Strategic Environmental Assessment (SEA) of the Offshore Renewable Energy Development Plan (OREDP) in the Republic of Ireland

Environmental Report Volume 2: Main Report

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Chapter 1: Introduction

1 Introduction

1.1 Introduction

This Environmental Report (ER) presents the results of the Strategic Environmental Assessment (SEA) of the Offshore Renewable Energy Development Plan (OREDP) for Ireland.

The Sustainable Energy Authority Ireland (SEAI) and Department for Communications, Energy and Natural Resources (DCENR) has appointed AECOM and Metoc to undertake an SEA of the potential effects that the development of offshore renewable (offshore wind, wave and tidal developments) would have on the marine and coastal environmental of Ireland. The results of the SEA, presented in this report, have been used by the Ocean Energy Development Unit (OEDU) in SEAI and DCENR to inform the preparation of its Offshore Renewable Energy Development Plan (OREDP).

The main aim of the OREDP is to establish scenarios for the development of offshore renewables in Irish waters up to 2030 and set out a longer term vision for the growth of the offshore renewable energy sector.

1.1.1 Offshore Renewable Energy SEA Key Facts

Name of Responsible Authority	Department of Communications, Energy and Natural Resources (DCENR)
Title of Strategy	Offshore Renewable Energy Development Plan (OREDP)
What Prompted the Strategy	The objective of the OREDP is to set out scenarios for the development of offshore renewable energy in Irish waters up to 2030 and set out a longer term vision for the growth of the offshore renewable energy sector in Ireland. This is in response to a number of factors including: ➢ The requirements of the EU Renewable Energy Directive and mandatory EU renewable energy targets for 2020. ➢ Continuing interest in developing offshore wind and marine renewable energy in Irish waters ➢ Opportunity to harness electricity from offshore renewable energy for domestic consumption therefore helping to improve the diversity and security of electricity supply across Ireland. ➢ Opportunity for Ireland to become a net exporter of electricity from renewable sources to the UK and mainland Europe. ➢ Reduce reliance on onshore wind energy for meeting EU renewable energy and carbon reduction targets.
Strategy Subject	Development of offshore wind, wave and tidal energy and the marine environment
Period Covered	From 2010 to 2030
Strategy Area	Irish waters from the average mean high water mark out to the 200m water depth contour off the west and south west coast of Ireland and the Irish Exclusive Economic Area (EEZ) off the north, east and south east coast of Ireland.
Contact Point	Ocean Energy Development Unit (OEDU), Sustainable Energy Authority Ireland (SEAI), Wilton Place Dublin 2. Tel: +353 1 808 2038 Web: http://www.seai.ie/Renewables/Ocean_Energy/

1.2 Strategic Environmental Assessment (SEA)

The focus of the SEA is to carry out a formal and systematic assessment of the likely significant effects of the proposals contained within the OREDP for the future development of offshore renewable energy in Irish waters.

1.2.1 Subject of the SEA (Screening Statement)

Under Directive 2001/42/EC on the Assessment of Certain Plans and Programmes (SEA Directive), transposed into Irish Law by the EC Environmental Assessment of Certain Plans and Programmes Regulations 2004 (S.I. 435/2004), an SEA is required for plans and programmes which:

- Are likely to have **significant environmental effects**.
- Are prepared for agriculture, forestry, fisheries, **energy**, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use, and which sets the framework for future development consent of projects requiring an EIA or an 'appropriate assessment' in accordance to the Habitats Directive.
- Are subject to **preparation and/or adoption by an authority at national,** regional or local level or which are prepared by an authority for adoption, through a legislative procedure by Parliament or Government, and which are required by legislative, regulatory or administrative provisions.

Based on the following it has been determined that an SEA is required for the OREDP:

- The OREDP will be prepared for energy related development.
- The OREDP will contain scenarios for the development of offshore renewable energy, which could, in some areas off the coast of Ireland give rise to significant environmental effects.
- The OREDP is being prepared by the Department of Communications, Energy and Natural Resources (DCENR) for adoption at a national level.

1.2.2 Objectives of the SEA Directive

The objectives of the SEA Directive, as set out in Article 1, are "*to provide a high level of protection to environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development*". These objectives have been integrated into the Irish SEA Regulations.

1.2.3 Requirements of the SEA Directive

The main requirements of the SEA process include:

- Preparation of an Environmental Report where the likely significant environmental effects are identified and evaluated.
- Consulting the public, environmental authorities, and any EU Member state affected, on the Environmental Report and draft plan or programme.
- Taking account of the findings of the report and the outcome of these consultations in deciding whether to adopt or modify the draft plan or programme.
- Making known the decision on adoption of the plan or programme and how the SEA has influenced the outcome.

The main requirements of the SEA Directive are reflected in the Environmental Protection Agency (EPA) Guidance on SEA the 'Development of Strategic Environmental Assessment (SEA) Methodologies for Plans and Programmes in Ireland'. This guidance document splits the SEA process into four separate stages:

- Stage 1: Screening of Plans and Programmes.
- Stage 2: Scoping the SEA.
- Stage 3: Identification, Prediction, Evaluation and Mitigation of Potential Impacts.
- Stage 4: Consultation, Revision and Post Adoption Activities.

Each of the stages listed above comprise a series of tasks relating to the main procedural requirements of the SEA process. With regard to this SEA, Stages 1 and 2 of the SEA process have been completed. Information relating to the screening of the Offshore Renewable Energy Development Plan (OREDP) is provided in 1.2.1 above. An overview of the scope of the SEA is provided in Section 1.3.1 below and a summary of the responses received as part of consulting on the scope of the SEA is provided in Chapter 4. A summary of the key tasks relating to Stages 3 and 4 is provided in Table 1.1 below.

Table 1.1: Stages of the SEA Process as set out in the EPA Development of Strategic Environmental Assessment Methodologies for Plans and Programmes in Ireland: Synthesis Report (EPA, 2003)

SEA Tasks	Description
Stage 1: Screening of Plans and Programmes	
Task 1.1: Apply pre-screening check using decision-tree	Complete
Task 1.2: Screening, applying environmental significance criteria	Complete
Output: Screening Statement	Complete
Stage 2: Scoping the SEA	
Task 2.1: Determine the key elements of the P/P to be assessed	Complete
Task 2.2: Determine the environmental issues to be assessed	Complete – summary is included in the Environmental Report
Task 2.3: Collect and report on relevant international standards (existing and emerging) that may influence or impact on the P/P	Complete – summary is included in the Environmental Report
Task 2.4: Develop draft environmental objectives, indicators and targets to allow the evaluation of impacts based on the findings from Tasks 2.2 and 2.3	It is proposed that, due to the complexity and nature of the marine environment and associated sea users and activities, that it would be more appropriate to focus the assessment on the headline environmental issues to be assessed rather than develop 'specific' SEA objectives. Although the use of SEA objectives is not a statutory requirement of the SEA Directive or SEA Regulations 2004, it is recognised as standard practice in the SEA process as a mechanism for identifying all 'possible' effects that need to be addressed in the assessment. However, they do not always offer the flexibility required when assessing complex plans or environments, and in some cases can lead to the 'over assessment' of issues which, in the context of the OREDP may not be appropriate. The environmental issues that will be assessed as part of this SEA are listed in section 1.3.2 below.

