 km north of Arklow. This nature reserve is a part of the Buckroney-Brittas Dunes and Fen SAC preserving the home of birdlife like the little terns and nesting ringed plover, and varied wildflower like pyramidal orchids, wild asparagus, purple thyme, pink centaury and storksbill, blue speedwell and yellow lady's bedstraw.

While crossing a SAC may not lead to a direct impact on the conservation objective, there is potential for indirect effects on habitat which may in turn impact the conservation objective. These SACs in the area pose minimal risk to project development in Arklow's coastal waters as the areas are protected for features rather than species.

FIGURE 4.10 ARKLOW BANK ENVIRONMENTALLY DESIGNATED AREAS (FIGURE PREPARED BY ERM)



4.4.2.2 ORNITHOLOGY

The east coast of Ireland is an important area for a number of seabird species. Arklow Bank is comprised almost entirely of circalittoral sand (Figure 4.16; section 4.4.2.4) and supports spawning habitat for a number of fish species, including sprat (*Sprattus sprattus*) (Figure 4.17; Section 4.4.2.5). As such, Arklow Bank may represent suitable foraging habitat for a number of seabird species, including pursuit-diving, plunge-diving, and surface-feeding birds.

As outlined in Section 3.4.2.2, species such as European herring gull (*Larus argentatus*), auks, Manx shearwater, and European shag make extensive use of the area, with relatively lower density populations of these species residing elsewhere on the Irish coast (Rogan *et al.*, 2018).

Species which use east Ireland, but also other areas around the coast in high densities, include black-legged kittiwake and northern gannet.

Jessopp *et al.* (2018) reviewed aerial survey data collected in the western Irish Sea in 2016. The most abundant taxa were auks, with over 24,000 individuals recorded, followed by Manx shearwater (4,736 individuals), European herring gull or common gull (*Larus canus*) with 2,726 individuals, and black-legged kittiwake (2,421 individuals).

Of the species with greatest potential for presence on the east coast, European herring gull and northern gannet are at greatest risk of collision, whereas auks are most at risk from displacement impacts (Furness *et al.*, 2013; Bradbury *et al.*, 2014). Black-legged kittiwake are considered sensitive to both effects.

Black-legged kittiwake were recorded along the full length of the east coast, with greatest density in the north and central east (Jessopp *et al.*, 2018), largely associated with the breeding population at Lambay Island. The northern distribution was primarily comprised of birds present in the autumn and post-breeding season. Royal Society for the Protection of Birds (RSPB) tracking data show that black-legged kittiwake make extensive use of the east coast of ROI (Wakefield *et al.*, 2017). Review of the data show that Arklow Bank Wind Park 2 is within the 70-85% utilisation distribution of the species (Figure 4.11), suggesting that kittiwake make use of the marine area and is likely to represent medium to high risk to development at the site. Through the Seabird Censuses (JNCC, 2023), kittiwake breeding populations on the east coast of Ireland have shown a general decline between Seabird 2000 (1998-2002) and Seabird Count (2015-2021) (Burnell *et al.*, 2023), with an average decline of 26% over the period (total: 11,366 pairs to 8,397 pairs). Only two sites in the region saw an increase in numbers: Loughshinny to Killiney (143 pairs to 165 pairs) and Bray (781 pairs to 873 pairs).

European herring gull were not easily distinguishable, and therefore were grouped with common gull in the 2016 surveys (Jessopp *et al.*, 2018). These birds were recorded along the full length of the east coast, however, were mostly concentrated in inshore waters north of Dublin. European herring gull is a qualifying feature of several SPAs in the region, including Skerries Islands, Lambay Island, and The Murrough (NPWS, 2023). European herring gull is unlikely to present risk to development at the Arklow Bank Wind Park 2 site. The results of the latest seabird census (Seabird Count; Burnell *et al.*, 2023) suggest that breeding herring gull populations on the east coast of Ireland have declined by an average of 34% between 1998-2002 and 2015-2021. The largest decline was at Lambay Island, with the population decreasing from 1,806 pairs in 1999 to 906 pairs in 2015.

Common guillemot and razorbill were not easily distinguished from one another; therefore, these species were grouped when analysis the survey data (Jessopp *et al.*, 2018). Common guillemot/razorbill were recorded in the full extent of the survey area, with greatest density recorded in the north in the autumn, with areas of >100 individuals/km^2 in the post-breeding period. In the central east, density was comparably lower, although there was still relatively high presence in the Arklow Bank Wind Park 2 site. As previously noted, the east coast supports in excess of 50,000 common guillemot during the breeding season (NPWS, 2011, 2012). Tracking data (Figure 4.12, Figure 4.13; Wakefield *et al.*, 2017) show that common guillemot and razorbill distributions overlap with Arklow Bank Wind Park 2, however, the relative density in the site is low compared with areas along the coastline associated with breeding grounds. Auks are sensitive to displacement (Furness *et al.*, 2013; Bradbury *et al.*, 2014; Wade *et al.*, 2016), especially during the post-breeding moult period where birds are flightless. As such, common guillemot/razorbill are expected to represent a medium to high risk to development. Between Seabird 2000 (1998-2002) and Seabird Count (2015-2021), guillemot populations showed an average increase, from 86,426 individuals to 92,710 individuals (7.3%) (Burnell *et al.*, 2023). The largest populations were recorded at Great Saltee (21,436-25,851 individuals) and Lambay Island (60,754-59,983 individuals). Razorbill numbers also increased, by 76% (9,070-16,045 individuals), with Great Saltee and Lambay Island supporting the largest populations (Burnell *et al.*, 2023).

Manx shearwater are common in the Irish Sea during the summer breeding season (Jessopp *et al.*, 2018). The species was recorded along the coast, although areas of greatest density were in the north and south. Individuals in these areas are likely to be associated with the breeding colonies at Lambay and Saltee Islands (NPWS, 2011, 2012). The Irish Sea Front SPA, located in UK waters, supports foraging area for up to 12,039 individuals from multiple colonies (JNCC, 2016). Individuals from southern Ireland may pass the Arklow Bank Wind Park 2 site during transit, and birds from other colonies using the Irish Sea Front SPA may pass when migrating south at the end of the breeding season. These birds may present medium risk to development, due to sensitivity to artificial light emissions. During the latest seabird census (Seabird Count, 2015-2021), Manx shearwater were not recorded at sites on the east coast of Ireland (Burnell *et al.*, 2023).

Although northern gannet abundance on the east coast is relatively high (Rogan *et al.*, 2018), the greatest densities were recorded in the northeast, with individuals foraging offshore of Lambay Island (Jessopp *et al.*, 2018). However, gannet tracking suggests that it is the Saltee Islands colony that makes most use of the southern and central east coasts (Wakefield *et al.*, 2013). Gannet is unlikely to present notable risk to development at the Arklow Bank Wind Park 2 site. Gannet abundance increased by an average of 115% on the east coast of Ireland from 1998-2002 to 2015-2021 (Burnell *et al.*, 2023), with the largest population recorded at Great Saltee.

Cormorant and European shag could not be differentiated during the aerial surveys (Jessopp *et al.*, 2018). These species were recorded on the east coast of ROI only (Rogan *et al.*, 2018), and both area qualifying features of the Lambay Island SPA. Tracking data suggest that European shag utilises the east coast (Wakefield *et al.*, 2017), however, greatest density is in close proximity to Lambay Islands, with Arklow Bank Wind Park 2 representing <5% utilisation distribution of the species.

(Figure 4.14), thus the species is likely to represent low risk to development. European shag were only recorded at one site on the east coast in the Seabird Count (Burnell *et al.*, 2022), Litle Saltee, with 28 pairs in 2000 and two pairs in 2016. Great cormorant counts on the east coast declined from 2,259 individuals to 1,481 individuals.

In addition to regional populations, SPA colonies may also present a notable constraint to development in the region. There are no SPAs within the ABWP2 Offshore Array Area, or between the array area and the coast (Figure 4.10), meaning direct impacts to designated sites are unlikely to occur. However, there are several SPAs located on the east coast of Ireland (Figure 4.10), as well as SPAs in Scotland, northwest and southwest England, Wales, and Northern Ireland, which may present risk to development at the ABWP2 site.

Notable seabird colonies on the east coast include those at Lambay Island, which is east of Dublin, and Saltee Islands, which are south of Waterford in southern Ireland. These sites support nationally important numbers of common guillemot, supporting more than 50,000 pairs combined (NPWS, 2011; 2012), as well as black-legged kittiwake (6,072 pairs), Manx shearwater (275 pairs), and northern gannet (68 pairs). The Saltee Islands SPA regularly supports a seabird colony exceeding 20,000 breeding pairs (NPWS, 2012).

The greatest offshore ornithology risks to development are expected to be breeding black-legged kittiwake (displacement and collision), common guillemot during the breeding and post-breeding moult period (displacement), Manx shearwater during post-breeding migration (artificial light), and northern gannet breeding (collision risk).

FIGURE 4.11 BLACK-LEGGED KITTIWAKE (*RISSA TRIDACTYLA*) 5-95% UTILISATION DISTRIBUTION AT ARKLOW BANK (SOURCE: WAKEFIELD *ET AL.*, 2017) (FIGURE PREPARED BY ERM)

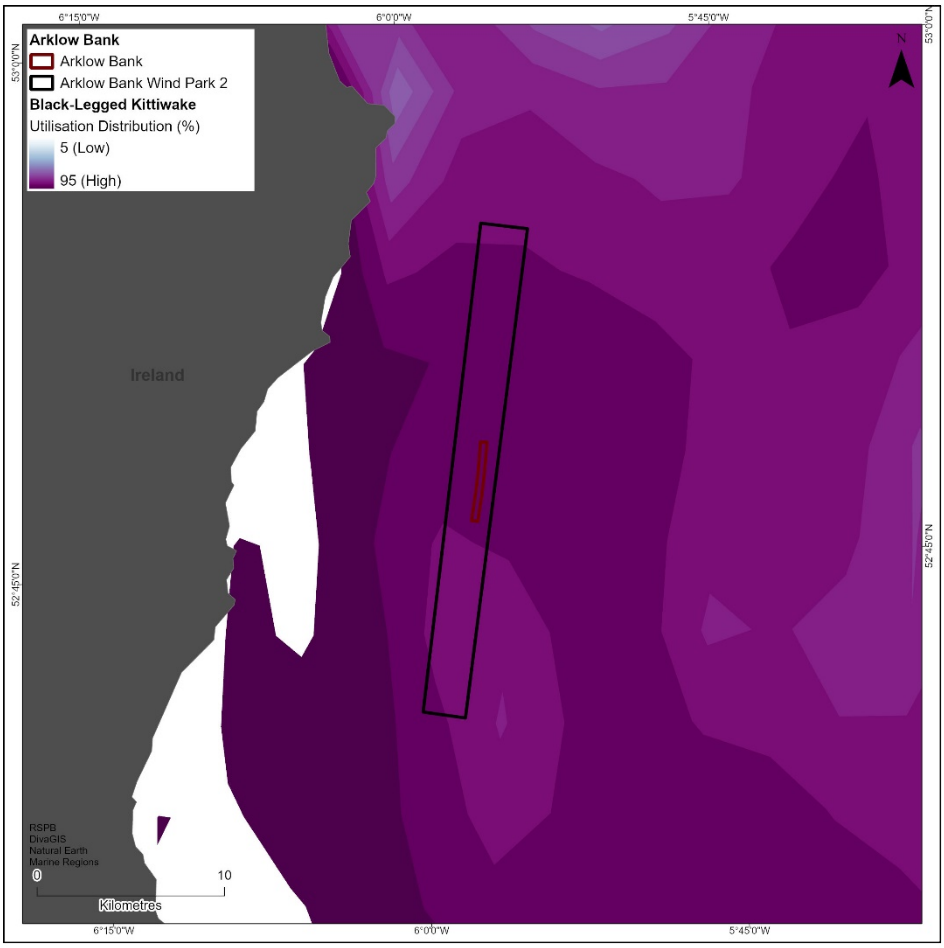


FIGURE 4.12 COMMON GUILLEMOT (*URIA AALGE*) 5-95% UTILISATION DISTRIBUTION AT ARKLOW BANK (SOURCE: WAKEFIELD *ET AL.*, 2017) (FIGURE PREPARED BY ERM)

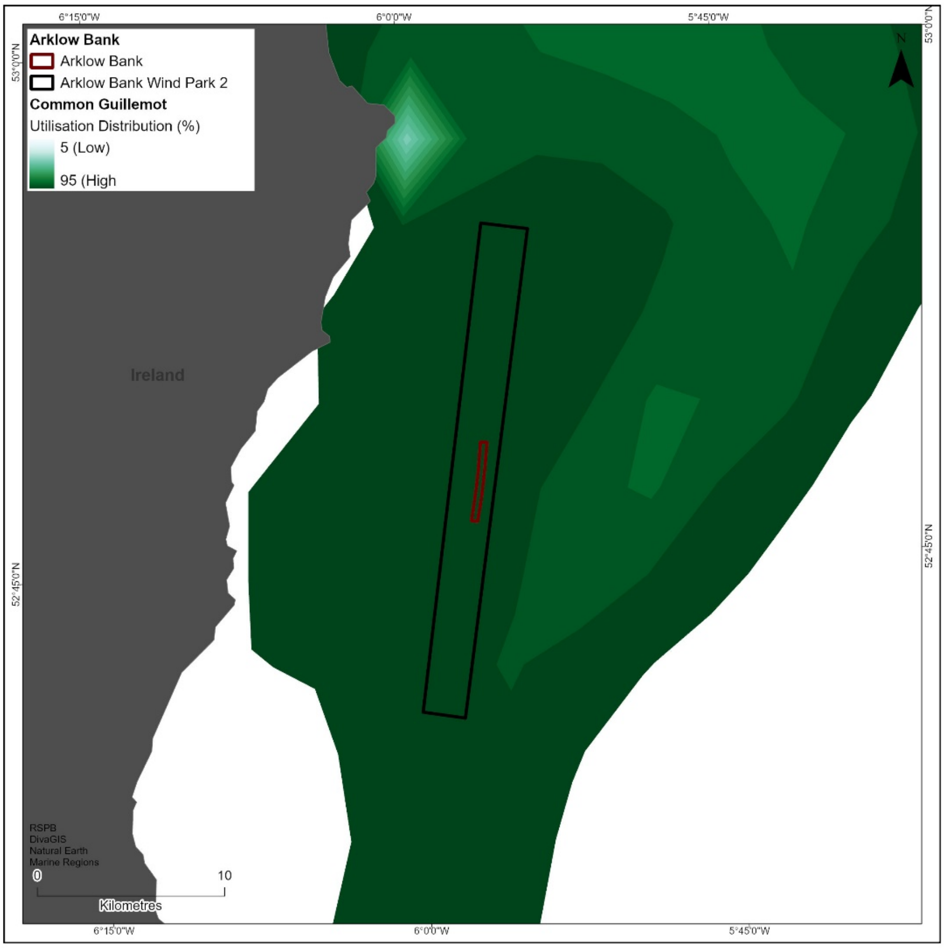


FIGURE 4.13 RAZORBILL (*ALCA TORDA*) 5-95% UTILISATION DISTRIBUTION AT ARKLOW BANK (SOURCE: WAKEFIELD *ET AL.*, 2017) (FIGURE PREPARED BY ERM)

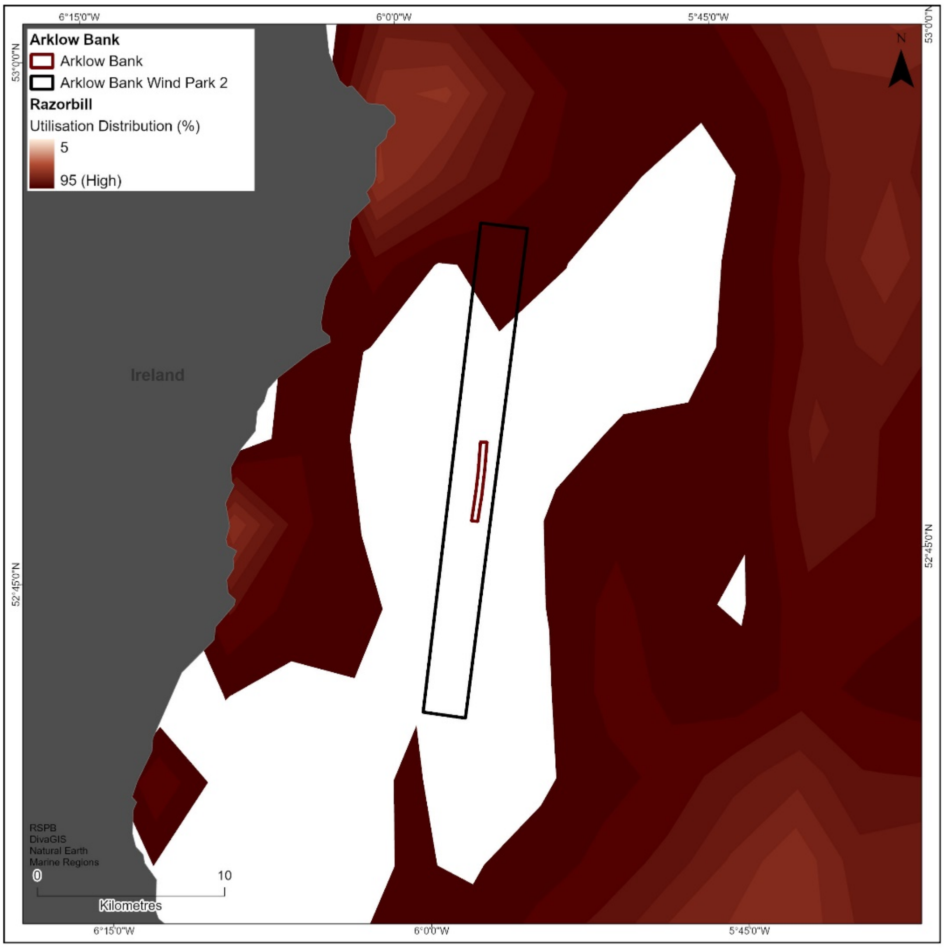
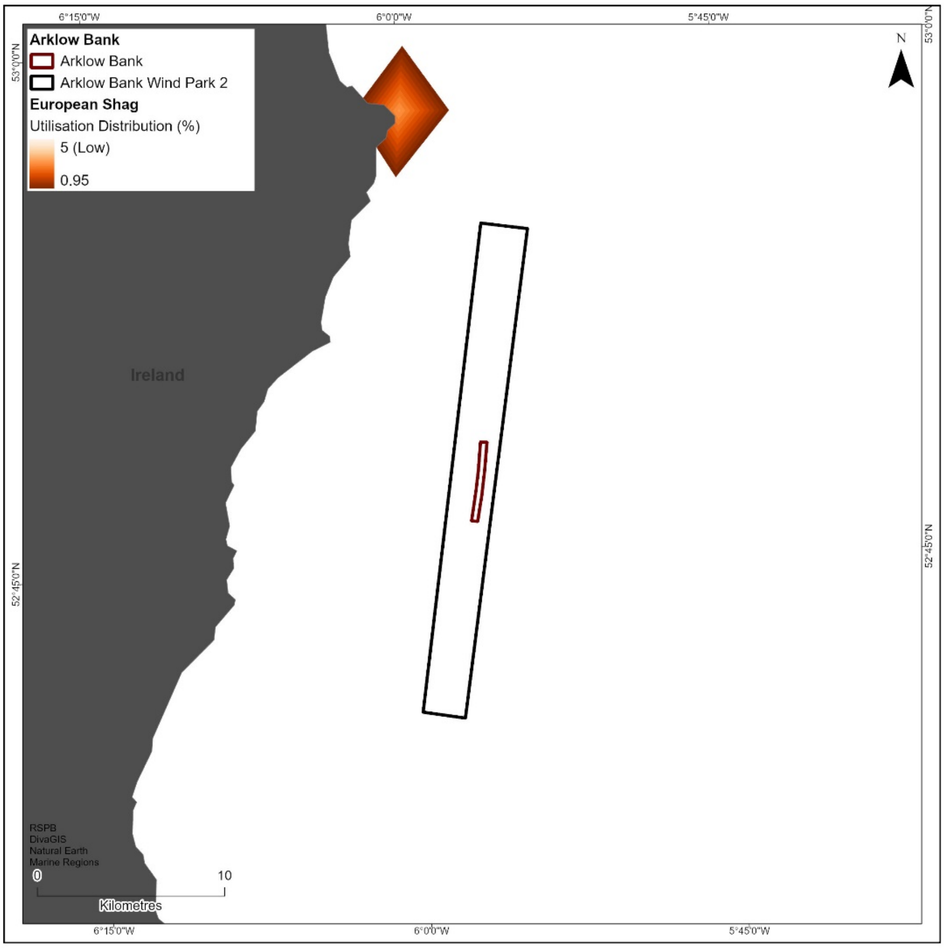


FIGURE 4.14 EUROPEAN SHAG (*GULOSUS ARISTOTELIS*) 5-95% UTILISATION DISTRIBUTION AT ARKLOW BANK (SOURCE: WAKEFIELD ET AL., 2017) (FIGURE PREPARED BY ERM)



4.4.2.3 MARINE MAMMALS & TURTLES

The east coast of Ireland and wider Irish sea support a number of marine mammal species. Extensive aerial surveys performed as part of the SCANS-IV programme identified 6 cetacean species/species groups with distributions within survey block CS-D, which overlaps with Arklow Bank. Species detected in this survey block were (in order of abundance estimates) harbour porpoise, bottlenose dolphin, common dolphin, minke whale, Risso's dolphin *Grampus griseus*, and beaked whale species (comprised of Cuvier's beaked whale *Ziphius cavirostris*, Sowerby's beaked whale *Mesoplodon bidens*, and unidentified beaked whale species) (Gilles *et al.*, 2023). Cetaceans are often highly mobile and wide-ranging; therefore, this list is not exhaustive and it is possible that other species may occasionally be present in these waters (e.g., Wall *et al.*, 2013), however these occurrences are considered to be rare and not representative of the fauna of Arklow Bank.

Harbour porpoise were the most commonly sighted species, with a density in survey block CS-D of 0.2803 individuals/km² and estimated abundance of 9,773 (Gilles *et al.*, 2023). Harbour porpoise are most commonly sighted as individuals (Rogan *et al.*, 2018), though group sizes increase in the winter (IWDG, 2019). The calving period for harbour porpoise runs between May and August, with a peak in June (IWDG, 2019). The closest SAC in Irish waters designated for harbour porpoise to Arklow Bank is the Rockabill to Dalkey Island SAC, however there are also SACs in Welsh waters (e.g., the West Wales Marine / Gorllewin Cymru Forol SAC) that must also be considered.

Bottlenose dolphin had a density of 0.2352 individuals/km² and estimated abundance of 8,199 within survey block CS-D (Gilles *et al.*, 2023). Sightings in the Irish Sea increased in 2022 compared to previous SCANS surveys; in SCANS-III the estimated abundance for survey block E (equivalent to CS-D) was only 288 individuals (Hammond *et al.*, 2021). Bottlenose dolphins in the Irish Sea are part of a wider North Atlantic population, therefore it is possible that these differences in abundance may reflect interannual spatial variation in prey availability across the wider range (Gilles *et al.*, 2023). Bottlenose dolphin group sizes range between 10s of individuals to pods of >100 animals, with mean group sizes higher in the winter season (Rogan *et al.*, 2018). Calving occurs primarily in summer (Berrow *et al.*, 2010). There are no bottlenose dolphin SACs in Irish waters in the Irish Sea.

Common dolphin distribution is likely to overlap with Arklow Bank, with SCANS-IV estimates of density and abundance at 0.0272 individuals/km² and 949 individuals, respectively (Gilles *et al.*, 2023). They are also widely distributed across the Irish Shelf, particularly in the neritic waters to the south and west of Ireland during summer and autumn where foraging on large biomasses of pelagic schooling fish occurs (Saunders *et al.*, 2010; Rogan *et al.*, 2018). Their presence in the southern Irish Sea is largely seasonal (late spring to mid-autumn), with individuals moving south and west from September onwards (Lacey *et al.*, 2022). Calving is primarily recorded from late summer to late autumn (Wall *et al.*, 2013).

Minke whales are the most likely whale species to overlap with the Arklow Bank project. Their density in the area (survey block CS-D) is 0.0137 individuals/km² and their estimated abundance is 477 individuals (Gilles *et al.*, 2023). Their distribution in the western Irish Sea is highest in the late spring period, most likely due to high concentrations of pelagic schooling fish, however they are recorded throughout Irish waters across all seasons (NPWS, 2019). Outside of late April to early August they are largely absent from the Irish Sea (Wall *et al.*, 2013). They are not known to calve in Irish waters, and likely migrate south to lower latitudes to breed during winter (Anderwald *et al.*, 2011).

Risso's dolphins are present in low numbers in the Irish Sea, with a density of 0.0022 individuals/km² and an estimated abundance of 75 individuals for survey block CS-D (Gilles *et al.*, 2023). This species tends to prefer waters of >200 m depth (e.g., continental shelf and slope), however there is a coastal community that is frequently sighted near the Saltee Islands off county Wexford (Rogan *et al.*, 2018). Occasional sightings of calves suggests that calving may occur in Irish waters (Wall *et al.*, 2013).

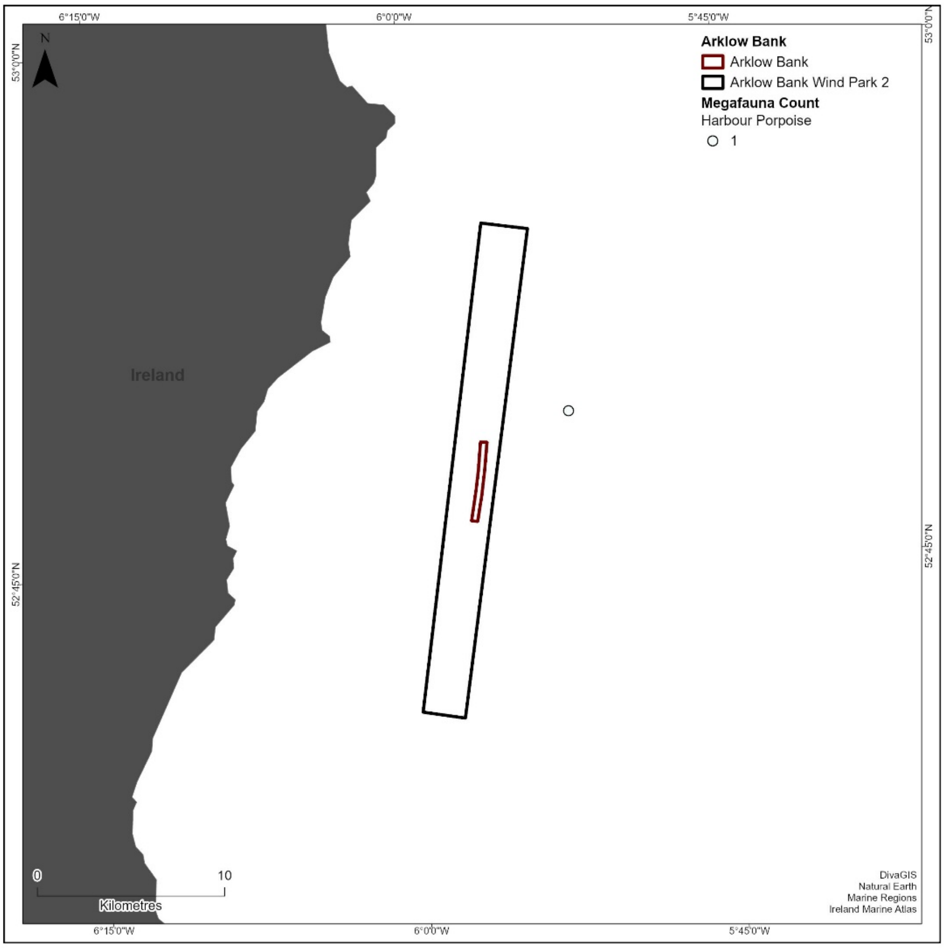
Five species of beaked whale have been recorded in Irish waters: northern bottlenose whale *Hyperoodon ampullatus*, Cuvier's beaked whale, Sowerby's beaked whale, True's beaked whale *Mesoplodon mirus*, and Gervais' beaked whale *Mesoplodon europaeus* (Wall *et al.*, 2013). In the most recent SCANS surveys, only Cuvier's and Sowerby's beaked whale were identified to species level. Their abundance in survey block CS-D was 0.0021 individuals/km² and their estimated abundance was 75 individuals (Gilles *et al.*, 2023). These species tend to prefer deep slope and canyon habitats such as those of the Rockall Trough (Wall *et al.*, 2013), although they are sometimes sighted in inshore areas, including the Irish Sea.

Occasional sightings are also recorded in the Irish Sea for fin whale, and humpback whale in late spring and summer, likely due to presence of pelagic schooling fish during this period (Wall *et al.*, 2013).

Grey seal are abundant in Irish waters, including the coasts of counties Wexford and Dublin (Morris and Duck, 2019). The Lambay Island SAC is the closest SAC to Arklow Bank that is designated for both resident species of Irish seals (grey seal and harbour seal). Harbour seal abundance in the southeast of Ireland is less than any other region in the country, making up less than 5% of the total Irish population (Morris and Duck, 2019). The closest SAC in Irish waters designated for grey seal is the Saltee Islands SAC, whereas the closest SAC with harbour seal designation in Irish waters is the Slaney River Valley SAC. The Slaney River Valley SAC is the only harbour seal breeding colony in the southeast region of Ireland. Any developments in the western Irish Sea must also consider transboundary effects on seal populations in Welsh waters, as the grey seal colonies in Pembrokeshire form the largest breeding population in the Irish Sea (Stringell *et al.*, 2014). SACs for seals in Wales include Sir Benfro Forol / Pembrokeshire Marine SAC, Cardigan Bay/Bae Ceredigion SAC, and Pen Llyn a`r Sarnau / Lleyn Peninsula and the Sarnau SAC.

The greatest marine mammals and turtles' risks from development are expected to be potential impacts via underwater (impulsive) sound from piling or UXO clearance during construction. As the ABWP2 site is within the foraging range (100km; SCOS, 2020) of several grey seal colonies, there is the potential for grey seal colonies in Welsh waters to be affected by activities at the ABWP2 site. Timings should therefore be considered when scheduling construction activities, particularly those that generate impulsive sound. Additionally, temporal mitigation (e.g., avoiding key breeding periods) should be implemented, where possible.

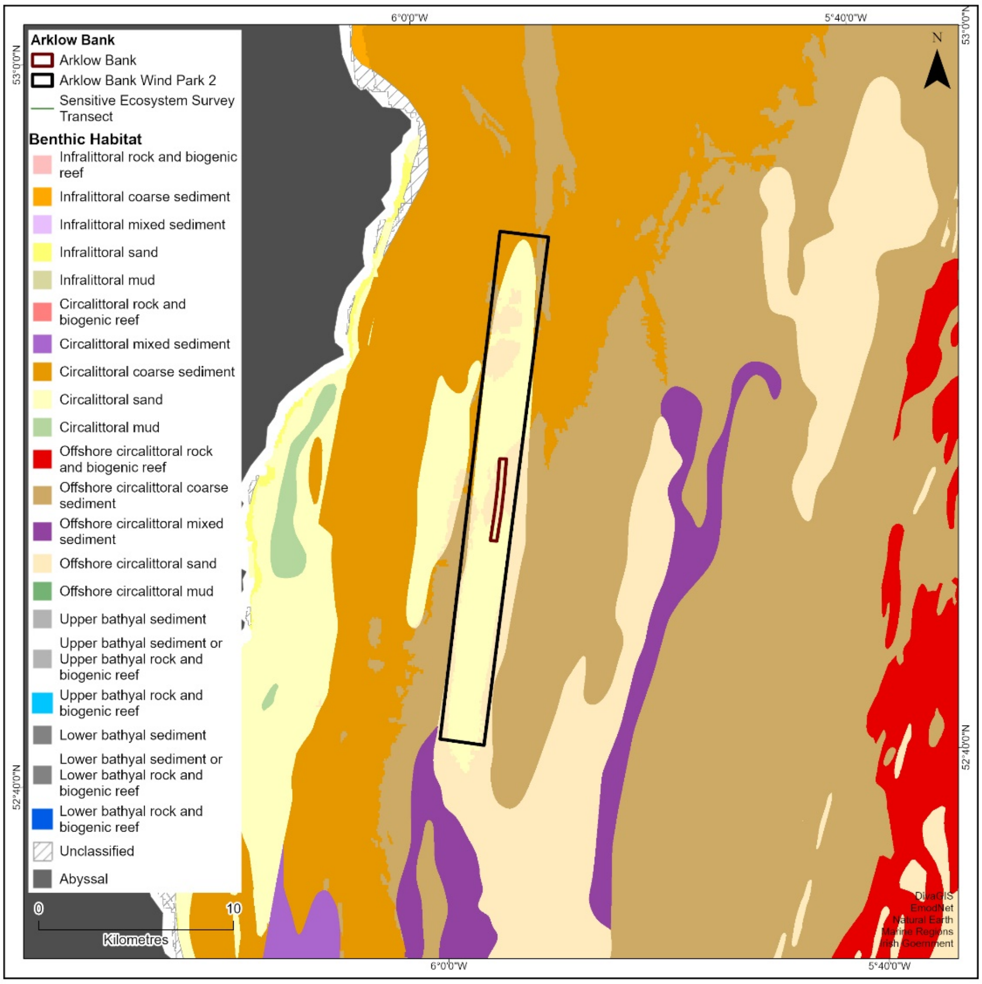
FIGURE 4.15 ARKLOW BANK MARINE MAMMALS & TURTLES (FIGURE PREPARED BY ERM)



4.4.2.4 BENTHIC ECOLOGY

The benthic ecology within the Arklow Bank Wind Park 2 site is primarily circalittoral sand with sections of infralittoral coarse sediment towards to northern corners. Sand is the preferred sediment type for fixed-bottom foundation types over coarse sediment. Circalittoral sand provides habitat for many species so disturbance can negatively impact the marine communities. Further studies and surveys would be required to evaluate the environmental impact. The benthic ecology to the west of Arklow Bank Wind Park 2 is primarily infralittoral coarse sediment with areas of mud and sand nearer shore. The east of the site is primarily infralittoral coarse sediment with some areas of sand, mixed sediment, rock, and biogenic reefs further offshore. Biogenic reefs are made of hard matter created by living organisms such as honeycomb and ross worms. These are known as Sabellaria Reefs, generally found in more exposed water and shores allowing currents to deposit new sand for continual building up of the reef structure. Changes to the distribution of sand caused by physical disturbance such as dredging, has a significant effect on the worms ability to generate reefs. Impacts of windfarm construction on these reefs will need to be considered.

FIGURE 4.16 ARKLOW BANK BENTHIC ECOLOGY (FIGURE PREPARED BY ERM)



4.4.2.5 FISH SPAWNING GROUNDS

According to the Marine Institute Ireland, spawning grounds are considered the locations where commercially important species of fish leave their eggs for fertilisation, and nursery grounds are habitats that promote the survival of young commercially important fish species.

These species are important for fisheries and seafoods, in particular mackerel, cod, herring, haddock, blue whiting, and whiting.

The Arklow Bank Wind Park 2 site is located within a zone of fish spawning for lemon sole and sprat, and a nursery ground for lemon sole. North of the ABWP2 site, there is whiting spawning and nursery ground, a plaice spawning ground, and a haddock nursery ground located 20 km, 5.5 km, and 10 km away respectively. There is a nursery and spawning ground for nephrops located 11 km northeast of the site, and a nursery ground for herring located 2.5 km to the west. There is potential for temporary direct habitat loss and disturbance to fish habitats due to site preparation activities and cable installation activities. Sediment disturbance, underwater noise and vibrations, increased vessel traffic, accidental pollution, and changes in Electromagnetic Fields (EMF) from subsea electrical cabling can all have a negative impact on fish spawning. Consultations will be necessary to assess the potential impacts.