SEA Tasks	Description
Task 2.5: identify reasonable alternative means of achieving the strategic goals of the P/P	Is covered in the Environmental Report
Output 2: Scoping Report	Complete – Scoping Report and response to scooping submissions are available for download from the SEAI website: http://www.seai.ie/Renewables/Ocean_Energy/Offshore_Renewable_SEA
Stage 3: Identification, Prediction, Evaluation and Mitigation of Potential Impacts	
Task 3.1: Establish the baseline environment (existing and future trends)	A review of the baseline environment (existing and future trends) is presented in Chapter 9 of this report. Additional technical information relating to the baseline environment is presented in referenced appendices to this report.
Task 3.2: Predicting the impact of the P/P	The main results from the assessment of the OREDP are presented in Chapters 10: Part 1 Generic Effects, 11: Part 2 Assessment of Assessment Areas, 12: Part 3 Cumulative Effects – Testing Renewable Energy Targets, 13: Part 3 Cumulative Effects of Other Plans and Programmes. The assessment includes the consideration of possible types of impact including direct and indirect, primary and secondary, short, medium and long term, temporary and permanent and cumulative effects.
Task 3.3: Evaluating the significance of impacts	The main part of the SEA process is to assess the likely significance of the potential effects of the P/P on the environment. Impact significance is a measure of a number of factors including the type and character of the potential effect (e.g. magnitude) and the sensitivity of the environment/receptor. The assessment of the potential significance of effects is included in Chapters 11, 12 and 13.
Task 3.4: Mitigate significant impacts and prepare monitoring programme.	The focus for mitigation is to identify measures to avoid, reduce, offset or compensate for any potential significant effects. In terms of the SEA, mitigation relates to measures that are included in the P/P and may include the removal or modification of policies or proposals or changes to the overall plan. In terms of this SEA, due to the nature of the environment and the development being assessed both plan level and project level mitigation measures have been taken into account. Project level mitigation measures are integrated in to the assessment of effects presented in Chapters 11, 12 and 13. Plan level mitigation measures, and a summary of the main project level mitigation measures, are included in Chapter 15. The main purpose of the monitoring framework is to develop a mechanism for identifying unforeseen environmental effects that could occur following implementation of the P/P. Further detail on proposals for monitoring the implementation of the OREDP is presented in Chapter 16.
Task 3.5: Justification for selected P/P alternatives	As part of the SEA process it is necessary to identify the preferred alternative based on environmental grounds, taking into account the 'do nothing' or 'business as usual' scenario as a benchmark. Where the preferred alternative is not the best environmental option but represents a balance of environmental, economic and social concerns this should be documented. Further information on the consideration of alternatives is provided Chapter 3.
Output 3: Environmental Report	The main findings from the SEA are presented in an Environmental Report (this document) which, with the non-technical summary is made available for public consultation.
Task 3.6: Quality review of Environmental Report	The EPA SEA Guidance includes a checklist which can be used to inform the review of the Environmental Report to ensure that is meets all statutory requirements.

SEA Tasks	Description
Stage 4: Consultation, revision and post adoption activities.	
Task 4.1: Review comments for applicability to SEA or P/P	Comments received following consultation on the Environmental Report will be reviewed to determine their appropriateness to the SEA and the OREDP.
Task 4.2: Undertake 'fast-track' SEA on significant changes to the P/P	Any changes to the P/P made in response to comments received from consultation need to be reviewed in terms of potential environmental effects to ensure that the SEA is consistent and watertight. Where significant changes are made to the P/P there may be a requirement to revisit the assessment and revise the Environmental Report.
Output 4: SEA Statement	The SEA Statement is prepared following adoption of the Final P/P. The SEA Statement is required to set out how the key findings from the SEA have been taken into account in the preparation of the Final P/P and how comments received from consultation have also been taken into account in the preparation of the Final P/P.
Task 4.3: Commence environmental monitoring of the implementation of the P/P	Implement the monitoring programme (Chapter 16).
Task 4.4: Periodic review and revision of monitoring programme	Where P/Ps are implemented over several years it may be necessary to revise the monitoring programme periodically so that it takes account of new methods and increased understanding of the baseline environment.
Task 4.5: Periodic reporting of the monitoring results.	The results from monitoring should be reported on a regular basis to ensure that the actual effects of the P/P are evaluated fully.

The main requirements of the SEA process are included in this Environmental Report (ER). Further information on the approach and method used to predict and evaluate potential effects is included in Chapter 6.

1.3 SEA of the OREDP

The following section provides detail on the scope and coverage of the SEA of the OREDP.

1.3.1 Scope of the SEA of the OREDP

Based on information presented in the SEA Scoping Report, prepared by SEI (now SEAI) in July 2009 and comments received following consultation on the Scoping Report as summarised in Chapter 4 of this report, the scope of the SEA of the OREDP includes:

- Timescale for the SEA and OREDP as 2030 horizon – *this has been extended from 2020 following feedback from consultation of the scope of the SEA.*
- Assessment scenarios for the production of up to 4,500 MW from offshore wind and 1,500 MW from wave/tidal.
- The **SEA Study Area** includes:
  - All Irish waters from the Mean High Water Mark out to the 200m water depth contour off the west and south west coast of Ireland and the Irish Exclusive Economic Area (EEZ) off the north, east and south east coast of Ireland.
  - The study area includes a number of **Assessment Areas** which focus on the main areas of resource identified for offshore wind (fixed and floating), wave and tidal energy.

- The **SEA Assessment Areas** include:
  - These are areas below Mean High Water Mark that encompass the main areas of resource for offshore wind (fixed and floating), wave and tidal energy, although potential effects above the Mean High Water Mark will be considered for particular SEA issues/subjects e.g. seascape.
  - Assess piled offshore wind, wave and tidal developments to a depth of 60m – *this was identified during consultation with developers as being the maximum depth for piled offshore wind, wave and tidal based on current and known future technologies and other operational parameters (e.g. installation etc).*
  - Assess floating wind structures to a distance of 100km from the shoreline - *this distance from the shoreline reflects the upper length limit of Alternating Current (AC) cable technology (for greater distances (beyond 100km) Direct Current (DC) cables would be required with convertor stations on land to convert to AC).*
  - Tidal devices will be assessed in areas where tidal stream velocities are 1.2m/s or greater - *this has been reduced from 1.5m/s following scoping to reflect operating parameters for a wider range of technologies in particular lower to mid stream technologies.*

- The assessment will consider:
  - Potential impacts of scenarios for developing up to 4500 MW of offshore wind and 1500 MW of wave and tidal energy **irrespective of commercial viability or other economic constraints.**
  - Spatial distribution of suitable areas for development **independently of the existing onshore power transmission grid.**
  - Areas within Natura 2000 sites or areas protected under other national or international instruments.

1.3.2 SEA Issues/Subjects

Table 1.2 below lists the main environmental issues (and associated SEA subjects for assessment) that are covered by this SEA. This list is derived from the SEA Directive and has been refined to make it relevant to the marine and coastal environment of Ireland. The main environmental issues have been identified through the authors' knowledge of the SEA process, the requirements of the SEA Directive and EC SEA Regulations 2004, the EPA SEA Guidance (2003) and an understanding of the potential affects that offshore wind, wave and tidal energy developments could have on the environment.

Table 1.2: SEA environmental issues/subjects covered by the SEA of the OREDP

SEA Directive Environmental Issues	Relevant SEA Subjects
Water, Soil (Sediment)	Bathymetry and hydrography
	Geology, geomorphology and sediment processes
	Water and sediment quality
Biodiversity, Flora and Fauna	Protected sites
	Benthic ecology
	Fish and shellfish
	Birds
	Marine mammals
	Marine reptiles
	Energy (noise and EMF)

SEA Directive Environmental Issues	Relevant SEA Subjects
Cultural Heritage including Archaeological Heritage	Marine and coastal archaeology and wrecks
Population and Human Health	Commercial fisheries, shell fisheries and aquaculture
	Ports, shipping and navigation
	Recreation and tourism
	Aviation
	Military activity
	Noise environment
Material Assets	Oil and Gas infrastructure
	Cables and pipelines
	Aggregates, dredging and disposal areas
Landscape/Seascape	Seascape
Climate	Renewable energy
	Gas storage areas

1.3.3 Socio-Economic Impacts

This SEA does not cover socio-economic impacts. However, in accordance with the SEA Directive, and the EC Ireland SEA Regulations 2004, the SEA does address 'population' and 'human health' issues. The main factors that have been considered in the context of population include key activities that occur within, or make use of, the marine environment.

These marine activities are considered to be a key component of the wider marine environment. The assessment will therefore consider whether the proposals for the development of offshore wind, wave or tidal energy would cause any disruption, disturbance or displacement to these activities.

The key marine activities considered in this SEA are listed in Table 1.2 above. Whilst it is recognised that some of these are commercial activities, the SEA **will not** assess the implications of any disruption, disturbance or displacement of these activities in a wider socio-economic context e.g. changes in revenue, job creation or loss etc.

At this strategic level, any socio-economic assessment would require an examination of how offshore wind, wave and tidal developments would support local communities in terms of employment and revenue as well their contribution to the wider economy of Ireland. This is beyond the scope of this SEA and the requirements of the SEA Directive.

1.3.4 Scoped Out SEA Issues

Based on an initial review of the main environmental issues/subjects identified for assessment in the SEA, it has been determined that **air quality** will not be included in the assessment i.e. will be scoped out from the SEA.

The justification for exclusion of air quality and associated subject areas from the main assessment is on the basis that the development of marine renewable technologies and offshore wind does not generate any atmospheric emissions (note: **air quality does not relate to CO_2 emissions** which are covered under climate change and greenhouse gas emissions). It is recognised that there could be localised impacts on air quality generated during the construction of offshore renewable energy developments (e.g. atmospheric emissions from construction vessels and dust generated at landfalls for export cables) and that the re-routing of vessels during the operation of developments could lead to an increase in localised emissions from those vessels. However, it is not anticipated that these potential effects will be of major significance at a strategic level and therefore will not be taken forward for more detailed assessment as part of this SEA.