FIGURE 4.17 ARKLOW BANK FISH SPAWNING AND NURSERY GROUNDS: BLUE WHITING, COD, HADDOCK, HERRING (FIGURE PREPARED BY ERM)

FIGURE 4.18 ARKLOW BANK FISH SPAWNING AND NURSERY GROUNDS: LEMON SOLE, MACKEREL, NEPHROPS, NORWAY POUT (FIGURE PREPARED BY ERM)

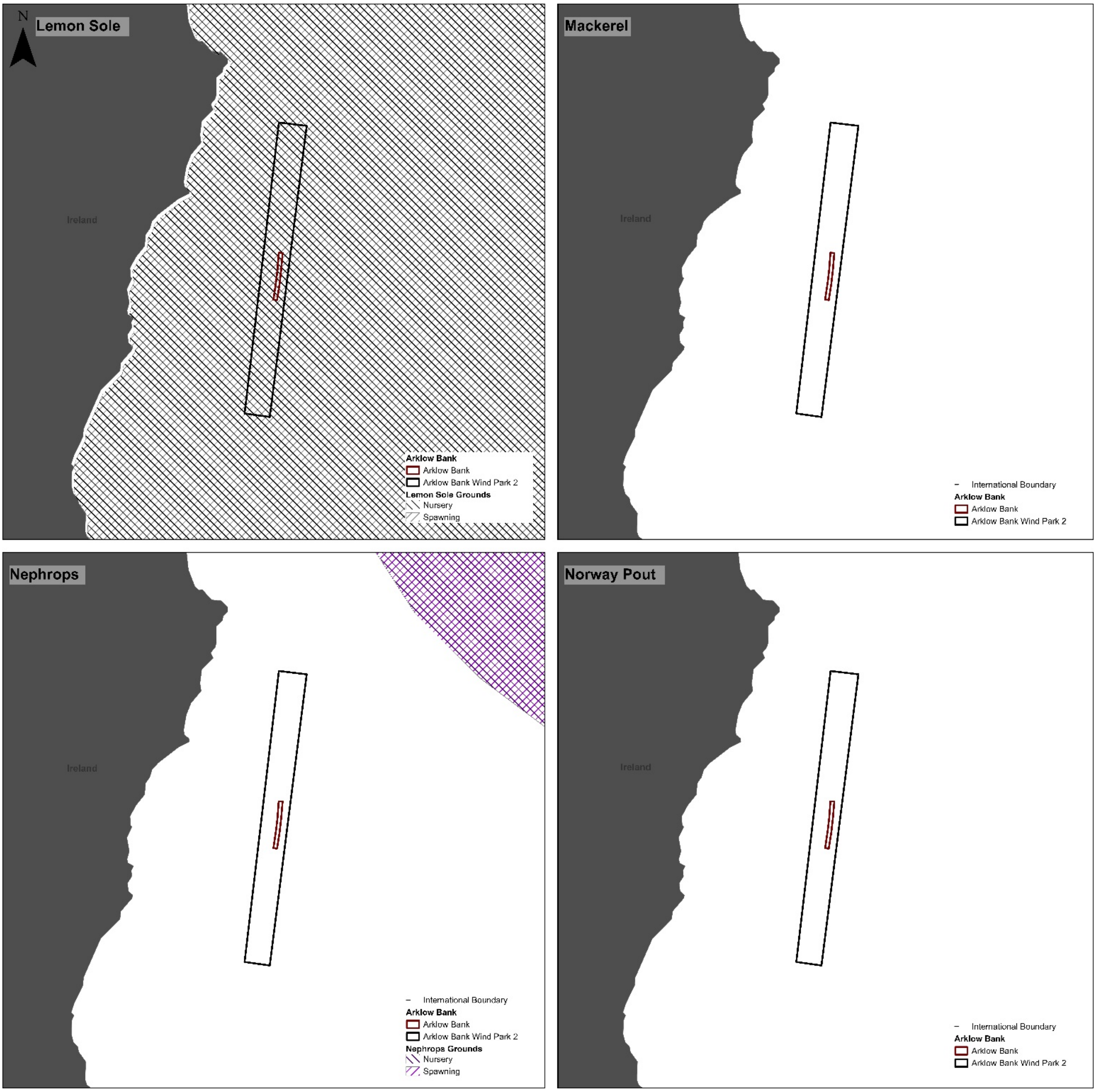


FIGURE 4.19 ARKLOW BANK FISH SPAWNING AND NURSERY GROUNDS: PLAICE, SAITHE, SAND EEL, SOLE (FIGURE PREPARED BY ERM)

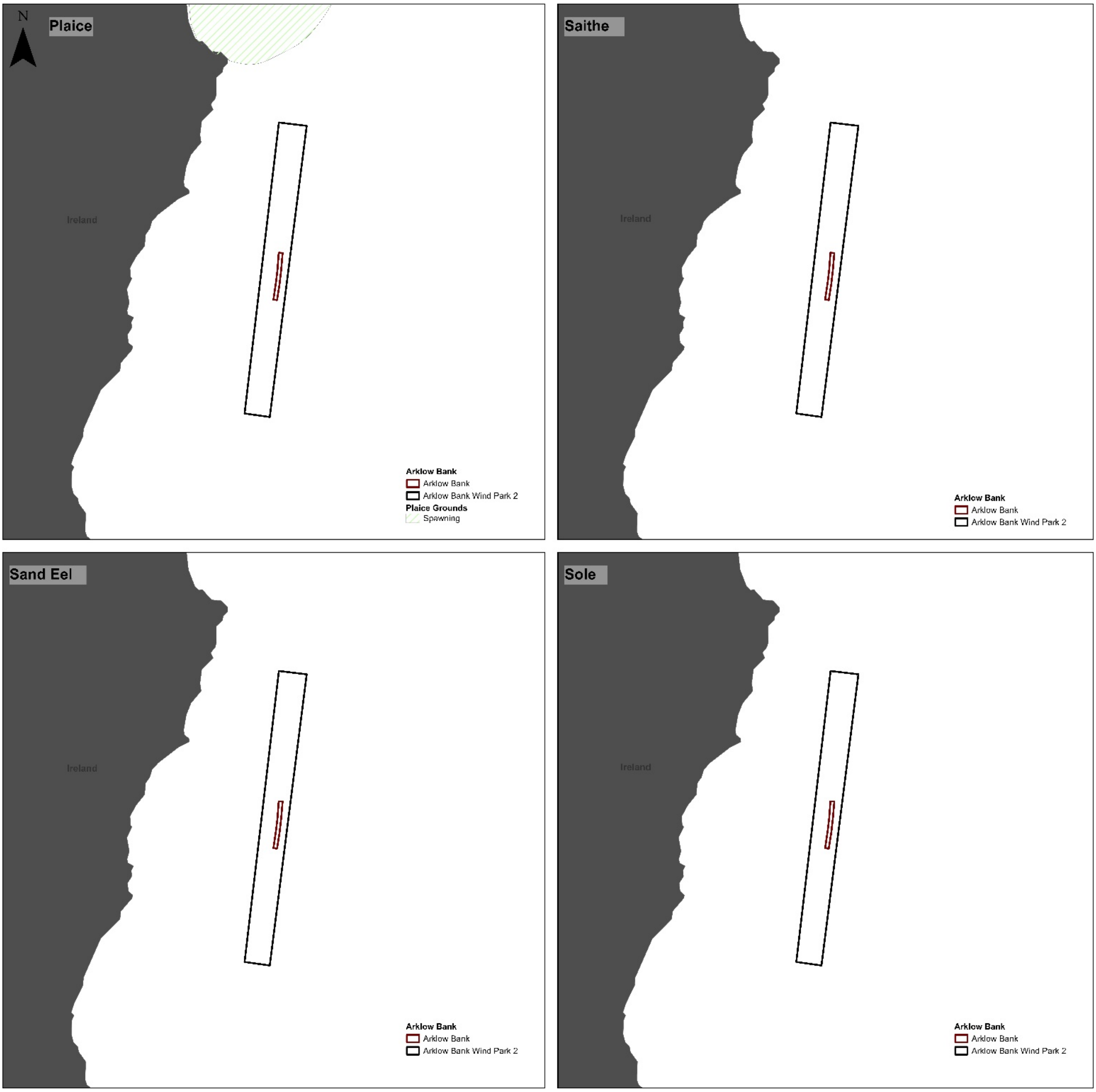
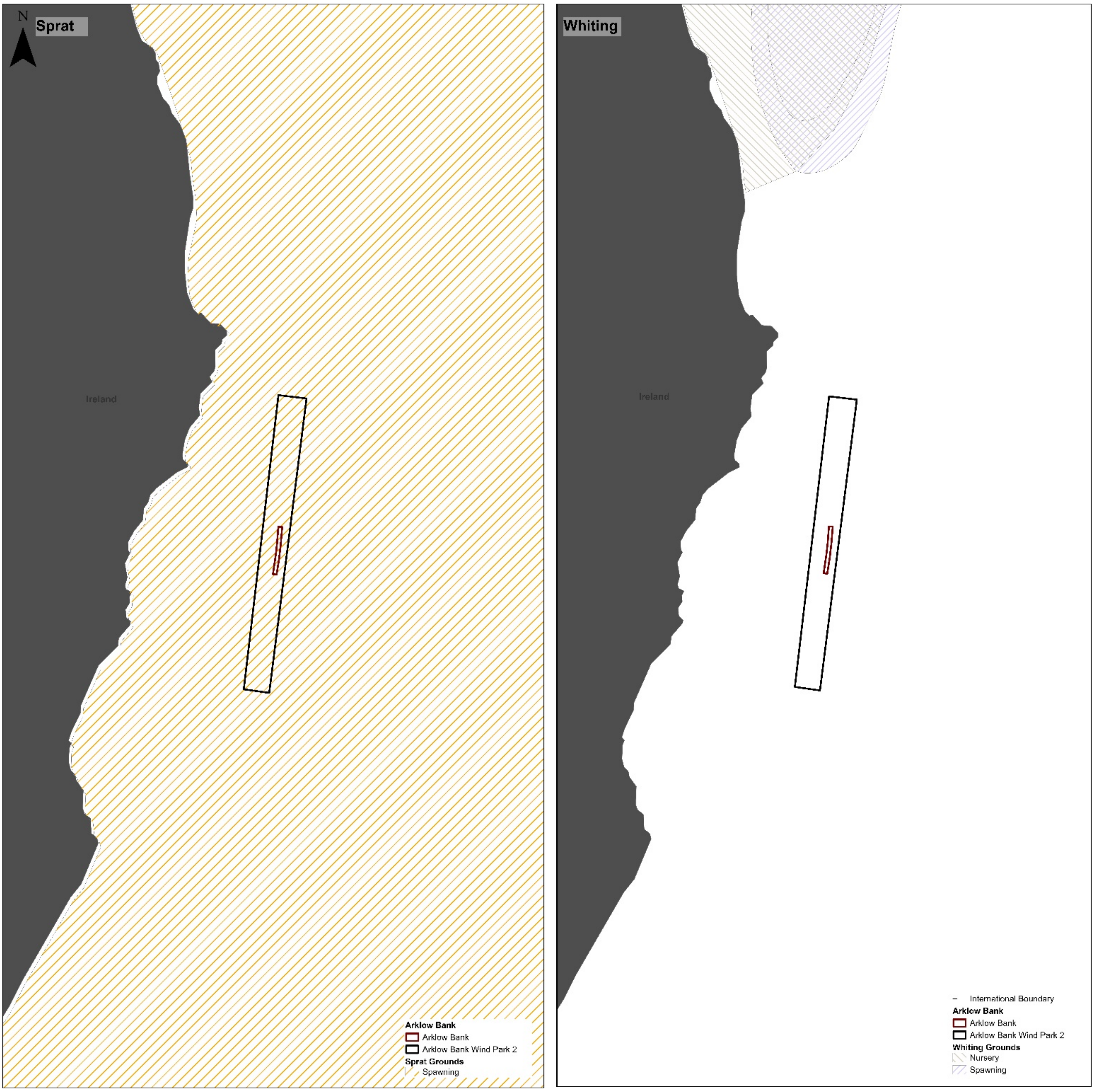


FIGURE 4.20 ARKLOW BANK FISH SPAWNING AND NURSERY GROUNDS: SPRAT, WHITING (FIGURE PREPARED BY ERM)



4.4.3 HUMAN

4.4.3.1 SHIPPING & NAVIGATION

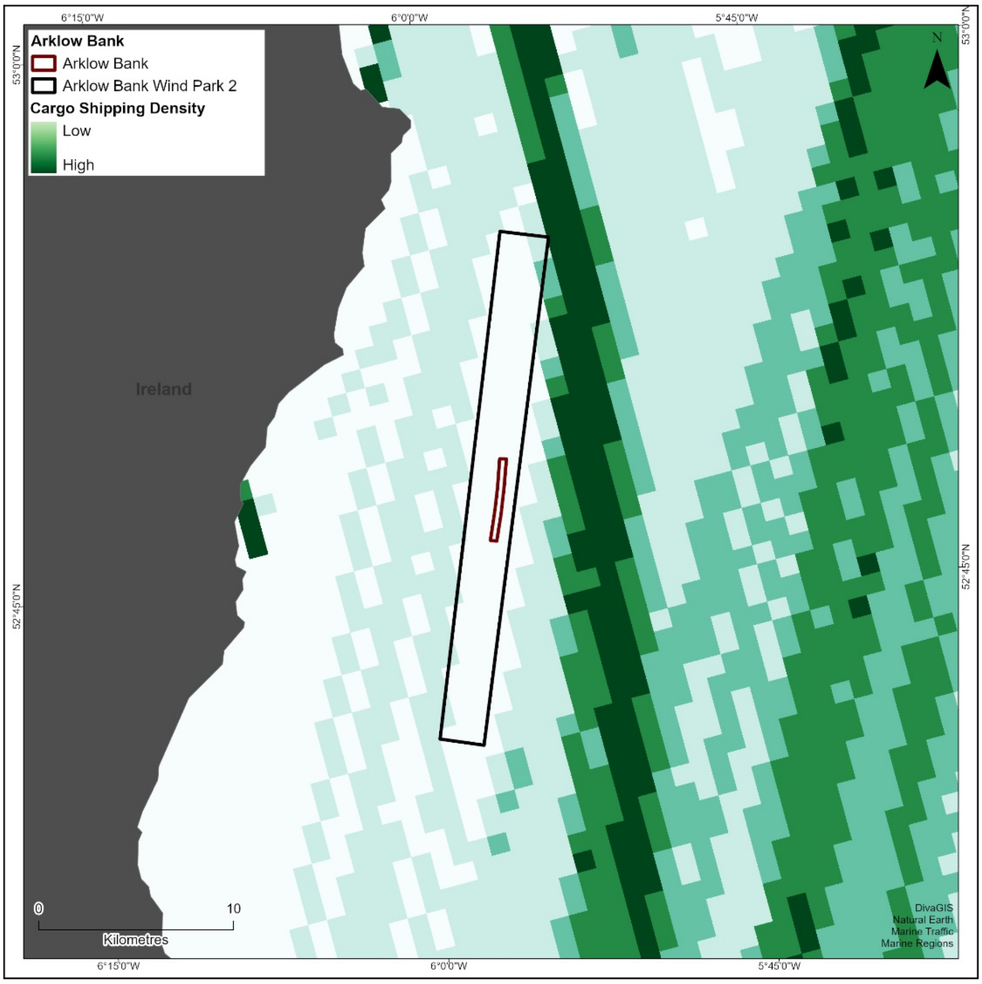
Figure 4.21 shows the ABWP2 site is located in an area of low vessel density. This is owed to the shallow waters surrounding Arklow Bank, which can reduce to 0.6 metres in some places as detailed in project documentation. The main flow of vessel traffic, traveling south out of Dublin, splits at Arklow Bank, with the majority of the vessels taking routes further offshore to the east of the ABWP2 boundary. However, other vessels do transit closer to shore and within the northwestern and southwestern corners of the ABWP2 site.

The water depths over the sandbanks have been noted to be variable and vessels are recommended to not approach within 50 m of the bank in foggy weather. The North Arklow Light north cardinal buoy, located within the ABWP2 site boundary and the north of Arklow Bank, indicates that safe water is located to its north and navigational hazards, due to the reduced water depths, to the south. Similarly, the South Arklow Light south cardinal buoy has been installed approximately 750 metres south of the wind turbine installation area for ABWP2. Furthermore, the ABWP1 wind turbines and associated meteorological masts within the ABWP2 site boundaries, have been present for over 20 years and represent a well-established navigation consideration in the region.

Significant traffic for cargo travelling through the Irish Sea is also seen further east, approximately 14 km from the Arklow Bank Wind Park 2 site boundary. However, interaction of the Project with such vessel traffic should be minimal.

Considering the shipping data represented in Figure 4.21, in addition to the existing offshore wind turbine facilities from ABWP1, disruption to existing vessel traffic due to the development of the ABWP2 offshore windfarm should be low. However, continued dialogue with local shipping and navigational stakeholders is recommended.

FIGURE 4.21 ARKLOW BANK SHIPPING & NAVIGATION (FIGURE PREPARED BY ERM)

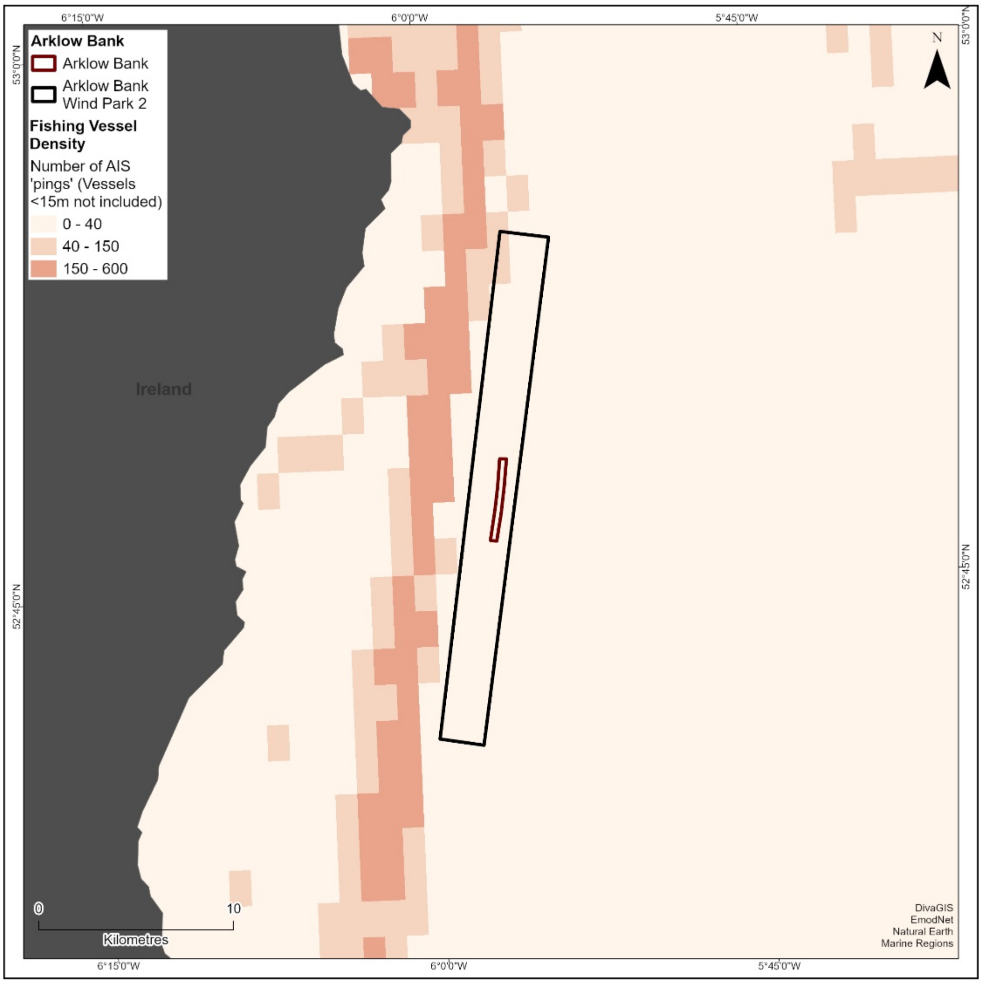


4.4.3.2 FISHING

Fishing activity in the vicinity of the Arklow Bank Wind Park 2 site is limited compared to other areas within the Irish EEZ. Wicklow is the most significant fishing port in this area with 1,695 tonnes worth €3.0 million landed in 2022, which makes it the 13th greatest in Ireland by landed weight and 16th by landed value. The other fishing ports present are Arklow with 499 tonnes landed (23rd) worth €1.2 million (30th), and Courtown with 363 tonnes (26th) worth €550,000 (49th).

The main commercial fishing methods seen in the Irish Sea surrounding the ABWP2 site are beam trawls, dredges and pots. Though fishing density data, as seen in Figure 4.22, shows that large (>15 m) fishing vessels fitted with AIS trackers tend to avoid the area within the ABWP2 boundary (broadly for similar reasons as discussed above in Section 4.4.3.1), development of the offshore wind activity can have impacts on smaller fishing vessels and fish activity and populations in the wider surrounding area. Therefore, consultation with the Irish fishing industry, alongside detailed investigations into the impact of ABWP2 on fishing activity and the implementation of any necessary mitigation measures is recommended.

FIGURE 4.22 ARKLOW BANK FISHING (FIGURE PREPARED BY ERM)



4.4.3.3 VISUAL & SEASCAPE

The sensitivity of the seascape is generally considered to be high for wind farm development within 30 km from shore. Beyond 30 km the effects of most sizes of wind turbines would be limited, although they may be visible in certain light and weather conditions. The ABWP2 site is located 6-15 km from shore, making visual sensitivities relatively high.

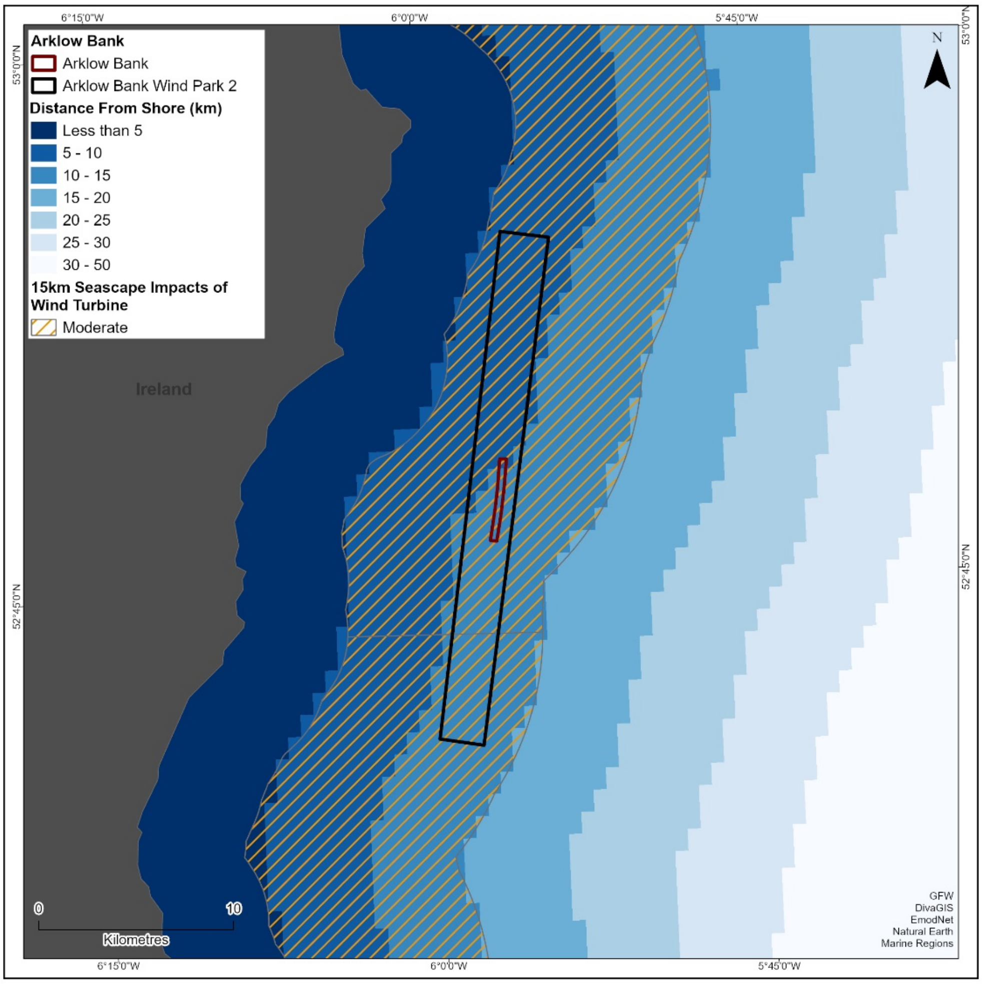
The Marine Institute's *Definition and Classification of Ireland's Seascapes* (2020) identifies the region surrounding the ABWP2 site as a mix of "broad estuarine bays and complex low plateau and cliff coastline" and "low lying and estuarine coastal plain with long, narrow sandy beaches" as corresponds to their seascape character types 7 and 8, respectively. Land uses near the site are mainly agricultural, with some holiday homes and caravan parks surrounding the beaches near Courtown, around 15 km south-west of the southern site boundary. The site is also located nearby county Wexford which forms part of the "Sunny South East", as well as "Ireland's Ancient East" which encompasses the majority of the southeast coast. Both regions are famous for being a particularly scenic and attract tourists all year round.

Arklow, located along the coast approximately 11 km from the centre of the western site boundary, is strongly connected with the marine environment with historic and current fishing grounds nearby. Popular beaches and walking routes surround the town with scenic backdrops of the Wicklow Mountains. Sailing is a common activity north of Arklow.

Wicklow, located less than 10 km north-west of the northern site boundary, acts as a fishing base and features the iconic Black Castle, a historic coastguard station and multiple lighthouses in the town and at Wicklow Head. North of the town, there are multiple day trip destinations and towns occupied by Dublin commuters. Scenic and historic walking routes are found around the Rathdown Upper deserted medieval settlement between Bray and Greystones, approximately 30 km north-west of the northern site boundary. Bray promenade has multiple tourism-related attractions and activities. Recreational angling, sailing, kayaking, and rowing are popular watersports in Wicklow, Greystones, and Bray. Visual impacts at this location will be less pronounced but require consideration nonetheless.

The low headlands along the coastline near the ABWP2 site paired with a lack of islands offshore make the existing Arklow Bank WTGs a visual reference point. Installation of large modern WTGs will therefore be noticeable and will affect the overall perception of the landscape inclusive of residents, travellers, visitors and recreational users.

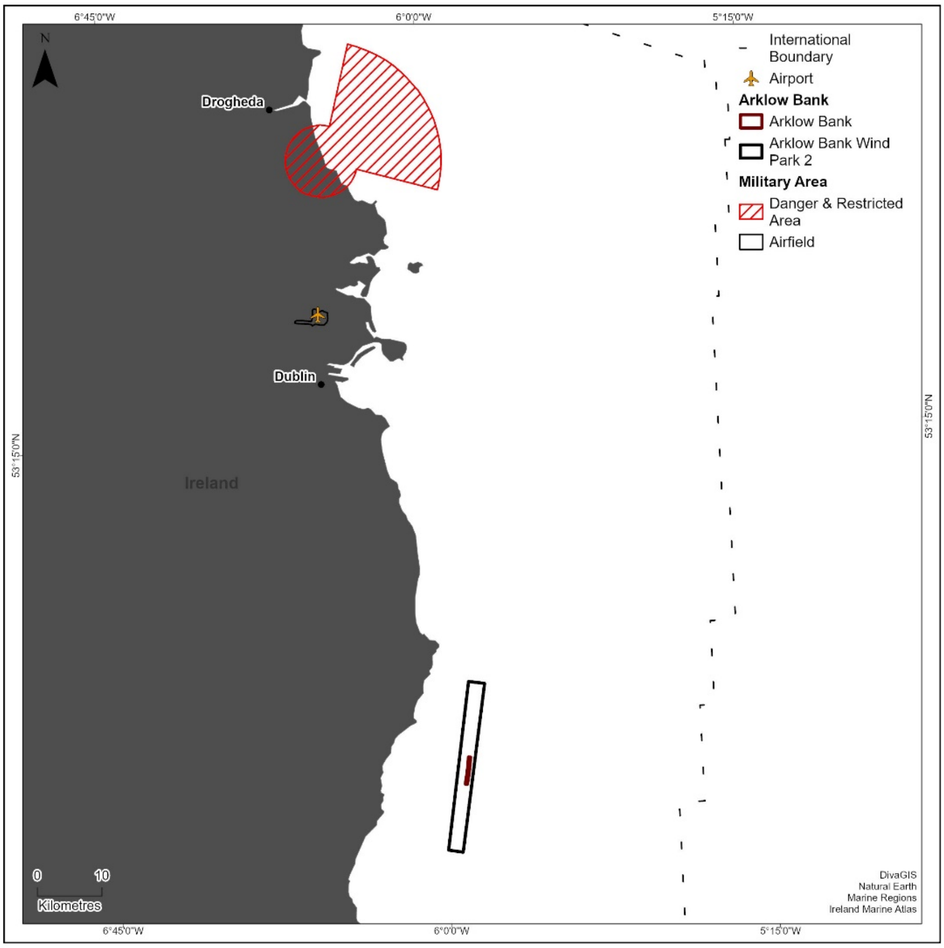
FIGURE 4.23 ARKLOW BANK VISUAL & SEASCAPE (FIGURE PREPARED BY ERM)



4.4.3.4 MILITARY & AVIATION

The area in the vicinity of the Arklow Bank Wind Park 2 site boundary is largely clear of any major military or aviation constraints. The closest military Prohibited or Danger Area is EID1 Gormanston, which is located north of Dublin. Additionally, ABWP2 is located between Dublin and Waterford airports, which are over 60 kilometres and 90 kilometres from the project site respectively, and thus that no major impacts to their operations should be expected from the development of offshore wind. However, early consultation with the Irish Aviation Authority, the Department of Defence and airports are still recommended to confirm that there is no major interference and disruptions expected.

FIGURE 4.24 ARKLOW BANK MILITARY & AVIATION (FIGURE PREPARED BY ERM)



4.5 LAND USAGE

4.5.1 OFFSHORE LEASES

4.5.1.1 ORE INSTALLATIONS

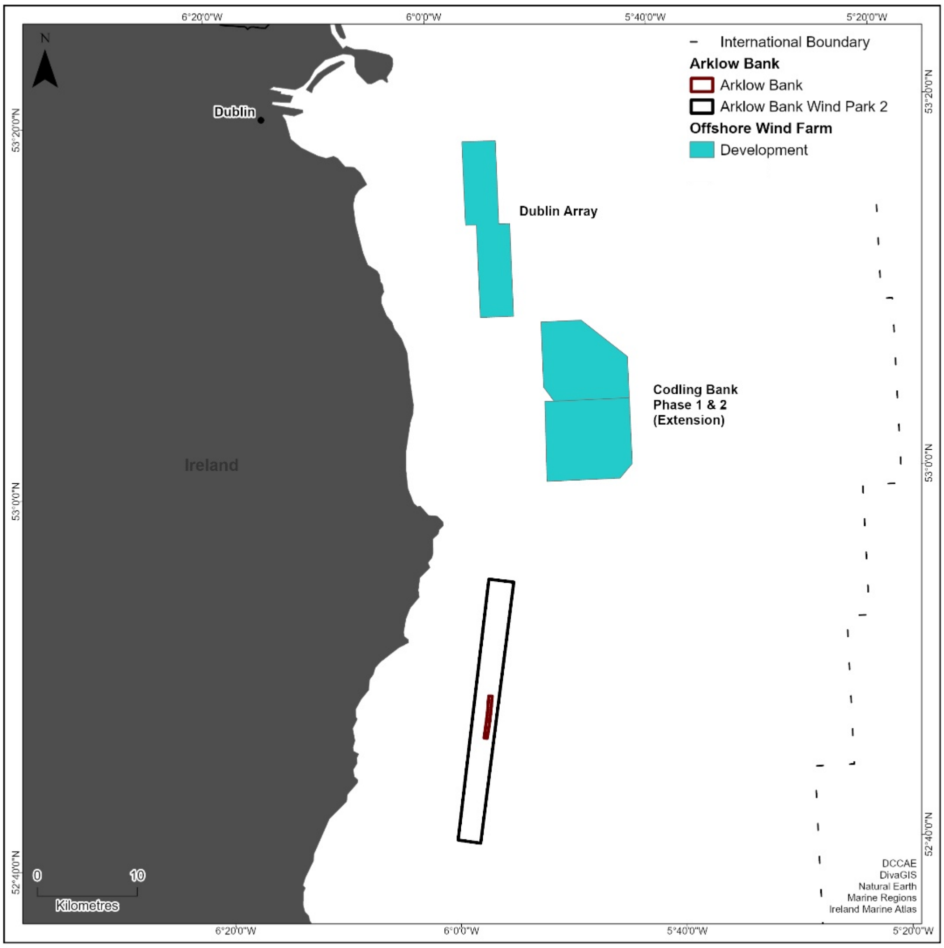
Arklow Bank Wind Park 1 is located within the ABWP2 site area, with seven 3.6 MW wind turbines installed in an area of approximately 1.35 km^2. A 15.5 km export cable transports the generated electricity to the onshore grid, with landfall at Arklow Harbour.

Under special transition provisions in the MAP Act, Arklow Bank Wind Park 2 was awarded a MAC by the Minister of Environment, Climate and Communications alongside five other Phase One projects. Five of these projects are located off the eastern coast, between the Northern Ireland border and Arklow, whilst one project is located off County Galway on the western coast. Of these Phase One projects, four projects totalling 3.1 GW secured a route to market in Ireland's first competitive offshore wind auction, the ORESS 1.

Beyond Phase One projects, Ireland is moving towards a plan-led approach to offshore wind energy development through the designation of sub national forward marine plans called

Designated Maritime Area Plans (DMAPs). The first ORE DMAP is the South Coast DMAP Proposal, setting out a broad geographical area for future offshore wind energy development to take place within. This proposed area will be refined through environmental assessment and consultation (including statutory public consultation) and an initial offshore wind site of 900MW aligned to available grid capacity will be defined within the area and auctioned through the next ORESS, ORESS 2.1. All future offshore wind energy development will be plan led and take place in DMAPs. Therefore, it is not envisioned that these offshore wind projects will affect the development of the Arklow Bank Wind Park 2 project.

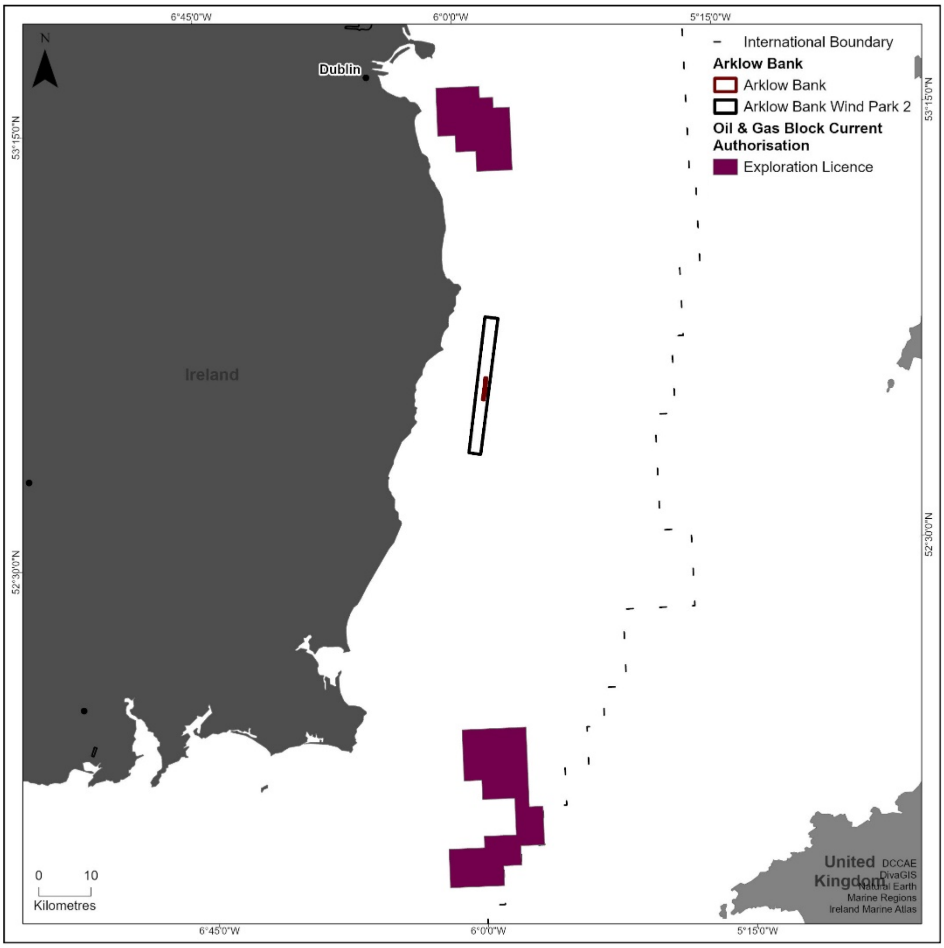
FIGURE 4.25 ARKLOW BANK ORE INSTALLATIONS (FIGURE PREPARED BY ERM)



4.5.1.2 OIL & GAS LICENCES

There are no existing oil and gas licences which have been granted in the sea area immediately surrounding Arklow Bank Wind Park 2. The closest licences are the EL2/11 and EL1/07 Exploration Licences, both owned by Providence Resources and located north and south of ABWP2 respectively. EL2/11 is located approximately 28 kilometres from the ABWP2 site boundary, whilst EL1/07 is approximately 52 kilometres from the site. Therefore, the existence of these oil & gas licences is not considered a key constraint for the development of the offshore wind project.