1.3.5 Transboundary Effects

Given the location of Ireland and its surrounding waters, the SEA has taken into consideration potential transboundary effects on the following areas:

- Northern Ireland territorial waters.
- Scotland territorial waters (mainly waters off the coast of Argyll and Bute (Peninsula of Kintyre and Isle of Islay)).
- Isle of Man territorial waters.
- UK territorial waters (mainly off the west coast of Wales).

Further detail on potential transboundary issues is included in Chapter 13: Cumulative Effects associated with other plans, programmes and developments.

1.4 Appropriate Assessment

Under the provisions of S.I. No. 94/1997 — European Communities (Natural Habitats) Regulations, 1997 (as amended), which translate the requirements of the Birds Directive 1979 and Habitats Directive 1992 into Irish law, a 'competent authority', is required to undertake an Appropriate Assessment (AA) of any plan or project[1], where the plan or project is likely to have a significant effect on a Natura 2000 site, before the plan can be adopted or consents or permissions for a project can be granted.

Natura 2000 sites that have to be considered include Special Areas of Conservation (SAC), Special Protection Areas (SPA), and Sites of Community Importance (SCI). Such consideration extends to candidate or proposed sites, or extensions to existing sites, all of which are afforded the same level of protection as fully adopted sites.

The legislation, as well as guidance published by DEHLG[2], makes it clear that a plan or project which may affect a Natura 2000 site cannot be approved until the AA has been undertaken and concluded and the findings of the AA used to influence or change the plan or programme where appropriate. Given that there are a number of Natura 2000 sites contained within the area covered by the OREDP, it has been determined that an AA is required on the basis that there is potential for the OREDP to have Likely Significant Effects (LSE) on the protected sites.

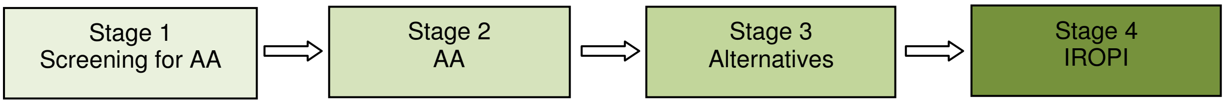
[1] Unless the plan or project is directly associated with the management of a European site.

[2] DEHLG (December 2009) *Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities*

1.4.1 *Requirements of the Appropriate Assessment*

The AA is being carried out in parallel to this SEA. In general, it is recognised that the AA process involves a number of stages, the requirements for each of which to be completed is dependent up on the outcome from the previous stage.

The AA Guidance published by DEHLG splits the AA process in four stages. These are summarised below:

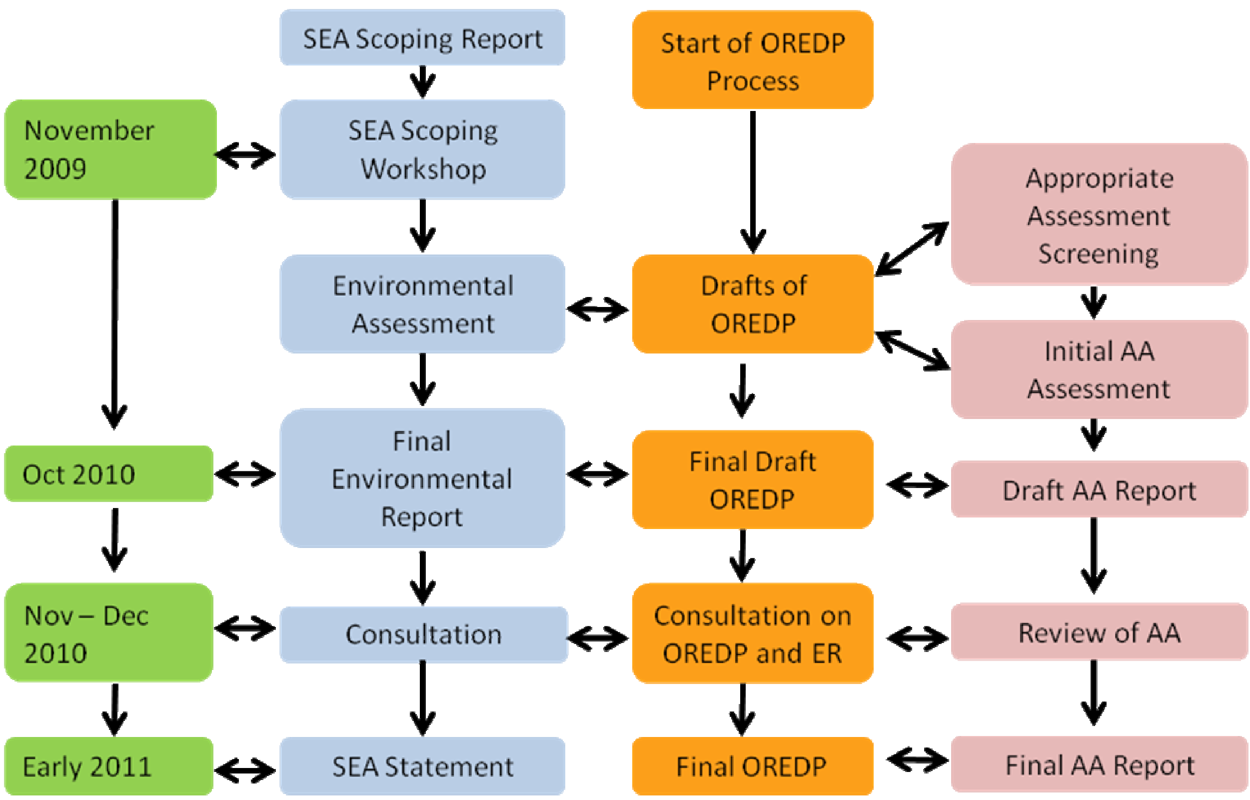


The first stage of the SEA process is screening the OREDP to determine whether it will have any LSE on a Natura site. Where it is identified that LSE could occur, there will be a requirement to carry out a full AA for certain sites. Based on the findings from the AA, SEAI and the DCENR may be required to modify or amend the OREDP to avoid or mitigate any LSE that have been identified. This will be required before the OREDP can be adopted. Further detail on the approach and method applied to the AA and the results from Stage 1: AA Screening and an initial assessment (Stage 2: AA) of the sites where there is potential for LSE to occur is presented the Draft AA Report.

1.4.2 *Links between the Appropriate Assessment and the SEA*

The AA is being carried out in parallel to SEA of the OREDP. The links between the two processes and the preparation of the OREDP are illustrated in Diagram 1.1 below.

Diagram 1.1: Links between the AA, SEA and OREDP



1.5 Informing the Preparation of the Offshore Renewable Energy Development Plan (OREDP)

The main focus of the SEA is to test the development scenarios for up to 4,500MW of offshore wind and 1,500MW of wave and tidal energy within Irish waters as set out in the OREDP. There are three development scenarios presented in the OREDP. These range from low to high and summarised in Table 1.3 below:

- **Low**: This scenario consists of the 800MW of offshore wind to receive a grid connection offer under Gate 3. It also includes 75MW of wave and tidal development, which is included in the Table 10 modelled scenario in the National Renewable Energy Action Plan (NREAP).
- **Medium**: This scenario consists of 2,300MW of offshore wind, which comes from the Table 10 non-modelled scenario of the NREAP (broadly based on the combination of offshore wind projects with either foreshore lease or grid connection) and the 500MW of wave and tidal energy in the same table (the Government's 2020 ocean energy target).
- **High**: This scenario consists of 4,500MW of offshore wind and 1,500MW of wave and tidal current. These figures come from the SEA Scoping Report.

Table 1.3 Development Scenarios

Development Scenarios to 2030			
	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)
Wind	800	2,300	4,500
Wave and Tidal	75	500	1,500

With regard to informing the development of the OREDP, the main objective of the SEA is to identify where development is most likely to occur, identify the potential environmental constraints in those areas and, taking potential environmental constraints into account assess the levels of development that could potentially occur in a certain area (Assessment Area). The findings from the results of the assessment of the levels of development that could occur within each of the Assessment Areas and across the entire study area, which are presented in Chapter 12, will then be reviewed against the development scenarios presented in the OREDP to determine which of the scenarios could be achieved without any likely significant adverse effects on the environment.

1.5.1 The SEA does not Identify Specific Sites for Development/Exclusion Areas

The strategic nature of the assessment reflects the level of detail provided in the OREDP, the overall scale of the study area and the vast offshore renewable energy resource that exists in Irish waters. As noted above, the aim of the SEA is to identify potential effects on the environment and the likely significance of those effects. The SEA does not involve an assessment of actual effects, which is the role of the EIA process, as, due to the strategic nature of the plan, and the scale of the overall study area and available resource, it is not possible to determine at this stage where certain individual developments are likely to occur (except where Foreshore Lease applications have been submitted/approved).

In summary the SEA will:

- Identify whether it is possible to achieve the development scenarios set out in the OREDP (as discussed above).
- Identify broad areas where development could potentially occur, acknowledging that within those broad area there are likely to be a number of data and knowledge gaps therefore potential effects on certain environmental receptor may be unknown/uncertain.

- Identify where further information/data is required in order to determine the significance of potential effects on certain environmental receptors e.g. site or area specific surveys/studies, and what would need to be taken into account as part of a project level EIA for development in certain areas.

It is not the role of this SEA to demarcate specific sites or areas for development or avoidance (other than where there are already specific exclusions within an area e.g. presence of other development such as oil and gas infrastructure). Main reasons for this relate to the following:

1.5.1.1 Range of Technologies and Device Types

There are a vast range of technologies/device types (current and emerging), each of which are likely to have different effects on the environment. The aim of the SEA is to identify the **potential effects** that certain groups of characteristics relating to different technologies/device types will have on the environment e.g. effects associated with the installation of devices with piled foundations, and evaluate the **likely significance** of those potential effects on certain environmental receptors. Further detail on the characteristics of the different technology/device types is provided in Chapter 8.

However, at the strategic level, the precise location of development is unknown (except where applications for foreshore leases for individual projects have been submitted/approved), as is the detailed design of a specific project e.g. device type, method of installation, footprint, generating capacity, configuration etc. Therefore, whilst the SEA can identify areas that are likely to be more sensitive to certain characteristics of a development (e.g. devices with piled foundations or devices that float on the surface) and therefore where there is a greater likelihood that an offshore renewable energy development could have a significant adverse effect on a particular environmental receptor, the actual evaluation of the exact effect on the environment can only be determined at a project stage where more detail on the location and design of a specific development is known.

Consequently, some areas may be excluded from development where, with design changes or slight alterations in the siting of a development, which can only be identified at the project stage, any potential significant adverse effects on the environment could be avoided or reduced.

1.5.1.2 Opportunities for Co-existence

This SEA also takes into account the potential effects of offshore renewable energy developments on other users of the marine environment. Similarly, as discussed above with regard to specific environmental receptors, the use of an area for another activity e.g. fishing or navigation does not necessarily exclude that area from development, in particular where there are opportunities for certain technologies and device types to co-exist with other marine users e.g. bottom mounted tidal devices could be installed in areas used for navigation subject to there being enough water depth to allow sufficient clearance between vessels and devices. Co-existence could also have potential positive effects for example by increasing navigational safety within busier navigation channels by creating exclusion areas, and increasing visibility of, areas where there are risks to navigational safety e.g. sand banks.

However, due to the vast range of technologies/device types that currently exist or could be developed in the future, the extent to which this coexistence can occur can only be determined at the project level, through detailed consultation and examining development design e.g. layout etc. Consequently, as with the environmental receptors above some areas could be excluded development where there could be an opportunity for a development to occur through co-existence.

1.5.1.3 Data Gaps

Further information on data gaps, and how they are dealt with in this SEA, is provided in Section1.8.2 below, Chapters 6, 9 and 14 of this report. Data gaps relating to limited information on the distribution of certain sensitive receptors across the study area are recognised as one of the main limitations to this SEA, and considerably reduce the confidence with which likely significance of a potential effect can be determined.

It is generally recognised as SEA good practice that where data gaps exist, in particular gaps relating to the location and distributions of certain receptors, a cautious approach should be adopted to the assessment of potential effects. This usually involves assessing a potential effect as unknown or qualifying the evaluation of likely significance as having high uncertainty. However, the approach can also assume that a specific receptor is present in a certain area and therefore could be affected by a development until proven otherwise (precautionary principle).

The risk with excluding areas at this stage on the basis of existing data gaps is that in some cases the environmental receptor to which the data gap relates may not actually be present in that area, and therefore may not be a constraint on development. Consequently by demarcating exclusion areas on the basis that a certain receptor may or may not be present, there is a risk that the offshore renewable energy industry could lose a number of feasible and economically viable sites for development. Additionally, once an area has been excluded from development it is less likely that the necessary studies/surveys that would be required to determine the presence of a certain receptor would be carried out, and the data gaps would remain unfilled.

Although the OREDP focuses on development to 2020 and 2030 it also has a longer term vision for further growth of the offshore renewable energy industry to 2050. Without opportunities for filling data gaps in certain locations as part of more detailed project level EIAs or survey/research programmes to inform regional planning in an area, areas could be permanently excluded from development without the necessary evidence ever being collected to prove that area could be suitable for development.

However, it is still essential that, where data gaps exist, the SEA identifies and acknowledges that in certain areas development could potentially have a likely significant effect on certain sensitive receptors should they be found to be present in that area. This approach, whilst not completely ruling out an area for future development, does highlight to offshore renewable energy developers that, should they be interested in developing a project in a certain location, they are likely, as part of a Foreshore Lease application and supporting EIA, to be required to undertake a range of surveys and studies to prove that a certain receptor is/is not present and, if it is present that their project would not have any significant adverse effects on that receptor.

The requirement for acknowledging and filling data gaps at both a strategic and project level will be looked at in more detail as part of the development of the plan and project level mitigation relating to this SEA and the OREDP. Further detail on mitigation is provided in Section 1.9 below and Chapters 11 and 15.

1.5.1.4 Lack of Evidence of Adverse Effects

As with data gaps, there is still a relative high level of uncertainty and lack of knowledge and understanding with regard to the potential effect that certain technologies and device types have on the environment and specific receptors, and the likely significance of those effects. This is mainly a result of a lack of information and knowledge on how marine renewable energy developments, in particular, interact with the environment.

In general the effects of offshore wind developments on the environment are better known and understood than wave or tidal developments. This reflects how the information, experience and knowledge gained from the onshore wind industry helped to inform and enable the deployment of a number of the initial offshore wind farms, which subsequently helped to inform further offshore wind developments and the growth and expansion of this industry.

In comparison, the wave and tidal industry is still at the testing and demonstration stage. As a consequence of this, and without any similar onshore or established industries from which experience and knowledge can be gained, there is still a relatively high level of uncertainty and lack of confidence with which potential effects can be identified. Consequently, there is risk, as with data gaps that creating exclusion areas on the basis that a certain technology has the potential to have a likely significant effect on the environment within a certain area without evidence to prove otherwise could mean that opportunities for developing offshore renewable energy projects in technical and economically suitable and viable location are severely restricted.

1.6 Links between the SEA, OREDP and Current Foreshore Licence Applications

It is recognised that there are a number of offshore wind projects that either have granted applications, or are awaiting the determination of applications made for a foreshore lease under the Foreshore and Dumping at Sea (Amendment) Act 2009. Whilst these offshore wind projects need to be taken into account in the SEA in the context that these are existing or potential future developments, a Parliamentary Statement, provided by Eamon Ryan, Minister of DCENR confirmed that the SEA should not influence or affect the processing of existing Foreshore Lease applications. The full summary provided by Minister Ryan[3] is presented below.

'*At the request of my Department, Sustainable Energy Ireland (SEI)* (now SEAI) *has commissioned a Strategic Environmental Assessment (SEA) on Wave, Tidal and Offshore Wind Development in Irish waters. The Ocean Energy Development Unit in SEI is progressing the SEA with the assistance of expert technical advice. The process is being overseen by a Steering Group which comprises my Department, SEI, the Marine Institute and the Department of Environment, Heritage and Local Government.*

The SEA will underpin the Offshore Renewable Energy Development Plan, which will inform the development consent framework for future offshore renewable energy projects. The SEA will provide an environmental assessment at a strategic high level. Under the relevant EU Directive individual projects are still required to carry out specific Environmental Impact Assessments (EIAs). Environmental Impact Statements already submitted with the current applications for foreshore leases may be taken into account in the SEA.

Under the Foreshore and Dumping at Sea (Amendment) Act 2009, responsibility for certain foreshore functions transferred to the Minister for the Environment, Heritage and Local Government with effect from 15th January 2010. This includes all energy related developments (including oil, gas, wind, wave and tidal energy) on the foreshore. Both the Offshore Renewable Energy Plan and the Strategic Environmental Assessment will encompass and recognise existing offshore wind projects and those projects with foreshore lease applications at an advanced stage and in the Gate 3 process. The requisite permissions for those projects will continue to be progressed while the SEA is completed'.