FIGURE 4.26 ARKLOW BANK OIL & GAS LICENCES (FIGURE PREPARED BY ERM)



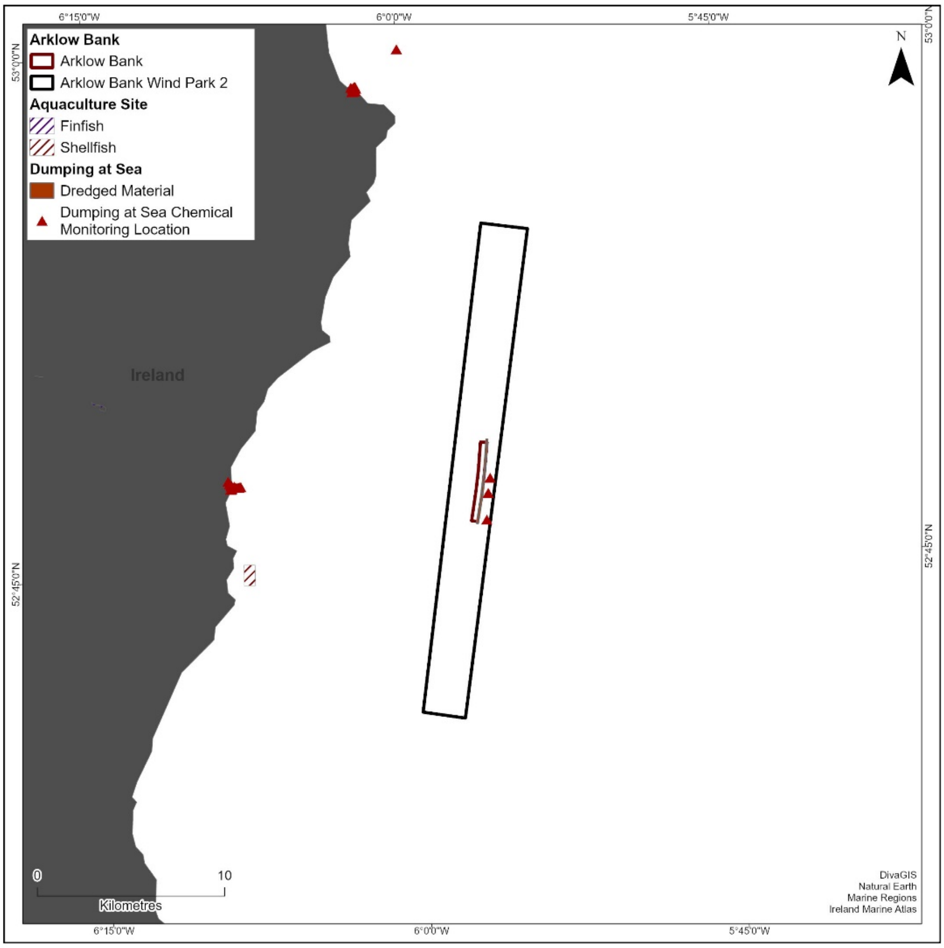
4.5.1.3 OTHER OFFSHORE USERS

There is a dumping at sea (DaS) licence area within the proposed site boundaries of the Arklow Bank Wind Park 2 project for 99,999 wet tonnes of dredged material produced in association with seabed levelling activities for Arklow Bank Wind Park 1. The permit was granted to Arklow Energy Limited in 2017 and is valid until 31st May 2025. Entries to the Environmental Protection Agency Dumping at Sea Register indicate that 60,000 tonnes of dredge material was loaded and dumped between 2009 and 2011 at the northern dumping site within Arklow Bank Wind Park 2. It is advised to ensure a strong understanding of the dumping activities within the project boundary. There are some further DaS areas between 8 to 10 kilometres west of the ABWP2 boundary indicated on the map in Figure 4.27 but these are primarily expired licences for the dumping of dredged materials by the Arklow Harbour Commissioners.

In the vicinity of the ABWP2 project, the only notable licenced aquaculture site is located in Clogga Bay, approximately 10 kilometres west of the ABWP2 site boundary, and is operated by the Irish Mussel Seed Company. Meanwhile, though areas surrounding the Project have been identified as potential marine aggregate resource areas, no licences have been granted.

The presence of DaS and aquaculture sites are not considered significant constraints to offshore wind development with sufficient consultation with the permit holders.

FIGURE 4.27 ARKLOW BANK OTHER OFFSHORE USERS (FIGURE PREPARED BY ERM)



4.5.2 EASEMENTS/CROSSINGS

4.5.2.1 CABLES & PIPELINES

No active interconnector, telecommunication cable or pipeline has been identified within the proposed ABWP2 site. The EXA North and South submarine cable runs to the east of the Project and is owned by EXA Infrastructure, landing at locations such as Dublin, Southport (UK), Halifax (Canada) and Lynn (United States). The ABWP2 site is sufficiently far removed from this cable route and thus the offshore wind development is expected to have minimal impact on its operation.

4.6 INTERCONNECTION

4.6.1 CONNECTION POINTS

The selected grid connection point for the Arklow Bank Wind Park 2 project is included in EirGrid's 2023-2032 Transmission Development Plan with both grid connection and substation consented by ABP. The Arklow Bank Wind Park 2 project grid connection project was added in the 2021-2022 plan and is still on the list of planned Construction Projects with the project code CP1396.

The 220 kV connection point is one of three potential grid connection with access to the transmission line on the East coast. The transmission line will reach the transmission capacity needed by 2030 after implementation of EirGrid's future grid reinforcement plan. EirGrid is updating the grid plans on an annual or bi-annual basis but reinforcement of the transmission line on the East coast is included in all of the potential scenarios and must be considered as prioritized project for implementation before 2030.

Selection of the grid connection point at Avoca River Business Park in Arklow is an outcome of a thorough analysis of constraints on four potential landfall locations and the corresponding onshore cable routes to three potential grid connection points. The constraint considered represents the categories Technical, Economic, Environmental and Deliverability.

The selected landfall at Johnstown North has a single risk to be considered in the project development; the investigations have identified a fault just off the shore, following the coast. The fault could pose a risk to HDD operations (both executional but also environmental risk) due to potential losses of drilling fluid in heavily fractured rock. Further investigations are needed to identify the specific location of the fault to engineer a solution avoiding or minimising the HDD risk. It can be assumed that the HDD will punch out to seabed before crossing the fault. A punch out location too close to the landfall and too distant to the 10 meter water depth contour line might impact the planned installation method leading to a two-vessel setup or a less weather resistant installation setup capable of operations in shallow waters.

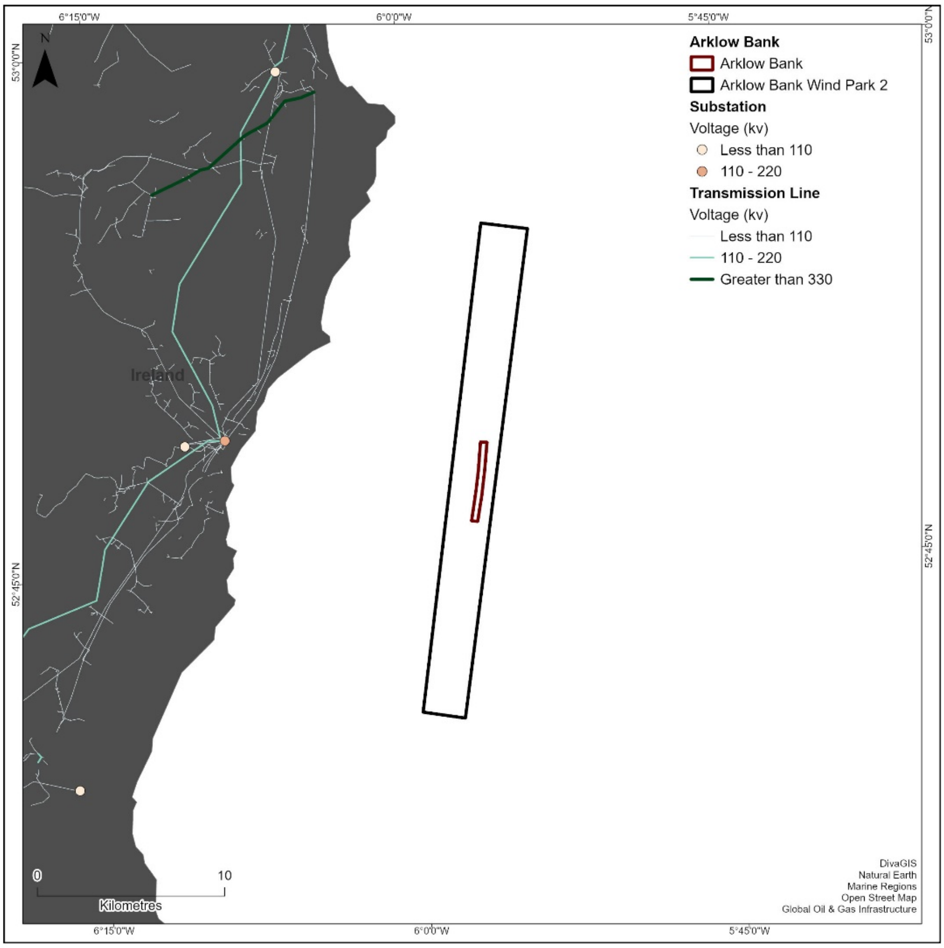
The other landfall locations considered are challenged by land use, environmental constraints and special areas of conservation (SAC). The overall assessment makes the landfall at Johnstown North the preferred location also having an uncomplicated onshore cable route even considering more onshore HDDs than the other onshore cable routes.

The landfall at Johnstown North is located within distance from residents and with a road close to the anticipated working area without need for construction of temporary access roads. The seabed conditions are not expected to become significantly different if moving the landfall further North to a position constrained by an SAC.

The Arklow Bank Wind Park 2 Project has proposed that a transition pit will be excavated on the landward side of the cliff, from which a borehole will be drilled underneath the cliff and the intertidal. Given the narrow intertidal zone, the drill exit point will be below the Low Water Mark. From the landfall point at Johnstown North, an onshore cable route of approximately 6 km has been developed and consented. The onshore cable route connects the 220 kV onshore export cable to a new 220 kV substation at Avoca River Business Park in Arklow. The new onshore substation is in the only business park (industrial area) located close to the EirGrid 220 kV substation (existing national transmission network).

ABWP2 has received consent for the onshore cable route and substation.

FIGURE 4.28 ARKLOW BANK TRANSMISSION GRID (FIGURE PREPARED BY ERM)



4.6.2 CABLE ROUTE

The Arklow Bank Wind Park 2 project has investigated three different OSS configurations resulting in a preference for the North-South design option. The main differentiator between the North-South design and the three OSS design is the current assessment of the feasibility of an export cable crossing the bank. The East-West OSS design also considered being even more impacted by the risks related to bank crossing making it the least optimal solution at this development stage.

The optimal export cable route solution for connection of the North-South OSS design is two separate export cables. Compared to the other OSS designs, the solution results in two separate survey corridors with a minor CAPEX and execution risk impact due to the double surveyed area. The main operational risk is related to the missing interlink between the two OSSs, with an array cable layout planned as radials and no loops, the current North-South OSS design has no redundancy and will experience significant impact in case of a single export cable fault. It should be considered to re-design the 66 kV array cable design enabling a 66 kV connection between the two OSSs.

The OSSs will be connected with two offshore export cables approx. 20 km in length each (total length of 40 km). The cables will be installed in separate trenches, with a planned corridor of up to 15 m wide and a burial depth (outside the bank) of up to 2.5 m depending on the seabed conditions. A Cable Burial Risk Assessment (CBRA) and Burial Assessment

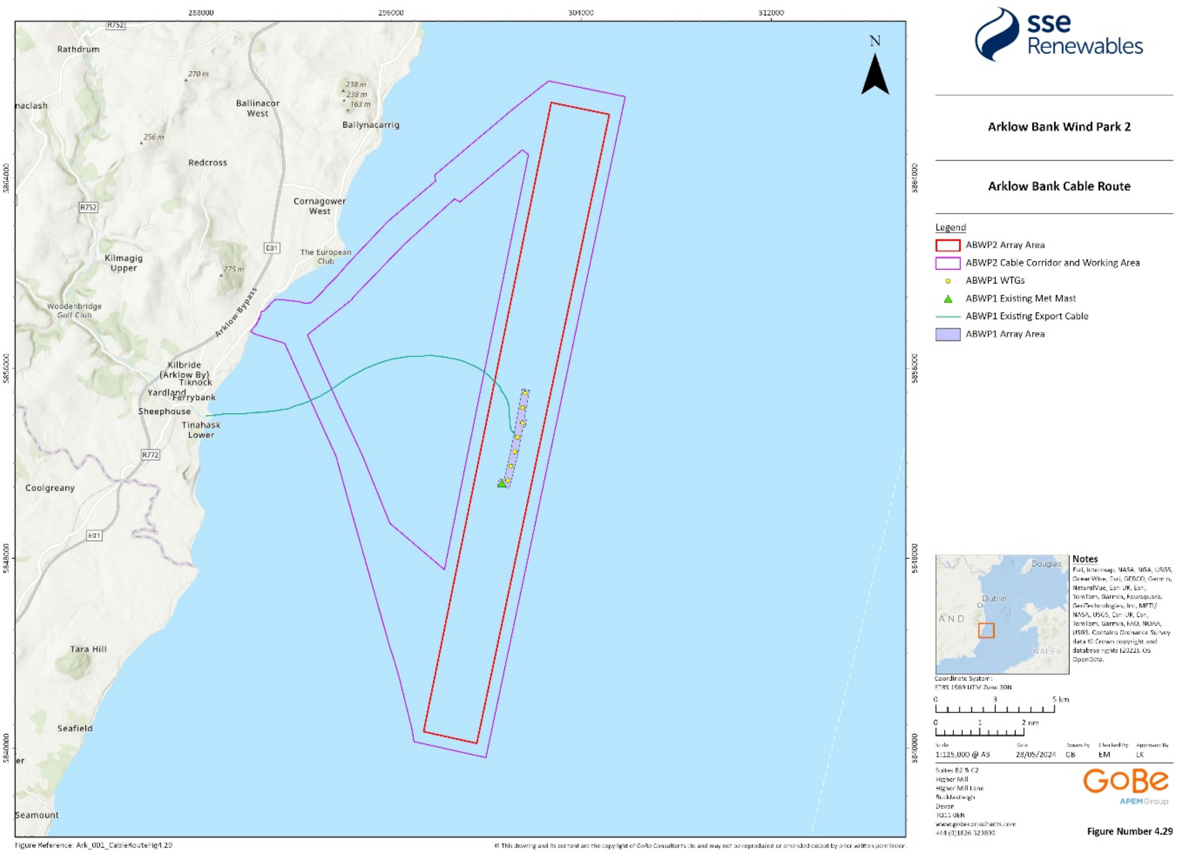
Summary (BAS) must be performed to investigate the needed burial depth both on-bank and off-bank to provide adequate protection of the cables taking seabed conditions, marine traffic, environmental and other aspects into consideration.

The export cable type is expected to be a three-core 220 kV High Voltage Alternating Current (HVAC) XLPE cable with integrated optical fibre element.

For cable installation on the bank, vertical injector is considered as the most realistic solution for achieving the needed burial without high CAPEX or extreme environmental impact. The vertical injector installation must be considered for both export and array cables. As an alternative to the vertical injector, the cable installation of export cable from the Arklow Bank to landfall could be a combination of ploughing, jetting and where needed burial depth is below the acceptable target, the cable protection will comprise of a combination of rock installation, concrete mattress, rock bags or cast-iron shells. However, if a vertical injector setup is mobilised for export and array cable installation on the bank, it will be favourable for the project to use it for the complete export cable installation campaign if the cable burial assessment deems it suitable for the task.

The sand bank mobility and the expected lifetime should be considered when engineering the cable access solution for OSSs and WTGs preventing free hanging, suspended and exposed export cables. A Cable Protection System (CPS) should be used for cable accessing the offshore structures taking the mobile seabed conditions into consideration. The final solutions for protection of the export cables will be confirmed during detailed design.