In terms of the SEA, these developments referenced above by the Minister will be taken into consideration in the context that they are potentially existing developments. Therefore, in Assessment Areas 1 and 2 off the east coast, where the majority of the existing developments are located, the assessment of potential development opportunity within those Assessment Areas will include those projects which have already been granted a foreshore lease or are due to receive an offer of grid connection. For example, in Assessment Area 1, taking into account technical and environmental constraints, the assessment identifies that there is potential to develop between 1200MW and 1500MW without likely significant adverse effects on the environment. However, the assessment also recognises that of that 1200MW to 1500MW, 480MW have already been granted a foreshore lease or are due to receive an offer of grid connection, therefore also taking into account existing projects the remaining resource in that Assessment Area is between 720MW and 1020MW

1.7 Links between the SEA, OREDP and the Implementation Programme for Grid25

This SEA is being carried out at the same time as the SEA of Eirgrid's Grid 25 Implementation Programme. Grid 25 is a long term strategy for the development of the transmission networks throughout Ireland. The strategy aims to support economic growth and provide the infrastructure to enable Ireland to realise its renewable energy potential and to achieve the target for 40% of Ireland's electricity to be generated from renewable sources by 2020. The SEA is of the Implementation of this strategy (the Grid 25 Implementation Programme).

The Implementation Programme is a practical overview of the intended commencement of implementation of the Grid25 Strategy. Projects that are implemented under the Implementation Programme will help to facilitate the transfer of renewable energy generated particularly in the west to the major demand centres in the east and also reinforce the existing transmission network in the west.

In terms of the links between this SEA and the SEA of the Grid 25 Implementation Programme it is recognised that one of the main factors influencing the longer term development and growth of the offshore renewable energy industry is the

[3] http://www.kildarestreet.com/wrans/?id=2010-01-20.1485.0

availability of onshore grid connections and the capacity of the onshore transmission infrastructure to accommodate increased electricity generated from offshore renewable.

Although SEAs for both plans have been carried out at a similar time, there have been limited opportunities for each assessment to directly influence the other this is mainly as a result of both SEAs and associated plans being prepared at a high national strategic level, where detail on the precise location of specific projects is unknown.

However, through consultation with Eirgrid it is understood that although, the location of offshore renewable energy developments in Irish waters, and associated onshore connections, is in most cases unknown (the exception being certain offshore wind projects), the Grid 25 Implementation Programme still recognises the need to provide sufficient capacity within any transmission network reinforcements to accommodate future increases in electricity generation from offshore renewable electricity generation. However, there is still some uncertainty over where this increased capacity will be provided. It is also acknowledged that both plans (OREDP) and Grid 25 Implementation Programme will need to remain flexible in order to respond to future proposals for offshore renewable energy developments, particularly along the west coast where connection to the existing transmission network is limited.

1.7.1 Links between the OREDP, Grid 25 Implementation Programme and Proposals for Offshore Grid.

As part of the longer term development of offshore renewable energy there is increased recognition that there may be a requirement to find alternative solutions with regard to grid connections and capacity to ensure that the full potential of Irelands offshore renewable energy resource can be realised. These include proposals for the creation of an offshore grid transmission network. As acknowledged in the OREDP, there are a number of ongoing studies which are currently exploring options/solutions for the creation of an offshore grid network. These include:

- Offshore Grid Study: Explores how offshore wind developments off the east coast could be integrated into the Irish transmission system through a series of offshore radial connections. The Irish Scottish Links on Energy Study (ISLES): Feasibility study being carried out on behalf of the Irish Government, Northern Ireland Government and Scottish Government to explore options for developing an offshore transmission network linking potential offshore sites for the future generation of offshore renewable energy in Ireland, Northern Ireland and Scotland.
- North Seas Offshore Grid Initiative: European initiative exploring options for the development of an offshore grid in a common and coordinated way.

Further detail on these is provided in Chapter 5: Policy Context.

It is likely that, as the proposals for offshore grid develop and start to be realised, there will be a need for these plans and strategies to take into account the proposals presented in the OREDP and the main findings from this SEA. There would also be a need for these plans and strategies for offshore grid to take into account the proposal for the development of the onshore grid to ensure that the onshore grid network, offshore grid network and offshore renewable energy developments are fully aligned. As appropriate, these offshore grid plans and strategies are also likely to be subject to SEA. Where possible it is suggested that any new SEAs and updates/iterations to existing SEAs (OREDP and Grid 25) are reviewed to explore links between the Implementation Programme, OREDP and any plans for offshore grid as these strategies are taken forward.

1.8 Study Limitations and Exclusions

The main limitations and exclusion relating to this SEA include:

- Scope of the SEA
- Data and knowledge gaps

1.8.1 Scope of the SEA

The scope of the SEA was defined by SEAI and the Marine Institute (MI) on behalf of DCENR, in the Scoping Report issued in July 2009, the Terms of Reference (ToR) set out in the SEAI Tender Document, the requirements of the SEA Directive and the EC (Environmental Assessment of Certain Plans and Programmes) Regulations 2004 (S.I. No. 435) and EPA Guidance on SEA (EPA, 2003). However, it should be noted that specific items of general concern or interest to a wider group of stakeholders may not be within the remit of this SEA. Some of these items are listed in Table 1.4.

Table 1.4: Summary of Scope of SEA

	Inside of Study Scope	Outside of Study Scope
1	Potential environmental effects will be identified and assessed at a strategic level.	Effects will not be assessed at a project specific level. The SEA also does not replace the need for project level EIAs to be carried out.
2	The SEA will provide baseline information pertinent to the strategic issues associated with the potential development of offshore renewable energy.	The SEA will not replace the need for developers to collect detailed project specific baseline data.
3	The SEA will inform the development and implementation of the OREDP.	The SEA will not specifically address issues of grid development policy, socio-economic development, or policy relating to consent procedures but will cross refer to other work where relevant.
4	The SEA will help identify areas where there may be opportunities for, or environmental constraints against, development.	The SEA will not examine the commercial viability of development or provide cost benefit analysis.

1.8.2 Data and Knowledge Gaps

As discussed in Sections 1.5.2.3 and 1.5.2.4 above, gaps in data, information and knowledge relating to the distribution of certain receptors and the potential effects of different technologies and device types on the marine environment are key limitation to this SEA. Ultimately data and knowledge gaps influence the certainty with which the likely significance of potential effects can be determined. Where data, information and knowledge gaps exist it is necessary for these to be identified as part of the SEA process and taken into account as part of the assessment process. In terms of this SEA, there are two ways in which this has been done:

- **Assessing potential effects as unknown** – generally, where there are significant gaps in data e.g. distribution or abundance of certain environmental receptors, or information/knowledge on how a certain receptor would interact with offshore renewable energy developments it may not be possible to conclude what the potential effect would be or what the likely significance of that effect would be therefore the effect would be unknown. However, as noted above, an area will not necessarily be excluded from development on the basis that a potential effect is unknown, although the potential risk of developing in that certain area will be highlighted and requirements for studies and surveys identified as necessary.

- **Attributing a low level of confidence to the assessment of likely significance** – this assessment is slightly different to an assessment of 'unknown' effect, in that, even though data and knowledge gaps may exist for a certain area/receptor, a judgement of the potential effect and likely significance of an effect can still be made based on experience and knowledge from other SEAs, other marine developments, monitoring, data collection and research programmes etc. However, a low level of confidence is attributed to this assessment.

Further detail on the main data and knowledge gaps is presented in Chapter 9: Baseline and Chapter 14: Data Gaps.

1.9 Mitigation Measures

This SEA takes into account two types of mitigation, **plan** and **project** level mitigation:

- **Plan level mitigation –** these are statements incorporated into the plan (OREDP) as commitments which aim to avoid/reduce or offset significant adverse effects. These relate to strategic level measures that have been identified as being necessary for the scenarios for the development of offshore renewable energy, as set out in the OREDP, to be achieved in a way that avoids or minimises any significant adverse effects on the environment. Plan level mitigation measures, could include for example, measures for filling strategic data and information gaps or implementing the deploy and monitor approach to development which aims to control the scaling up of commercial developments so that necessary data (evidence) in relation to potential effects on the environment can be obtained before development is extended to its full commercial scale.
- **Project level mitigation –** these are measures that are not necessary incorporated into the plan but are recognised as good practice and it is assumed that these would be incorporated into future projects. It is recognised that the OREDP cannot guarantee that these measures will be implemented (hence the use of the words could and should as opposed to will in the assessment of effects present in Chapters 11, 12 and 13). However, it is considered reasonable to assume that these measures would be implemented by a responsible developer and they are likely to be necessary in order to achieve development consent/Foreshore Leases at the project level.

There are a wide range of project level mitigation measures that could be incorporated into future projects. Where appropriate these measures have been fully integrated into the assessment of potential effects presented in Chapter 11: Assessment of the Assessment Areas and Chapter 12: Cumulative Assessment – Testing the OREDP Development Scenarios. In Chapter 11, detail on the different types of project level mitigation that could be incorporated into future projects in relation to the individual environmental receptors is included in the assessment matrices. This is necessary to enable an assessment of potential effects (without mitigation) and residual effects (with mitigation) to be made.