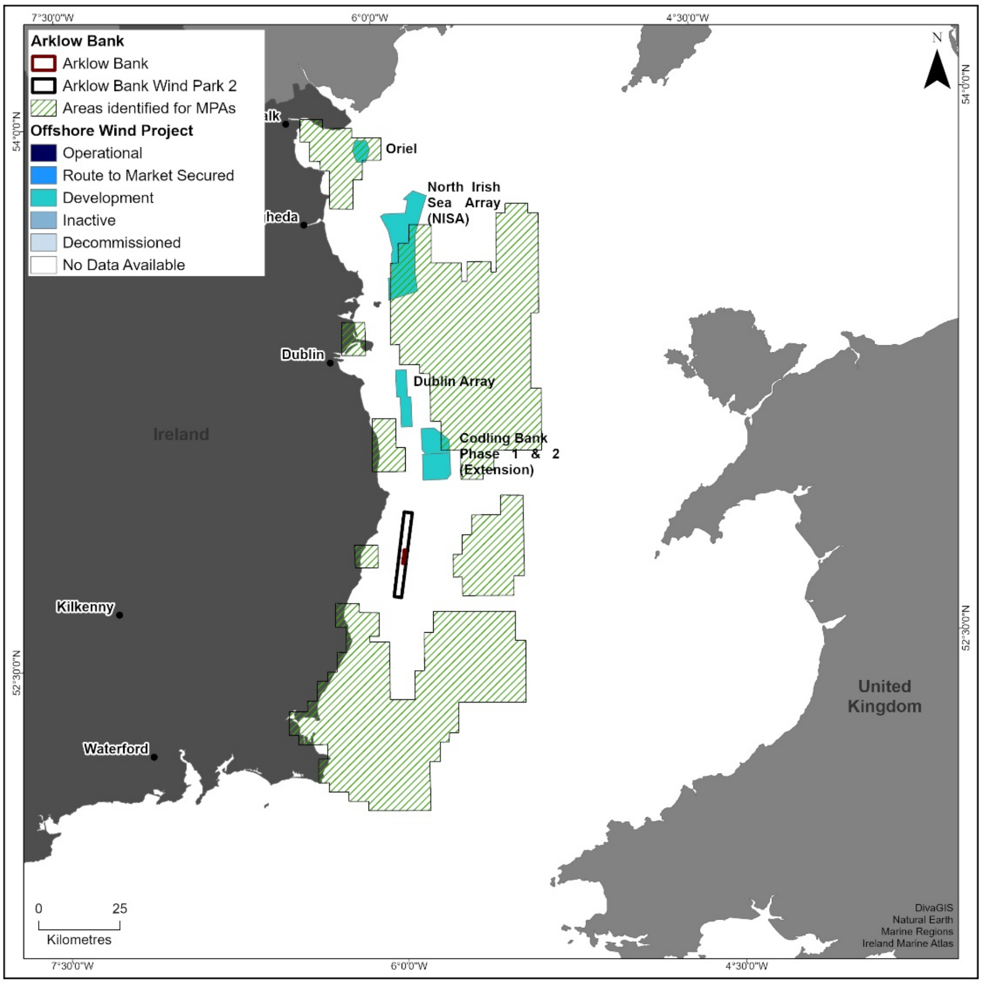
FIGURE 4.29 ARKLOW BANK CABLE ROUTE (FIGURE PREPARED BY SPL)



5. ECOLOGICAL SENSITIVITY ANALYSIS

Conservation prioritisation analysis was carried out by The Marine Protected Area Advisory Group to identify areas of high and low priority for protection, considering current and proposed future sectoral activities. The advisory group identified forty biological and environmental features for spatial protection. The suitable areas identified for potential MPAs are shown on the map in Figure 5.1 alongside the location of Arklow Bank Wind Park 2. All offshore wind farms in development are either overlapping or in very close proximity to the areas identified to be suitable for MPAs, apart from Arklow Bank Wind Park 2. Arklow Bank and Arklow Bank Wind Park 2 are the furthest projects away from the areas identified for MPAs, the closest being over 6 km away. Key datasets from the constraints identified for the ESA have been mapped out alongside Arklow Bank Wind Park 2 in the sections below. The highest risk has been identified with spatial protection, shipwrecks and fishing. However, none of these constraints are severe enough for Arklow Bank to be identified within a potential MPA.

FIGURE 5.1 ECOLOGICAL OVERVIEW OF OFFSHORE WIND FARMS (FIGURE PREPARED BY ERM)



5.1 SEABED HABITATS

The western Irish Sea is characterized by a series of north-south trending linear sandbanks of 20m water depth, an example being Arklow Bank. These sandbanks provide a diverse habitat of burrowing fauna including worms, crustaceans, and molluscs. Surrounding estuaries, tidal mudflats, and sandflats host a significant number of migratory birds, particularly in the winter months. Directly north of Arklow Bank is the Wicklow Reef SAC, a subtidal reef constructed by the honeycomb worm. These habitats have potential to be disturbed by the construction of Arklow Bank Wind Park 2 Offshore Wind Farm and potentially be a major constraint.

FIGURE 5.2 ESA SEABED HABITATS (SOURCE: THE MARINE PROTECTED AREA ADVISORY GROUP, 2023)

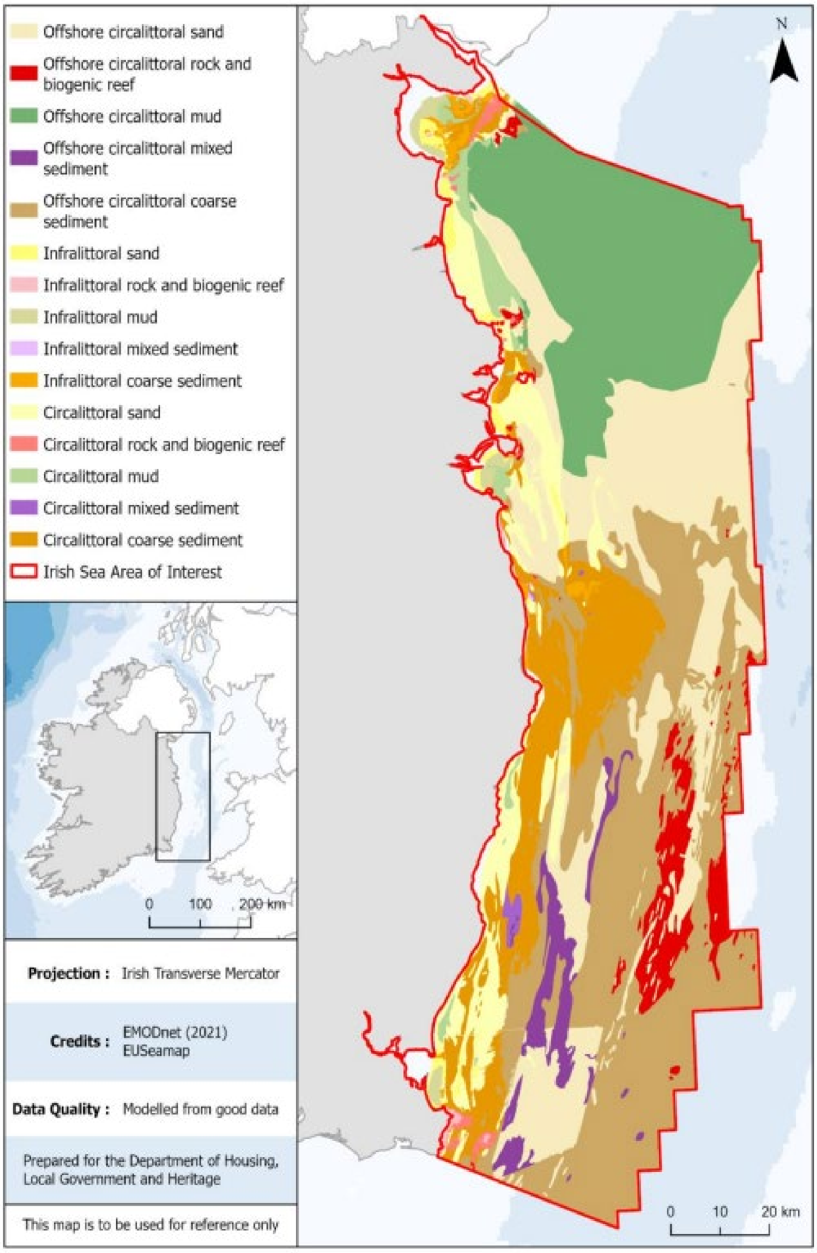


Figure 2.1.1. Broadscale seabed habitat map showing MSFD classifications from the EMODnet EuSeaMap v2021 habitat map for Europe (Vasquez et al., 2021).

5.2 SPATIAL PROTECTION

SPAs are designed to protect specific bird species under the EU Birds Directive and SACs are established under the Habitats Directive. Directly north of the Arklow Bank Wind Park 2 site is the Wicklow Head SPA, Wicklow Reef SAC, and the Murrough SPA. The Wicklow Head SPA protects a nationally important population of Kittiwake and supports a pair of breeding Peregrine. The Murrough SPA protects 34 species of bird including heron, owl, and goose. This could be a potential constraint for the project if migratory routes overlap with the site.

FIGURE 5.3 ESA SPATIAL PROTECTION (SOURCE: THE MARINE PROTECTED AREA ADVISORY GROUP, 2023)

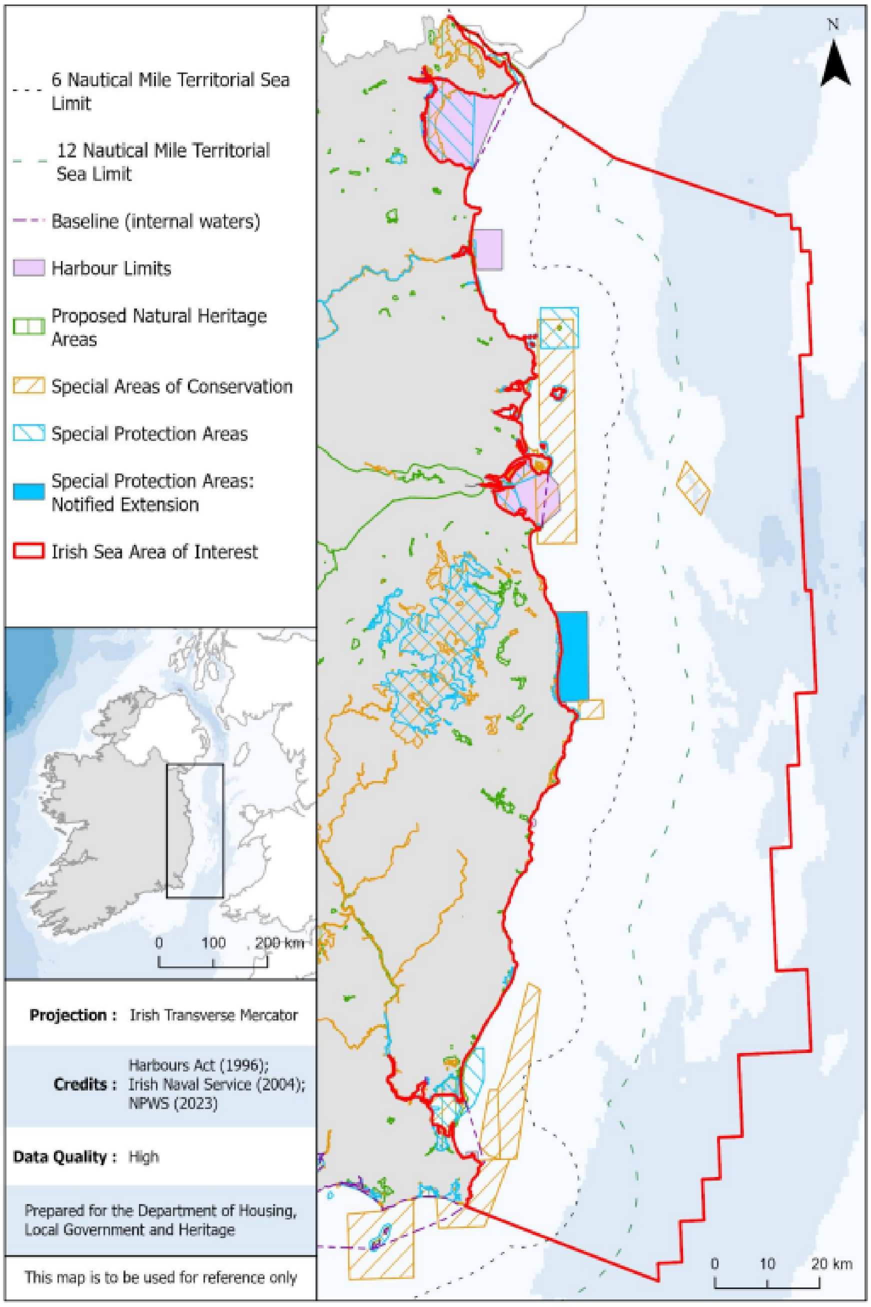


Figure 2.1.2. Existing spatial protection (SACs, SPAs and NHAs), Territorial Sea limits, and harbour limits in the western Irish Sea. The 6nm and 12nm limits are buffered from the coastline and the closing baselines of Dundalk Bay, Dublin Bay and Wexford Bay. Data quality: high.

5.3 SHIPWRECKS

The western Irish Sea has a high abundance of shipwrecks recorded by the Wreck Inventory of Ireland, many of which are protected. Dublin Bay has a particularly high density of shipwrecks due to the strong tides. Sandbanks were another cause of shipwrecks, evident by the strip of wrecks along Arklow Bank. This could be a significant constraint for the offshore wind project as most of these wrecks are protected.

FIGURE 5.4 ESA SHIPWRECKS (SOURCE: THE MARINE PROTECTED AREA ADVISORY GROUP, 2023)

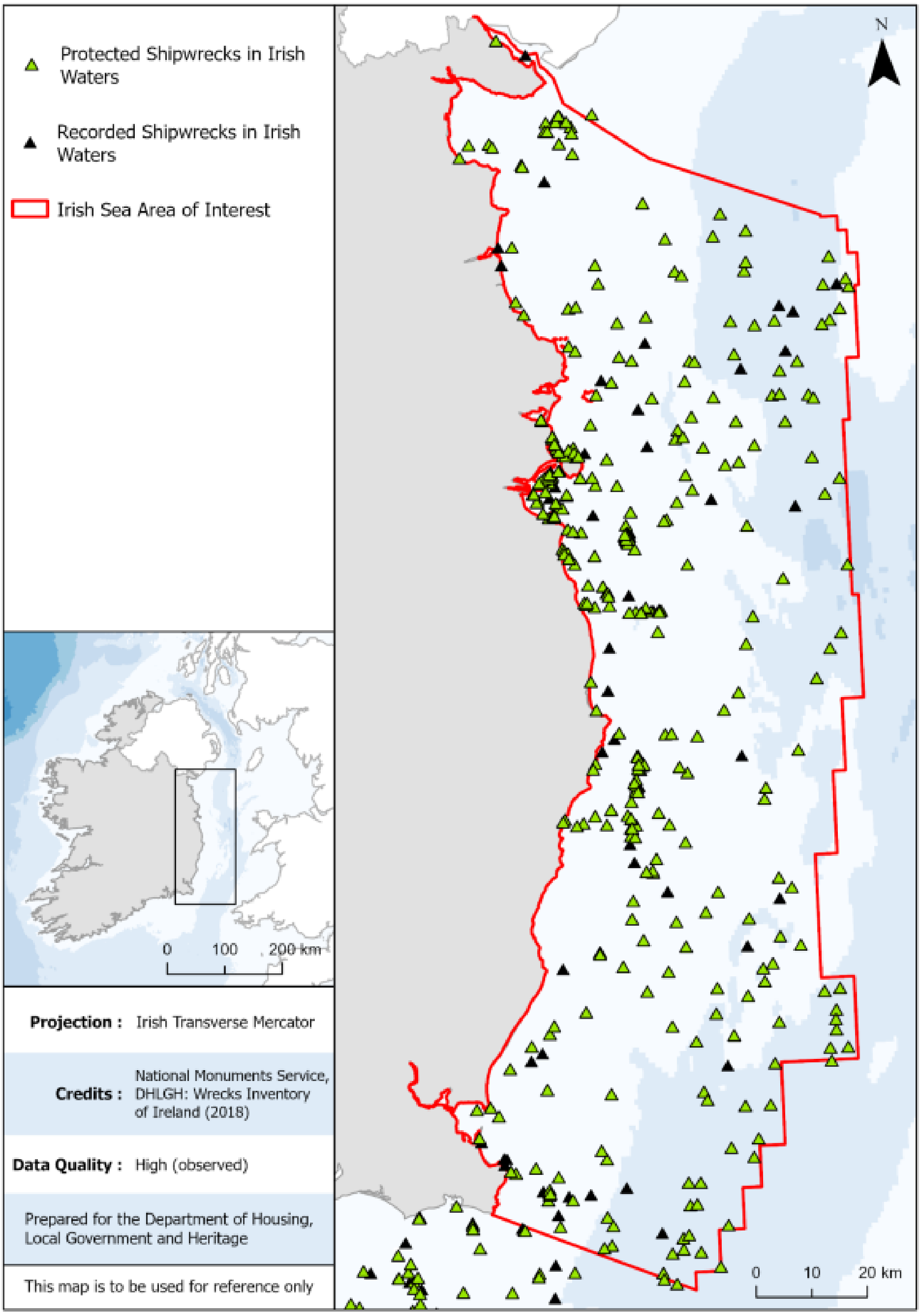


Figure 2.1.3. Shipwrecks in the western Irish Sea, recorded and protected.

5.4 FISHING

The main fishing activities in the western Irish Sea occur on the northern and western sides of the area of interest. The spatial distribution of fish species is driven by specific habitats and conditions such as sediments and currents. In the south Irish Sea the currents are stronger and sediments are coarser, so fisheries for scallops, rays, and mixed demersal fish are present. Towards the coast, there is an extensive pot fishery for whelk along the slopes of the sandbanks. Mussel beds are present at the edge of sandbanks which are fished in autumn by large dredging vessels. Arklow Bank sits within the pot fishing areas which could be a significant constraint for the offshore wind project.

FIGURE 5.5 ESA FISHING (SOURCE: THE MARINE PROTECTED AREA ADVISORY GROUP, 2023)

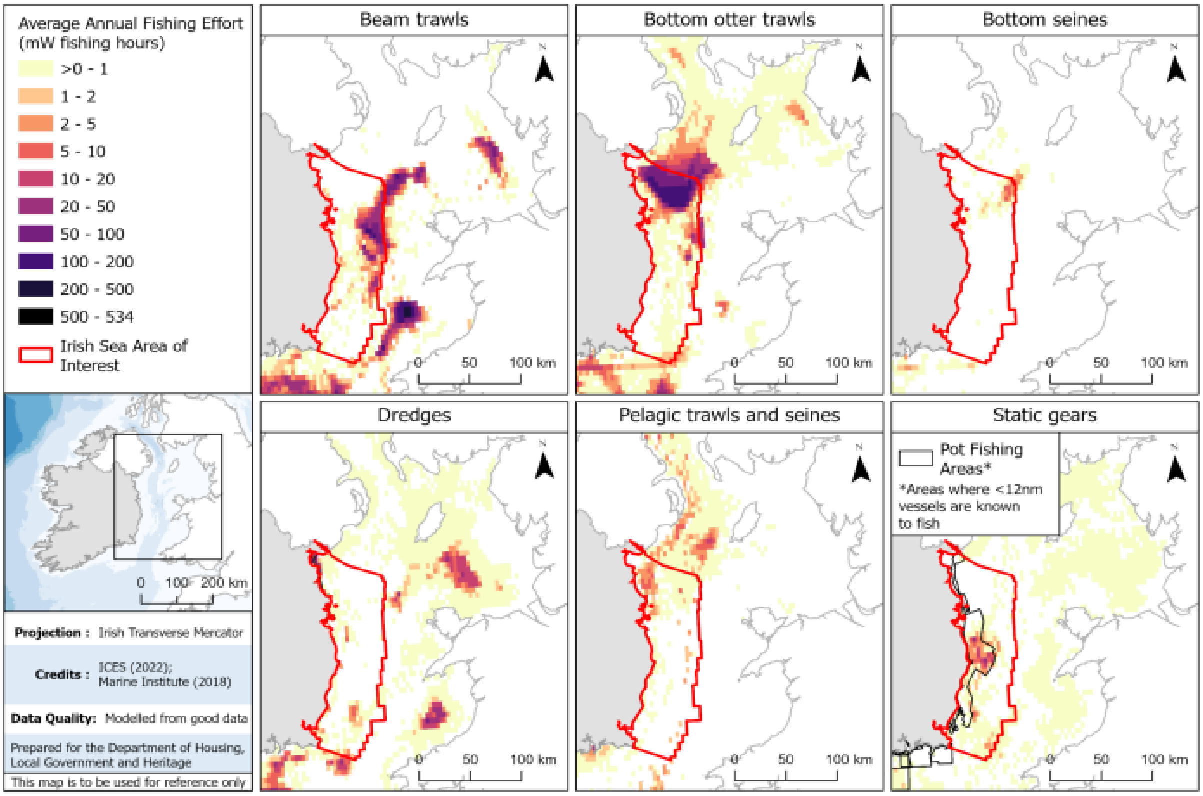


Figure 2.2.1. Average annual total fishing effort (mW fishing hours) for the main commercial fishing gear types used in the Irish Sea. International VMS data is 2018-2021 average. National inshore VMS (iVMS) data is available for certain areas but not visible at this resolution. Static gears include gill nets, trammel nets, traps and lines.

5.5 CARGO VESSEL ACTIVITY

Ireland is heavily reliant on maritime transport, shown by the level of activity from cargo ships, tankers, passenger ferries, cruise liners and pleasure craft. Vessel activity is concentrated in the vicinity of ports and shipping lanes, particularly Dublin Port and Warrenpoint Port. This means port availability will be limited around Arklow Bank, so vessel activity associated with offshore wind construction and O&M will have to compete with other sectors.

FIGURE 5.6 ESA CARGO VESSEL ACTIVITY (SOURCE: THE MARINE PROTECTED AREA ADVISORY GROUP, 2023)

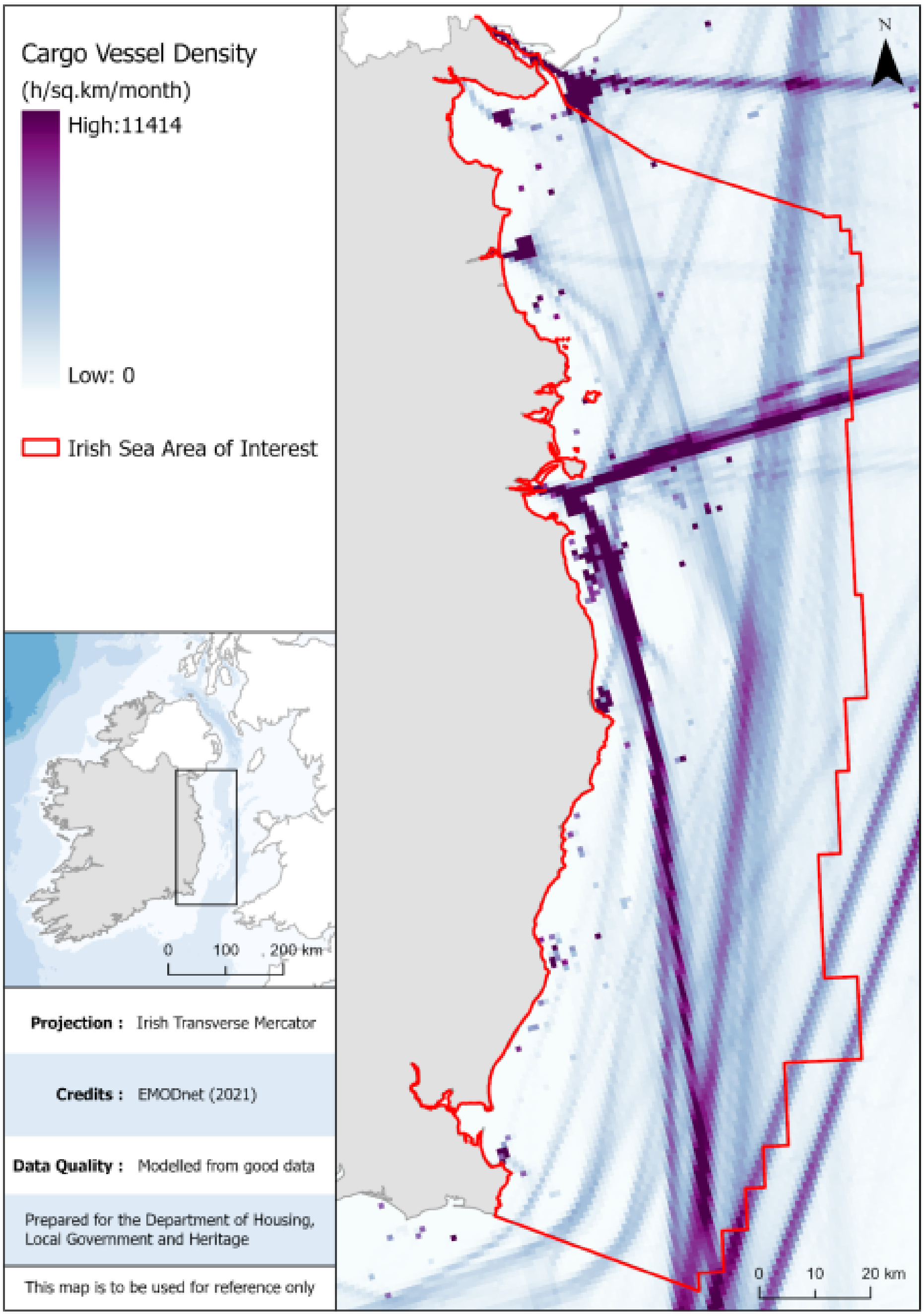


Figure 2.2.2. Density of cargo vessel transits in the western Irish Sea from interpolated AIS pings.

5.6 ORE

Spatial data for Phase One offshore wind energy projects were derived from application information officially submitted to the foreshore licensing unit of the Department of Housing, Local Government, and Heritage (DHLGH). Many of the proposed offshore wind farms are concentrated in the north of Irish Sea Area of Interest which is a popular area for fishing due to the soft, muddy habitats. These projects could encounter challenges with engineering design as well as push back from fisheries. A couple of offshore wind farms have been proposed in the middle of the Area of Interest which could potentially interact with shipping lanes and SPAs/SACs.

FIGURE 5.7 ESA ORE (SOURCE: THE MARINE PROTECTED AREA ADVISORY GROUP, 2023)

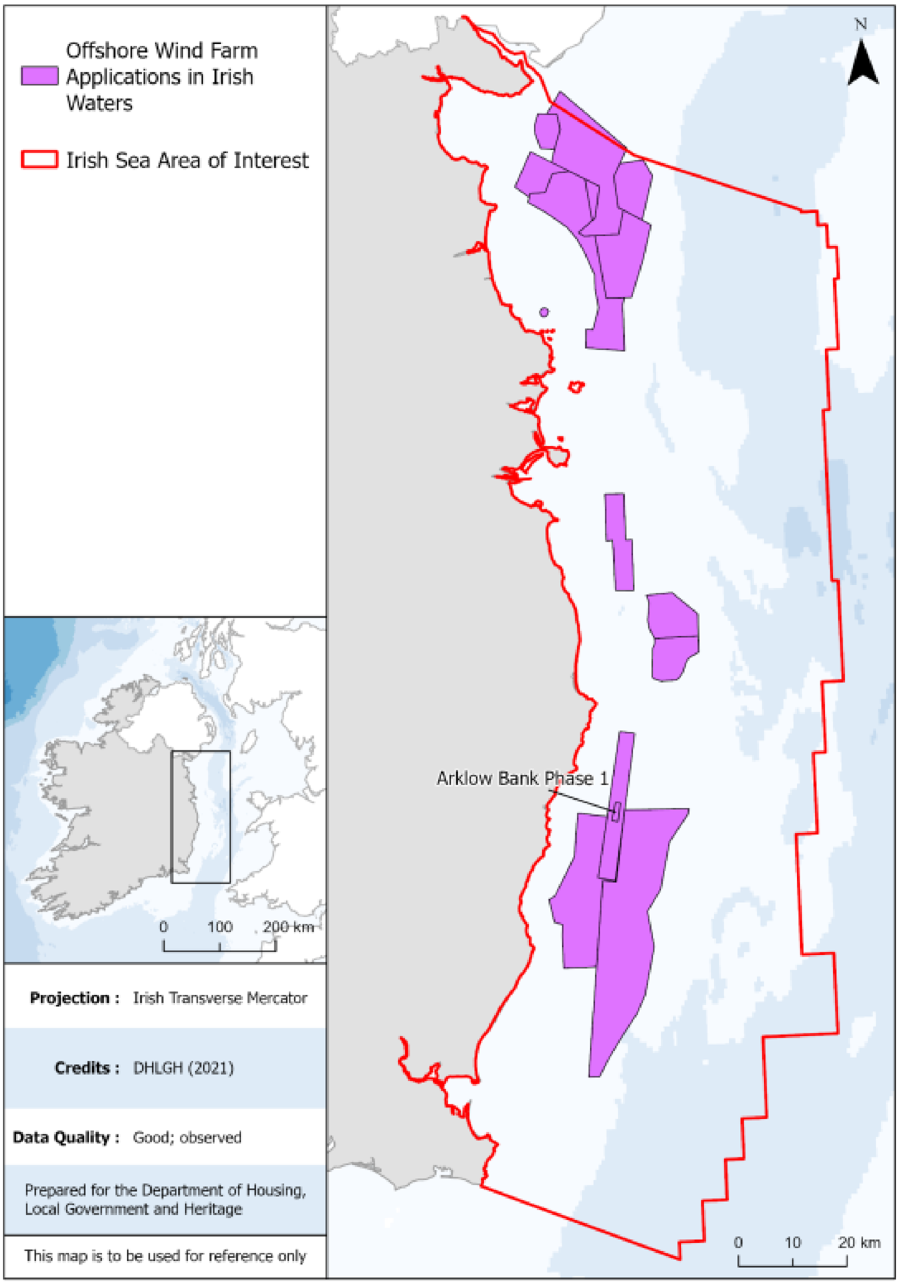


Figure 2.2.3. Outline of ORE application sites in the western Irish Sea.

6. CONSTRAINTS SUMMARY

The following table provides an overview of key factors contributing to the overall Arklow Bank Wind Park 2 project feasibility, with the constraints coloured and ranked based on their overall risk level.

- A dark red colouring indicates a severe risk, which could lead to project termination if left unmitigated.
- Light red indicates a major risk to project progress and/or project margins.
- An amber colour indicates a moderate risk, which while may have impacts should not be considered a significant risk to project development and has feasible mitigation options.
- A light green colour indicates a minor risk to the project, which may have some effect on the project margins or other factors.
- A dark green rating indicates a constraint with no expected or only slight impacts to the project based on the available data.

TABLE 6.1 CONSTRAINTS SUMMARY

Constraint & Risk Level	Consideration
Resource & Wind Climate	Site average wind speeds at 150 m above MSL in excess of 10 m/s make the resource ideally suited to OSW development. Combining this with the moderate seasonal variance, the resource is well suited throughout the year. Storms and extreme winds do not appear to pose a significant risk from the analysed data.
Bathymetry	The majority of the ABWP2 site is located on a sandbank with a gentle slope which has water depths between 25 m and 40 m, suitable for fixed-bottom foundations. Some areas along Arklow Bank within the site have been documented as having depths of as little as 0.6 m, which should be considered in the construction and installation strategy.
Seabed Conditions	The lithology within the ABWP2 site is primarily sandstone with some metamorphic rock, and the substrate is coarse-grained sediment with some mixed sediment. Sands are well suited for all fixed-bottom offshore wind foundations. Between ABWP2 and shore, the lithology is primarily slate, and the substrate is coarse-grained sediment which indicates a high energy environment. A Cable Burial Risk Assessment (CBRA) and Burial Assessment Summary (BAS) must be performed to investigate the needed burial depths.
Metocean Conditions	Mean wave heights of 0.5-0.75 m within the site do not present a significant constraint, with OSW farms having been commissioned in rougher conditions throughout the North Sea. Extreme wave heights also appear similar to those encountered in operational OSW farms. The site is located in proximity to a zero-tide point, making tidal ranges relatively limited. Strong currents further offshore may affect seabed mobility at the site however and could impact design considerations.

Constraint & Risk Level	Consideration
Ports	Most major Irish ports are located along the south and east coasts, with OSW-specific development plans in motion at Rosslare and Cork and a new ORE terminal in development at Bremore, although quays may not be constructed in time for the installation of WTGs at the ABWP2 site. Rosslare's development plans show limited laydown area and depths unsuited to large OSW vessels. Port space may be available at Dublin, or Belfast if Northern Ireland/UK is a possibility. Engagement with Bremore port owners to confirm availability timelines and with Rosslare port owners to advise further dredging and secure as much area as possible is advised to minimise risks to project development.
UXOs, Wrecks & Archaeology	There is no known UXO presence based on the available data. Site surveys have revealed multiple wrecks around Arklow Bank which may require mitigation in the form of further surveys, micrositing and consideration during seabed installation. Major impacts to project development are not expected.
Environmentally Designated Areas	There are no SPAs, SACs or Ramsar sites within the project areas. However, designated areas along the coast protect geological formations, biodiversity, and wetland birds, warranting caution during surveying, cable routing, and development. The SACs near the project, including Kilpatrick Sandhills, Buckroney-Brittas Dunes and Fen, and Magherabeg Dunes, safeguard diverse habitats crucial for biodiversity, but their features-focused protection minimizes direct impact on project development.
Ornithology	The east coast of Ireland and the Irish Sea are important to several seabird species at a regional level. Furthermore, classified SPA populations within this region are protected under the EU Birds Directive (Directive 2009/147/EC) and under European Communities (Birds and Natural Habitats) Regulations 2011 (as amended) (S.I. No. 477/2011) Ireland. The level of legal protection assigned to classified populations and their supporting habitats makes this constraint relatively high and poses a potential development risk.

Constraint & Risk Level	Consideration
Marine Mammals & Turtles	The majority of SACs for marine mammals are located on the west coast. Furthermore, of the 25 plus species of cetacean recorded in Irish waters, primary distribution is over continental shelf and shelf edge. Those with coastal distribution include harbour porpoise and grey seals, which have a significant presence in the Irish Sea. Consideration must be given to disturbance of species through underwater noise impacts alongside temporary habitat loss. Cetaceans are classified as Annex IV species.
Benthic Ecology	The benthic ecology is primarily circalittoral sand with sections of infralittoral coarse sediment. Sand is the preferred sediment type for foundation installation over coarse sediment. However, circalittoral sand provides habitat for many species. This may affect turbine placementt.
Fish Spawning Grounds	The site is located within a zone of fish spawning for lemon sole and sprat, neither of which are commercially protected species and are in fact commercially targeted. However, sprat are likely to be an important prey species for Kittiwake colonies at Wicklow Head SPA. There is potential for temporary, direct habitat loss and disturbance to fish habitats. Consultations have been taken throughout the EIA process to assess the impacts.
Shipping	The shallow bank is marked by buoys to the north and south extremes of the site, with vessels avoiding the buoys and the ABWP1 WTGs between them which are also marked. Some leisure vessels do enter the site but as an area already avoided by commercial vessels there is very little risk associated to shipping.
Fishing	Fishing activity levels in the area surrounding ABWP2 appears lower than in other regions within the Irish EEZs and larger fishing vessels tend to avoid areas within the project site boundaries. It is expected that there is a presence of smaller fishing vessels not picked up by AIS data in the region however, which has caused complications in the development of other nearby offshore wind projects. Understanding the impact of the Project on fish populations within the area and consultation with fisheries is recommended to mitigate risks to project development.

Constraint & Risk Level	Consideration
Visual & Seascape	ABWP2 is located within 5-15 km of areas of tourism and recreational uses, increasing the possibility of opposition due to visual impacts and posing a risk to the project's continued development. There are multiple scenic beaches and walks along the coast adjacent to the site which could pose a risk, as well as mountains and peaks overlooking the site. Extensive engagement with local communities has been carried out regarding the project and a relationship has been established, potentially mitigating this risk although continued engagement is strongly advised.
Military & Aviation	There are no military areas or airports within 60 kilometres of ABWP2 and thus any risks to project development are considered minimal. However, early consultation with the Irish Aviation Authority, the Department of Defence and airports are still recommended to confirm that there is no major interference and disruptions expected.
ORE Installations	Given ABWP2 has been granted a MAC and there are no offshore wind developments in the vicinity of ABWP2, there are no major risk to project development from other ORE Installations.
Oil & Gas Licences	There are no O&G licences within approximately 30 km of ABWP2 and thus it is expected to be a minimal constraint to the Project.
Other Offshore Users	The presence of DaS and aquaculture sites close to ABWP2 are not considered significant constraints to development with sufficient consultation with the permit holders.
Cables & Pipelines	There were no subsea cables or pipelines identified traversing the site or the export route corridor.
Connection Point	The dedicated 220 kV site connection point is included in EirGrid's development plan and is scheduled for completion by July 2027. No alternative connection points were identified.

Constraint & Risk Level	Consideration
Cable Route	The optimal export cable corridor solution for connection of the North-South OSS design is two separate export corridors, each 20 km in length. The current OSS design has no redundancy and will cause significant impacts in case of a single export cable fault. The option for two cables results in separate trenches, with a planned corridor of up to 20 m wide and a burial depth (outside the bank) of up to 2.5 m depending on the seabed conditions. A Cable Burial Risk Assessment (CBRA) and Burial Assessment Summary (BAS) must be performed to investigate the optimal routes and burial depths taking seabed conditions, marine traffic, environmental and other aspects into consideration.
Interaction with Environmental Sensitivity analysis	All offshore wind farms in development are either overlapping or in very close proximity to the areas identified to be suitable for MPAs, apart from ABWP2. ABWP2 is the furthest offshore wind development from the areas identified for MPAs, the closest being over 6 km away.

7. KEY CONSTRAINTS & PROJECT FEASIBILITY

Overall, ABWP2 represents a favourable site in the context of Irish offshore wind. An excellent wind resource combined with calmer metocean conditions than in most other areas of the Irish exclusive economic zone, and depths well suited to fixed-bottom foundations, make the site attractive from an engineering perspective.