Further detail on both the proposed plan and project level mitigation measures is also included in Chapter 15: Mitigation.

1.10 Differences between the SEA ad EIA Process

One of the outputs from this SEA process will be the preparation of EIA guidance to inform the future development of offshore renewable energy developments. This guidance will comprise a separate document that will be prepared in addition to this Environmental Report.

The following provides a brief overview of the main differences between the SEA and EIA process. Further detail on the main contents of the EIA Guidance is provided in Chapter 15: Mitigation.

The SEA process focuses purely on the assessment of plans or programmes, where as the EIA (Environmental Impact Assessment) process focuses on individual development projects. The plans and programmes subject to an SEA can range from national to local level plans and are generally prepared by public bodies (e.g. central or local Government or regulatory authorities) or utilities companies. These plans and programmes set the framework for future development projects, some of which will then be subject to an EIA as part of an application for development consent.

In regard to offshore wind and marine renewable energy developments there are a number of significant differences between the SEA and EIA processes. These are discussed in Table 1.5 below:

Table 1.5: Differences between the SEA and EIA processes

SEA Process	EIA Process
Subject of the SEA is the OREDP	Subject of an EIA would be individual developments (projects) e.g. offshore wind farms, wave/tidal demonstration projects or arrays
SEA is area wide (e.g. covers geographical areas such as Ireland, regions, counties or towns and parts of towns). This SEA covers the full extent of Irish waters from the average Mean High Water mark out to the 200m water depth contour off the west coast and the Irish Exclusive Economic Area off the north, east and south (east) coast.	EIA is generally site specific (e.g. applies to the site of a specific development (project) and immediate surrounding area (potential receptors).
SEAs are desk based assessment based on existing available information. Additional studies (e.g. additional data collection exercises) may be undertaken to support the SEA if it is determined that particular data gaps could invalidate the findings of the SEA and affect the decision making process.	EIA involves a range of assessment methods including: ▪ Desk based assessments ▪ Site visits ▪ Surveys and monitoring ▪ Modelling ▪ Sampling and laboratory testing ▪ Research studies
At the plan level the assessment of environmental effects is generally based on: ▪ Plan objectives and strategies ▪ Development/planning policies Occasionally information may be available on: ▪ Potential sites or areas for development ▪ Broad scheme/ project descriptions However, this is not a statutory requirement for all plans.	For EIAs, project descriptions have to include information on: ▪ Site parameters/application boundaries ▪ Development type and scale of development ▪ Design (materials and layouts) ▪ Heights and footprints ▪ Timescales for development ▪ Construction methods ▪ Hours of operation/construction ▪ Shift patterns etc ▪ Levels of construction and operation traffic
The focus for SEA is to look at a range of proposals, projects or schemes that could emerge from a plan or programme and assess whether individually or in combination (cumulative) these are likely to have a significant adverse effect on the environment.	The focus for EIA is to accurately determine whether an individual development project would definitely have a significant adverse effect on the environment.
At the plan level, mitigation associated with the SEA process generally involves changing the plan or removing/changing certain policies or proposals presented within the plan to reduce, avoid or offset any significant adverse effects. In some cases where there is uncertainty over the nature of a potential effect, mitigation may include the identification of more detailed surveys or monitoring that would have to be undertaken as part of the consenting of individual projects that are taken forward (e.g. as part of an EIA).	At the project level, mitigation is much more specific and generally includes changes to the detailed design of a project, detailed surveying and monitoring, control of construction activities (e.g. timescales) and operational controls e.g. limiting noise emissions. Mitigation measures are usually implemented as conditions of planning permission/development consent or through an Environmental Management Plan (EMP).

Chapter 2: Offshore Renewable Energy Development Plan (OREDP)

2 Offshore Renewable Energy Development Plan (OREDP)

2.1 Introduction

The following chapter provides a summary overview of the main contents, aims and objectives of the OREDP. The full version of the OREDP can be downloaded from http://www.seai.ie/Renewables/Ocean_Energy/.

The international drive to develop renewable energy sources has increased significantly in response to increased concern over the security of supply of energy from fossil fuels and the growing awareness of their impact on the environment and climate. The effects on the environment and climate were first identified at an international level through the Kyoto Agreement, which was adopted in 1997. It has since become a focal point of both international and domestic political agendas, with targets and long term strategies for reducing CO_2 emissions being implemented through a series of Directives, Bills and Acts.

2.2 Background to Renewable Energy

In 2007 the European Union (EU) agreed new climate and energy targets by 2020. These were based on 20% reduction in greenhouse gas emissions, 20% energy efficiency and 20% of the EU's energy consumption from renewable sources. The recently implemented EU Renewable Energy Directive 2009/28/EC (repealing Directive 2001/77/EC and Directive 2003/30/EC) has set individual and legally binding targets on each Member State for increasing the level of renewable energy across the European Union in order to achieve the targets set in 2007.

2.2.1 Need for Renewable Energy

Global energy demand is predicted to increase by 50% by 2030 with fossil fuels remaining the dominant source of power[4]. In order to secure future energy supply alternative sources need to be developed and implemented to ensure energy demands are met in a sustainable manner, tackle climate change and ensure social and economic growth worldwide.

Within Ireland the energy market is limited by the indigenous fossil fuel supplies. Population and economic growth in the latter part of the 20th century and beginning of the 21st century has resulted in increased demand and an ever increasing reliance on imported sources. The development of home grown renewable sources of energy generation will ensure future sustainable growth.

2.2.2 Offshore Renewable Energy

The offshore renewables market is one of the fastest growing sections of the renewable energy industry. Over the past ten years there has been a vast increase in energy generated from offshore renewable sources. In 2002 less than 100MW of offshore renewable capacity was operating across the world[5].

[4] Government White Paper, Department of Communications, Marine and Natural Resources (2007), Delivering a Sustainable Energy Future for Ireland, The Energy Policy Framework 2007-2020

[5] The World Offshore Renewable Energy Report 2004-2008

2.3 Renewable Energy in Ireland

Under Directive 2009/28/EC, Ireland's target is that 16% of all energy (heat, transport and electricity) consumed is from renewable sources by 2020. In addition, the Irish Government set its national targets for the production of energy from renewable sources at 33% by 2020 (The Energy White Paper, 2007). This target was then increased to 40% in the 2009 Carbon Budget.

2.3.1 National Renewable Energy Action Plan (Ireland)

Under Directive 2009/28/EC each Member State is to submit to the EU a 'National Renewable Energy Action Plan' (NREAP) by the end of June 2010 setting out how it plans to reach its overall individual target. Ireland's NREAP sets out how Ireland will meet the overall target of 16% which will broadly be made up of 12% heat from renewable sources (RES-H), 10% transport from renewable sources (RES-T) and 42.5% electricity from renewable sources (RES-E).

With regard to the targets set out in the NREAP, the Government has identified that offshore renewable energy (offshore wind, wave and tidal energy) will make a significant contribution to the RES-E element of Ireland's overall renewable energy target. The NREAP recalls several times the Government's target of 500MW for ocean energy (wave and tidal) by 2020 set out in the Government's White Paper on Energy Policy (March 2007) and the 2007 Programme for Government.

2.3.2 Sustainable Energy Authority of Ireland (SEAI) Strategic Plan 2010 to 2015

The Sustainable Energy Authority of Ireland (SEAI) has launched a new five year strategic plan 2010-2015 with the mission of Ireland a global leader in sustainable energy[6]. The plan vision sets out to increase electricity supply from wind over the next five years, within 15 years renewable sources representing over half of the national supply, with the capability to export green energy to the rest of Europe within 25 years. The plan sets out a vision for electricity supply in Ireland which is "*Electricity supplied entirely be renewable sources, delivered through intelligent deployment of resources and technologies underpinned by the best physical, regulatory and market infrastructure*".

2.3.3 Delivering Offshore Renewable Energy in Ireland

Delivery of offshore renewable in Ireland is being approached at both a technical and strategic level. At the technical level the Government has been actively supporting the delivery of the National Strategy for Ocean Energy which was prepared in 2005 by the Marine Institute and the Sustainable Energy Authority of Ireland (SEAI). The main focus of this strategy is to introduce ocean energy into the wider portfolio of renewable energy and to develop an ocean energy sector through a number of initiatives including[7]:

- The establishment and operation of the Ocean Energy Development Unit in SEAI
- The establishment of grid connected wave and tidal test facilities
- The enhancement of the national wave tank facility
- A power-purchase scheme for electricity produced from OE
- A support fund to support research and prototype development by industry.

[6] Sustainable Energy Authority of Ireland (May 2010) Strategic Plan 2010-2015
[7] http://www.seai.ie/Renewables/Ocean_Energy/Ocean_Energy_Development_Unit/

In 2007 the Irish government adopted Sea Change: A Marine Knowledge Research and Innovation Strategy for Ireland 2007-2013. This strategy aims to drive the development of the marine sector in Ireland by:

- Strengthening competiveness and sustainability of the marine sector;
- Promoting economic stimulation and diversification;
- Increasing research capacity;
- Promoting regional development & North-South co-operation;
- Improving public service; and
- Introducing improvements in environmental quality and management.

2.3.4 Current and future Offshore Renewable Energy in Ireland

Electricity generated from renewable sources in Ireland in 2009 was 14.4% which exceeded the EU interim target of 13.2% generation by 2010, of this wind energy accounted for 10% of all electricity generation.8. The total installed capacity for energy generated from wind sources was 1,264MW in January 2010. A further 155MW from wind sources have been contracted and an additional 3,900MW proposed within the Gate 3 planning process. Within the first 8 years of the Gate 3 ITC programme 2010-2017 601.5MW of offshore wind generation is due to be connected to the grid (364MW from Dublin Array offshore wind farm and 237.5MW from Oriel offshore wind farm).

The 2004 SEAI commissioned study entitled "Tidal and marine current energy in Ireland" estimated there to be generation potential from tidal energy of 0.92TWh/year. This is the equivalent of 3.4% of the total electricity demand in Ireland during 2008.

With regards to wave energy it is estimated that within Irish Waters a total of 21TWh per year wave energy is available, this is the equivalent of over two thirds of the total electricity demand in 2008. The Irish Government has set targets for 500MW of energy generation from wave power to be installed within Irish waters by 2020. Currently a test site for wave energy is being developed off the coast of North Mayo. In addition a number of wave devises are currently being tested in Galway Bay.

2.4 Background to the Offshore Renewable Energy Development Plan

In addition to providing support at the technology/industry development level, the Government, through the Department of Communications, Energy and Natural Resources (DCENR) is also working on the delivery of offshore renewables at a strategic level through the preparation of the Offshore Renewable Energy Development Plan (OREDP). The OREDP, which is the subject of this SEA, sets out Ireland's long term vision for the development of offshore renewable energy and identifies scenarios for delivering offshore renewable energy by 2030 with a review of progress at 2020.

2.5 Offshore Renewable Energy Development Plan (OREDP)

2.5.1 Aim of the OREDP

The aim of the OREDP is to set out scenarios for the development of up to 4,500 MW from offshore wind energy and 1,500 MW from wave and tidal energy in Irish waters up to 2030 and set out a longer term vision for the growth of the offshore renewable energy sector in Ireland.

[8] Sustainable Energy Authority of Ireland (2010), Renewable Energy in Ireland 2010 Update.

2.5.2 Objective of the OREDP

The objectives of the plan are to:

- Describe the policy context for development of the offshore marine renewables sector;
- Provide information on the state of play on activities and initiatives that are underway in the marine renewable energy sector;
- Set out some development scenarios for the period 2030; and
- Set out the long term vision for the sector.

2.5.3 Overview of the Main Proposals within the OREDP

The SEA is based on the main proposals set out in the OREDP which include a series of scenarios for the development of up to 4,500MW of offshore wind and 1,500MW of wave and tidal energy within Irish waters. These development scenarios, as set out in Table 2.1 below, are based on the following:

- **Low**: This scenario consists of the 800MW of offshore wind to receive a grid connection offer under Gate 3. It also includes 75MW of wave and tidal development, which is included in the Table 10 modelled scenario in the National Renewable Energy Action Plan (NREAP).
- **Medium**: This scenario consists of 2,300MW of offshore wind, which comes from the Table 10 non-modelled scenario of the NREAP (broadly based on the combination of offshore wind projects with either foreshore lease or grid connection) and the 500MW of wave and tidal energy in the same table (the Government's 2020 ocean energy target).
- **High**: This scenario consists of 4500MW of offshore wind and 1500MW of wave and tidal current. These figures come from the SEA Scoping Report.

Table 2.1 Development Scenarios

Development Scenarios to 2030			
	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)
Wind	800	2,300	4,500
Wave and Tidal	75	500	1,500

2.5.4 Longer Term Vision for the Growth of the Offshore Renewable Energy Industry

The plan also provides information on the other areas that potentially influence the establishment and long term growth of the offshore renewable energy industry but which are outside the scope of this plan. These areas for growth or future investment therefore do not form part of the SEA but are important factors that could influence the effectiveness with which the growth of the offshore renewable energy sector is taken forward. These areas include:

- Development and successful operation of the grid connected test facilities, as appropriate;
- The evolving planning for a development of offshore and onshore grid infrastructure;
- The evolution of the regulatory, consenting and trading environment and mechanisms that will allow for electricity export; and
- The establishment and operation of effective foreshore leasing and consenting process.

In addition to identifying these key areas for growth of the offshore renewable energy industry the plan also outlines a longer term vision for the offshore renewable energy sector. This has been split down into six groups, wave, tidal, wind; offshore grid developments; infrastructure (ports) and the regulatory framework. Essentially the plan concludes that to be able to exploit the full natural resource offered within Ireland's ocean territory and to become an exporter to energy to the rest of Europe the following factors need to be addressed in the period up to 2030:

- Technological advances in wave and tidal devices;
- Technological advances in wave, tidal and wind in order to harvest /exploit the natural resources in more arduous conditions, in particular off the west coast;
- Grid developments to facilitate increased capacity;
- Increased joined up working with Northern Ireland, the rest of the UK and Europe on the development of the offshore grid;
- Development and provision of onshore sites (ports) for the construction and maintenance of offshore devices; and
- An improved and streamlined regulatory framework.

Again the mechanisms for addressing these factors fall outside the scope of the OREDP and therefore are not subject to the SEA. However, with regards to potential effects on the environment it is necessary to be aware of the other types of development that could occur in the future to support the growth of the offshore renewable energy industry and the policy and regulatory frameworks within with future offshore renewable energy developments would be taken forward.

Chapter 3: Alternatives

3 Alternatives

3.1 Introduction

The following chapter discusses the 'alternatives' that have been considered to the OREDP and as part of the ongoing preparation of the OREDP. This chapter also gives an overview of the potential environmental implications associated with each of the alternatives proposed.

However, it should be noted that most of the alternatives identified in terms of the preparation of the OREDP have been subject to rigorous assessment as an integral part of the wider SEA process and are therefore discussed in much greater detail in the later chapters of this report (e.g. Chapters 11 and 12).

In terms of this SEA and the OREDP, two alternatives have been considered:

- Evolution of the environment without implementation of the plan (OREDP)
- Testing alternative scenarios for the development of offshore wind and marine renewable energy presented within the OREDP – including an analysis of different spatial distributions of offshore wind, wave and tidal developments within the Assessment Areas and across the entire study area (Chapter 12: Cumulative Effects – Testing the OREDP Development Scenarios)

3.1.1 Relationship Between the SEA and OREDP

In undertaking an assessment of the alternatives it is necessary to firstly understand how the plan (OREDP) has evolved in relation to the SEA. In some instances where plans are subject to an SEA, the plan being assessed may already exist in a preferred format with agreed objectives and policies based on the previous selection of the preferred option. In this situation there is limited opportunity for the SEA to influence the overall direction of the plan which is likely to be predetermined. Consequently the assessment focuses more on the policies and proposals that have already been developed, and relies on the modification or removal of policies or proposals as the mechanism for mitigating any potential significant adverse effects on the environment.

However, in this case, the SEA was commenced at the start of the OREDP process and has been carried out in parallel to its ongoing preparation. Consequently the SEA has been able to influence both the direction for the development of the OREDP and content of the OREDP. This includes the integral and ongoing assessment of the main development scenarios for the development of offshore renewable energy included in the OREDP.

3.2 Evolution of the Environment Without the Plan

As part of the SEA process it is necessary to evaluate the actual need for the OREDP in the first place and to appraise how the environment would evolve in the absence of the plan (e.g. the do nothing scenario or continue with current practice scenario). In this scenario there would be no plans, programme or strategies for offshore wind and marine renewable energy development within Irish waters. The focus for the SEA is therefore to appraise how the environment would evolve without the plan (e.g. continue with current practice).

3.2.1 *Drivers for the OREDP*

As set out in Chapter 2, the main driver for the OREDP is to set out a high level strategy for the long term growth of the offshore renewable energy sector in Ireland. This is in response to the ever increasing concern over security of supply of energy from fossil fuels and Ireland's obligation to reducing CO_2 emissions and increasing the amount of energy from renewable sources in line with International and European targets.