There are several risks from the potential environmental impacts of the project. The pairing of potential disruption to small-scale fishing resulting in opposition from local fishing organisations with the high level of protection of several bird species in the local area makes extensive engagement with local stakeholders a requirement for risk management, which the developer has done through the appointment of a fisheries liaison officer. Ornithology is a key risk to project development and will possibly require some mitigation. The presence of harbour porpoise and grey seals within the Irish sea may necessitate consideration of their disturbance. The extensive presence of circalittoral sand habitats may require mitigation during the siting of turbines and seabed infrastructure. Finally, the ABWP2 site's proximity of 6-15 km from shore, including popular recreational and tourism destinations, makes visibility from land certain and potentially impactful on local communities and businesses. Extensive and early-stage engagement has been held with local communities to help mitigate potential impacts, but the risk should be managed carefully during WTG selection through continued engagement.

As discussed previously, seabed substrates at the ABWP2 site present mixed suitability to fixed-bottom WTG foundations, with sand in some areas which is well suited, but some areas of coarse-grained sediment which may complicate installation. The underlying bedrock has been identified as sandstone, which is generally suited to monopile installation. Along the cable routes, sand, muddy sand and coarse-grained sediments are present which while on their own do not present a significant risk, when in a high-energy environment arising from currents such as those seen in the region, require deeper cable burial depths and other mitigations. The slate bedrock identified along the cable route is not well suited to burying cables given its hard and brittle nature. Substrate thickness will be a key factor in determining the cable routes. The optimal export cable solution is two separate corridors approx. 20 km in length each (total length of 40 km). A Cable Burial Risk Assessment (CBRA) and Burial Assessment Summary (BAS) must be performed to investigate the precise cable routes and necessary cable burial depths.

There is some risk to project development from a lack of ports suited to support WTG marshalling activities in Ireland within the project timelines. Rosslare enabled the installation of the WTGs at Arklow Bank but has limited area and depths when considering the size of current and future generation WTGs and the size of the required vessels. The in-development port at Bremore would be well suited to the ABWP2 project, but quays are not expected to be available in time. Belfast Port's purpose-built D1 facility or options along the west coast of England may be suitable if considering options outside of ROI.

The ESA identified suitable areas for MPAs, and ABWP2 has the best location in comparison to all other proposed offshore wind farms on the east coast of Ireland. The other offshore wind farms are either overlapping or in very close proximity to identified areas for MPAs. Key datasets from the analysis were mapped out alongside ABWP2, and the highest risk was identified with spatial protection, shipwrecks and fishing.

8. CONCLUSIONS & RECOMMENDATIONS

Following the ABWP2 site selection two decades ago, constraints to offshore wind development in Ireland and identification of preferred regions were re-examined. The interaction of these and local constraints with the ABWP2 site was subsequently analysed to assess the overall project feasibility and identify key risks to project development.

Ireland-wide perspective

The Ireland-wide assessment identified extreme wave heights as a major engineering constraint, with high mean wave heights limiting the areas viable for offshore wind development relatively near the west coast, which is also further from the main demand centres on the island. In the context of the grid, the east coast is favoured as fewer grid upgrades would be required for large-scale OSW development. Environmentally sensitive areas are also more common along the north and west coasts, although impacts on marine mammals and bird populations will require careful consideration in all regions. Shipping vessel activity was found to be highest along the east coast, with most major ports and routes located on the Irish Sea. In terms of ports suited to support offshore wind development, the west coast has relatively limited options while the south and east coasts were found to have several ports with existing and upcoming offshore wind facilities, in addition to benefitting from being nearer UK ports.

A summary table of ERM's understanding of the regional constraints to OSW development is provided below, making use of the same colour scheme detailed in the Constraints Summary section above (section 6).

TABLE 8.1 REGIONAL CONSTRAINTS OVERVIEW

Constraint	East	South-east	South-west	West	North
Shipping					
Interconnection					
Biological					
Visual Sensitivity					
Seabed Conditions					
Metocean Conditions					
Fishing					
Overall Rank	*1 out of 5*	*2 out of 5*	*4 out of 5*	*5 out of 5*	*3 out of 5*

Project site

To further progress the ABWP2 development, consideration needs to be given to the presence of sensitive bird species and marine mammals, potential pushback from small-scale fishing communities and visual impacts to the local landscape. Whilst the ground conditions of the project site are largely favourable to fixed foundations, the conditions may be less favourable along the export cable routes to shore, which could have implications for CAPEX and/or in the chosen cable routes within the corridors. Using the findings from the ESA report, the location of ABWP2 is not constrained with regard to the sites identified for MPAs.

9. AUTHORS

Expert	Qualifications	Relevant Experience
Gareth Lewis	BSc Biology University of Plymouth MSc Underwater Technology Cranfield	Partner ERM, global lead for development services Project Director, Seagreen Offshore Wind Farm Head of Development, Dogger Bank Teeside and Breyke Beck consent
Ross McNally	Bachelor's Degree Geography Planning and Environmental Policy, University College Dublin Masters Degree Energy Technology with focus on Wind Power Project Management, Uppsala University	Associate Partner, ERM Programme Manager, Wind Energy Ireland
James Taylor	Masters of Engineering in Renewable Energy, University of Exeter	Associate Director, ERM Power client lead and GIS lead Renewables Advisory, ERM Principal, RCG
Bernd Okkels	BSc Electrical Engineering, Technical University of Denmark	Technical Director, ERM Head of New Technologies, Ramboll Head of Offshore Cable Installation, Orsted Project Manager Grid Connection, Orsted
Madeleine Tholen	MSc Geophysics University of Southampton	Consultant, ERM Market Analyst, 4C Offshore
Taliesin Slatter	BEng Engineering Physics Aberystwyth University MSc Sustainable Energy Technologies, University of Southampton	Consulting Senior Associate, ERM
Mark Wilson	Bachelor's Degree in Geography, University of Southampton	Associate, ERM GIS Consultant, PJA GIS Operator, Worldpop

Sean Peedle	Natural Sciences, Materials Science University of Cambridge	Consultant, ERM
Jordanna Palmer	B.A Political Science; Sociology, Macalester College	Consultant, ERM Research Fellow, The Fullbright Program
Josiah Mault	B.S Atmospheric Sciences, University of Washington	Principal, ERM Senior Team Leader, DNV
Roy Spence	BSc/BS Mechanical Engineering, University of Strathclyde PhD Mechanical Engineering, Cranfield University	Technical Director, ERM Technical Leader, Wood
Liam Dickson	BSc Wildlife Biology, University of Guelph MSc Marine Environment and Resources, University of Southampton/University of Liège/University of the Basque Country PhD Marine Spatial Ecology, Queen Mary University of London	Senior Marine Consultant, ERM
Liam Porter	BSc (Hons) Environmental Conservation, Sheffield Hallam University MSc Marine Environmental Protection, Prifysgol Bangor University	Senior Marine Consultant, ERM Marine Consultant, MarineSpace

10. REFERENCES

10.1 GIS DATASETS

CEFAS, all data are available under the terms of the UK Open Government Licence http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

© Duke University

Department of the Environment, Climate & Communications (DCCAE): https://www.dccae.gov.ie/en-ie/natural-resources/topics/Oil-Gas-Exploration-Production/data/Pages/Spatial-(GIS)-Data.aspx

DivaGIS, 2011: http://www.diva-gis.org/Data

Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N. and Brown, M. 2010. Mapping the spawning and nursery grounds of selected fish for spatial planning. Report to the Department of Environment, Food and Rural Affairs from Cefas

© EMODnet Geology, European Commission, 2019

© EMODnet Human Activities: Shipping Density

© European Environment Agency (EEA), 2022

European Maritime Safety Agency (EMSA) produce Traffic Density Maps (TDM's) to support the VTMIS purposes and objectives

Flanders Marine Institute (2019). Maritime Boundaries Geodatabase: Maritime Boundaries and Exclusive Economic Zones (200NM), version 11. Available online at http://www.marineregions.org/. https://doi.org/10.14284/386

GEBCO Compilation Group (2019) GEBCO 2019 Grid (doi:10.5285/836f016a-33be-6ddc-e053-6c86abc0788e)

Global Fishing Watch data is licensed under a Creative Commons Attribution-ShareAlike 4.0 International license and code under an Apache 2.0 license

Global Wind Atlas 3.0, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU). The Global Wind Atlas 3.0 is released in partnership with the World Bank Group, utilizing data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info

© Government of Ireland. This data has been released for download as Open Data under the DPER Open Data Strategy and is licensed for re-use under the Creative Commons Attribution 4.0 International licence.

© Government of Ireland. This dataset was created by the National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht. This copyright material is licensed for re-use under the Creative Commons Attribution 4.0 International license. http://creativecommons.org/licenses/by/4.0/

© Ireland Marine Atlas, 2020

Made with Natural Earth. Free vector and raster map data @ naturalearthdata.com.

© National Mapping Division of Tailte Éireann

NGIA: The World Port Index Prepared and published by the National Geospatial -Intelligence Agency

© OpenStreetMap contributors. OpenInfraMap https://openinframap.org

© RSPB, protected under CC 4.0 Deed

Rose, K.; Bauer, J.; Baker, V.; Bean, A.; DiGiulio, J.; Jones, K.; Justman, D.; Miller, R. M.; Romeo, L.; Sabbatino, M.; Tong, A. Development of an Open Global Oil and Gas Infrastructure Inventory and Geodatabase; NETL-TRS-6-2018; NETL Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Albany, OR, 2018; p 594; DOI: 10.18141/1427573.

10.2 TEXT REFERENCES

10.2.1 ORNITHOLOGY

Bradbury, G., Trinder, M., Furness, B., Banks, A.N., Caldow, R.W.G. & Hume, D. (2014). Mapping Seabird Sensitivity to Offshore Wind Farms. *PLoS ONE*, 9(9), e106366.

Burnell, D., Perkins, A.J., Newton, S.F., Bolton, M., Tierney, T.D. & Dunn, T.E. (2023). *Seabirds Count A census of breeding seabirds in Britain and Ireland (2015-2021)*. Lynx Nature Books, Barcelona, Spain. 528 pp.

Cummins, S., Lauder, C., Lauder, A. & Tierney, T.D. (2019). *The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013 – 2018.* Department of Communications, Climate Action & Environment and National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland. 78 pp.

EEA (2023). *Natura 2000 Viewer*. European Environment Agency. Available online at: https://natura2000.eea.europa.eu/ [Accessed November 2023].

Furness, R.W., Wade, H.M. & Masden, E.A. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management, 115*, pp. 56-66.

Jessopp, M., Mackey, M., Luck, C., Critchley, E., Bennison, A. & Rogan, E. (2018). *The seasonal distribution and abundance of seabirds in the western Irish Sea.* Department of Communications, Climate Action & Environment and National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland. 90 pp.

JNCC (2016). *DEPARTMENTAL BRIEF Irish Sea Front potential SPA.* Joint Nature Conservation Committee (JNCC), Peterborough, UK. 19 pp.

JNCC (2023). *Seabird Censuses*. Available online at: https://jncc.gov.uk/our-work/seabird-censuses/ [Accessed December 2023].

NPWS (2011). *Site Synopsis: Lambay Island SPA.* National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland. 2 pp.

NPWS (2012). *Site Synopsis: Saltee Islands SPA.* National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland. 2 pp.

NPWS (2023). *Special Protection Areas (SPA).* National Parks and Wildlife Service. Available online at: https://www.npws.ie/protected-sites/spa [Accessed November 2023].

Rogan, E., Breen, P., Mackey, M., Cañadas, A., Scheidat, M., Geelhoed, S. & Jessopp, M. (2018). *Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017*. Department of Communications, Climate Action & Environment and National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland. 297 pp.

Wade, H.M., Masden, E.A., Jackson, A.C. & Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. *Marine Policy*, 70, pp. 108-113.

Wakefield, E.D., Bodey, T.W., Bearhop, S., Blackburn, J., Colhoun, K., Davies, R., Dwyer, R.G., Green, J.A., Grémillet, D., Jackson, A.L., Jessopp, M.J., Kane, A., Langston, R.H.W., Lescroël, A., Murray, S., Nuz, M., Patrick, S.C., Péron, C., Soanes, L.M., Wanless, S., Votier, S.C. & Hamer, K.C. (2013). Space Partitioning Without Territoriality in Gannets. *Science*, 341, pp. 68-70.

Wakefield, E.D., Owen, E., Baer, J., Carroll, M.J., Daunt, F., Dodd, S.G., Green, J.A., Guilford, T., Mavor, R.A., Miller, P.I., Newell, M.A., Newton, S.F., Robertson, G.S., Shoji, A., Soanes, L.M., Votier, S.C., Wanless, S. & Bolton, M. (2017). Breeding density, fine-scale tracking, and large-scale modeling reveal the regional distribution of four seabird species. *Ecological Applications*, 27(7), pp. 2074-2091.

10.2.2 MARINE MAMMALS

Anderwald, P.,A.K. Daníelsdóttir,T. Haug, F. Larsen,V. Lesage, R.J. Reid, G.A.Víkingsson, & Hoezel, A.R. (2011). *Possible cryptic stock structure for minke whales in the North Atlantic: implications for conservation and management*. Biological Conservation, 144, pp. 2479-2489.

Berrow, S.D., Whooley, P., O'Connell, M., & Wall, D. (2010). *Irish Cetacean Review (2000-2009)*. Irish Whale and Dolphin Group, pp. 1-60.

Botterell, Z., Penrose, R., Witt, M., & Godley, B. (2020). *Long-term insights into marine turtle sightings, strandings and captures around the UK and Ireland (1910–2018).* Journal of the Marine Biological Association of the United Kingdom, 100(6), pp. 869-877.

Cronin, M. (2010). *The status of the harbour seal (Phoca vitulina) in Ireland*. NAMMCO Sci. Publ. 8, pp. 129-142.

Cronin, M., Duck, C., Ó Cadhla, O., Nairn, R., Strong, D. & O' Keeffe, C. (2007). *An assessment of population size and distribution of harbour seals in the Republic of Ireland during the moult season in August 2003*. Journal of Zoology, 273, pp. 131-139.

Doyle, T., (2007). *Leatherback Sea Turtles (Dermochelys coriacea) in Irish waters*. Irish Wildlife Manuals, No. 32. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland.

EEA (2023). *Natura 2000 Viewer*. European Environment Agency. Available online at: https://natura2000.eea.europa.eu/ [Accessed November 2023].

Gilles, A., Authier, M., Ramirez-Martinez, N.C., Araújo, H., Blanchard, A., Carlström, J., Eira, C., Dorémus, G., Fernández Maldonado, C., Geelhoed, S.C.V., Kyhn, L., Laran, S., Nachtsheim, D., Panigada, S., Pigeault, R., Sequeira, M., Sveegaard, S., Taylor, N.L., Owen, K., Saavedra, C., Vázquez-Bonales, J.A., Unger, B., & Hammond, P.S. (2023). *Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys.* Final report published 29 September 2023. Pp.64.

Irish Whale and Dolphin Group (IWDG) (2019). *Harbour Porpoise*. Available online at: https://iwdg.ie/harbour-porpoise/ [Last accessed Nov 2023].

Lacey, C., Gilles, A., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Sveegard, S., Vingada, J., Viquerat, S., Øien, N., & Hammond, P.S., (2022). *Modelled density surfaces of cetaceans in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys*. University of St Andrews, UK.

National Parks and Wildlife Services (NPWS), (2019). *The Status of EU Protected Habitats and Species in Ireland*. Volume 3: Species Assessments. Unpublished NPWS report.

O'Brien, J., Berroz, S., McGrath, D., & Eyans, P. (2009). *Cetaceans in Irish waters: A review of recent research*. Biology and Environment: Proceedings of the Royal Irish Academy, 109B(2), pp. 63-88.

Ó Cadhla, O., Keena, T., Strong, D., Duck, C., & Hiby, L. (2013). *Monitoring of the breeding population of grey seals in Ireland, 2009 – 2012*. Irish Wildlife Manuals, No. 74. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Dublin, Ireland. Morris C, and Duck C, 2019. Aerial thermal-imaging survey of seals in Ireland 2017 to 2018. National Parks and Wildlife Service. Irish Wildlife Manuals, No.111, 2019.

Rogan, E., Breen, P., Mackey, M., Cañadas, A., Scheidat, M., Geelhoed, S., & Jessopp, M. (2018). *Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017*. Department of Communications, Climate Action and Environment and National Parks and Wildlife Service (NPWS), pp. 297.

Saunders, R., O'Donnell, C., Campbell,A., Lynch, D., Egan,A., Lyons, K. and Wall, D. (2010). *Celtic Sea Herring Acoustic Survey Cruise Report 2010*. FSS Survey Series, Marine Institute, Oranmore, Co. Galway.

Stringell, T.B., Millar, C.P., Sanderson, W.G., Westcott, S.M., McMath, M.J., (2014). *When aerial surveys will not do: grey seal pup production in cryptic habitats of Wales*. Journal of the Marine Biological Association of the United Kingdom, 94, pp. 1155-1159.

Wall, D., Murray, C., O'Brien, J., Kavanagh, L., Wilson, C., Ryan, C., Glanville, B., Williams, D., Enlander, I., O'Connor, I., McGrath, D., Whooley, P., & Berrow, S. (2013). *Atlas of the distribution and relative abundance of marine mammals in Irish offshore waters 2005 – 2011*. Merchants Quay, Kilrush, Co.Clare: Irish Whale and Dolphin Group.

Witt, M., Broderick, A., Johns, D., Martin, C., Penrose, R., Hoogmoed, M., & Godley, B. (2007). *Prey landscapes help identify potential foraging habitats for leatherback turtles in the NE Atlantic*. Marine Ecology Progress Series, 337, pp. 231-243.

ERM HAS OVER 160 OFFICES ACROSS THE FOLLOWING COUNTRIES AND TERRITORIES WORLDWIDE

Argentina
Australia
Belgium
Brazil
Canada
China
Colombia
France
Germany
Ghana
Guyana
Hong Kong
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Kenya
Malaysia
Mexico
Mozambique

The Netherlands
New Zealand
Peru
Poland
Portugal
Puerto Rico
Romania
Senegal
Singapore
South Africa
South Korea
Spain
Switzerland
Taiwan
Tanzania
Thailand
UAE
UK
US
Vietnam

ERM Dublin
Suite 308 The Greenway,
Block C Ardilaun Court,
112 – 114 St Stephen's Green,
Dublin 2, D02 TD28
Ireland

T: +353 1 592 5960

www.erm.com