In addition to onshore wind and biofuels, ocean energy has been identified as having the potential to make a significant contribution of the overall renewable energy mix in Ireland and achieving EU targets for carbon reduction and energy generated from renewable sources. It has also been recognised through the Sustainable Energy Authority of Ireland (SEAI) Strategic Plan 2010 to 2015 that with appropriate support and investment in the renewable energy sector, that in the longer term, there are aspirations for Ireland to become a net exporter of green energy, of which ocean energy could be an important element.

Although not as advanced as onshore wind, or biofuels, the offshore renewable energy sector has over recent years seen significant growth and development, in particular in offshore wind, but also with ongoing development of wave and tidal technologies. There is already significant interest at the project level for developing offshore wind in Irish waters, as demonstrated through the six offshore wind farm developments that have, or are awaiting, approval of their Foreshore Lease applications. Additionally, Ireland plays host to a number of developers of wave and tidal technologies, including OpenHydro which is currently being tested at EMEC with plans for commercial scale development in the Pentland Firth over the next few years.

The OREDP provides the strategic level vision and commitment for the longer term development, growth and expansion of the offshore renewable energy sector. It sits within a wider delivery programme for offshore renewable energy which is supported at the technical level through the delivery of the National Strategy for Ocean Energy, prepared in 2005 by the Marine Institute and SEAI, and other related plans and initiatives such of the Sea of Change: A Marine Knowledge Research and Innovation Strategy for Ireland 2007 – 2013 and ongoing work into strengthening supporting onshore and offshore grid infrastructure e.g. Grid 25 and The Isles Project. Further information on these other plan and programmes is provided in Chapter 5: Policy Context.

3.2.2 *Development Scenarios*

As part of the development of the OREDP, it was recognised that in order to demonstrate support and commitment at a strategic level to the growth of the offshore energy sector that there was a need to give an indication as to the levels of development (MW) that the Government would seek to achieve for offshore wind, wave and tidal technologies. The plan therefore sets out three scenarios, low, medium and high, for the development of offshore wind, wave and tidal energy. These scenarios are summarised in Table 3.1 below. Additional information on the criteria relating to the low, medium and high figures is provided Chapters 1 and 2.

Table 3.1: OREDP Development Scenarios

Development Scenarios to 2030			
	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)
Wind	800	2,300	4,500
Wave and Tidal	75	500	1,500

The focus of this SEA is to determine whether the development scenarios for offshore wind, wave and tidal energy presented in the OREDP can be achieved without significant adverse effects on the environment. However, it is also recognised that there are a number of other factors which are outwith the scope of the OREDP and the SEA that could influence the delivery of these development scenarios. These include for example the provision of supporting onshore and coastal infrastructure such as onshore grid, manufacturing facilities, and ports and harbours.

3.2.3 *Potential Environmental Effects of Not Implementing the OREDP*

The SEA has identified that, in some locations, there is potential for the development of offshore wind, wave and tidal energy to have likely significant adverse effects on the environment. This is mainly off the west coast of Ireland which is recognised as being of significant environment and seascape/landscape importance/value. However, the assessment also concludes that there are areas off the coast of Ireland where development (subject to detailed surveys at the EIA stage) could occur without likely significant adverse effects on the environment. Further detail on the potential effects of the OREDP is presented in Chapters 11, 12 and 13.

In terms of evaluating alternatives, it is also necessary to consider the potential effects that not developing offshore wind, wave or tidal energy (e.g. not implementing the OREDP) would have on the environment. A summary of these potential effects is provided below:

- Risk of not achieving the proposed national target for 40% of Ireland's energy to be from renewable sources by 2020 set out in the 2009 Carbon Budget or meeting EU targets for 16% of all energy (heat, transport and electricity) consumed to be from renewable sources. Environmentally there are a number of potential knock on effects associated with failure to meet these targets. These include:
  - Potential effects relating to not combating climate change such of continued effects on temperature, sea levels, precipitation, storminess, sea temperatures and these effects of these on species and habitat distribution and abundance, food chains etc.
  - Looking to achieve targets by increasing contributions from other renewable energy technologies for example increased reliance on onshore wind. This could potentially have a number of environmental effects in terms of increased pressure on sensitive habitats such as moorlands, increased adverse effects on landscape character and visual amenity, in particular in relation to cumulative effects, impacts on other wildlife (birds and bats) through habitat loss and disturbance.
  - Possible continued reliance of fossil fuels – the range of environmental effects associated with the use of fossil fuels excluding carbon emissions is extensive e.g. increased risks of oil spills etc and the consequences of these.

Whilst some of the potential environmental effects listed above are global issues e.g. effects of climate change on species and habitat abundance and effects of continued use of fossil fuels, Ireland still has a role in contributing towards reducing these potential effects. As noted the development of offshore renewable energy also has potential effects on the environment, although a large proportion of these are localised affects, most of which can be mitigated as part of the design of an individual project. It is therefore important to assess to development scenarios in the OREDP to determine the extent to which offshore renewable could contribute towards assisting Ireland in meeting its renewable energy targets and therefore fulfilling its wider European and global obligations.

3.2.4 *Other Potential Effects of Not Implementing the OREDP*

Although not directly related to potential environmental effects, there could be a number of wider implications resulting from not implementing the OREDP. These include:

- Security of supply – it is likely that without development of offshore renewable energy Ireland would continue to rely on imported electricity from fossil fuels and possible increased reliance on onshore wind. At present 85% of Ireland's electricity is imported. This has a number of potential implications in terms of:
  - Volatility of prices of electricity from fossil fuels and the implications of these on business/enterprise in Ireland as well as the effects on domestic customers in terms of fuel poverty etc.
  - Limitations relating to intermittency of supply from onshore wind. In comparison tidal energy is much more predictable and constant and offshore wind is generally less intermittent.

- Economic development – renewable energy (including offshore renewable energy) could potentially stimulate significant economic investment at all stages in the supply chain from technology developments, through to manufacturing, installation and maintenance with the potential for employment opportunities i.e. "green jobs". This opportunity would potentially be lost in absence of the development of these offshore renewables.

3.2.5 Baseline Environment – Key Issues and Future Trends

The baseline data review (Chapter 9) includes information of key issues and future trends. This information looks at current environmental conditions and provides information on how these may change in the future in absence of the implementation of the OREDP. These key issues and future trends have been taken into consideration in the main assessment (Chapters 11 and 12).

In general, the quality of the marine environment off the coast of Ireland is improving. This is due to a number of factors, mainly an increased awareness of the importance and value of the marine environment and its sensitivity to pollution and misuse. There have been a number of obligations and regulatory instruments introduced from an International to National level that focus specifically on the protection and conservation of the marine environment. These have generally been effective in improving the overall quality of the marine environment over the last few decades. Further detail on these obligations and regulatory instruments is provided in Chapter 5: Policy Context.

There are also a number of new measures being implemented which focus on future protection and enhancement of the marine environment through increase data collection and monitoring (Marine Strategy Framework Directive (MSFD)) and better coordination and management of marine activities (Marine Planning). These are also discussed in more detail in Chapter 5. However, the quality of the marine environment, in particular, the integrity of marine ecosystems, is still at risk from the impact of global climate change, especially increasing sea temperatures.

Environmental change in absence of the OREDP and offshore renewable energy developments is therefore likely to be both positive and negative. The assessment (Chapters 11 and 12) has identified that, in certain locations, offshore renewable energy developments could potentially have a likely significant effect on certain environmental receptors. Therefore, in absence of these developments, these potential adverse effects are unlikely to occur and the marine environment would continue at a local level to show general improvements in quality. However, there are a number of options for offshore renewable energy developments to take place while avoiding these potential significant effects.

On the negative side, offshore renewable energy developments have been identified as having the potential to make a significant contribution towards the wider mix of renewable energy source required to enable Ireland to meet its national and European targets for the percentage of energy consumed from renewable sources. These targets (National target of 40% energy to be from renewable sources and EU target that 16% of all energy (heat, transport and electricity) consumed is from renewable sources) have been set specifically to help combat carbon emissions and climate change. In absence of these measures to cut carbon emissions, there is a potential risk that in the long term the overall quality of the marine environment could as a result of increasing sea temperatures deteriorate, in particular in waters off the coast of Ireland which due to their position in the golf stream are recognised as being some of the most biologically diverse waters in the world.

3.3 Testing Alternative Development Scenarios

The OREDP has set out three scenarios for the development of offshore wind, wave and tidal energy. These scenarios reflect current (low), short term (medium) and longer term (high) aspirations for the development of offshore renewable energy in Irish waters. The main objective of the SEA has been to assess the potential effects of different amounts of offshore renewable energy development, comprising a mixture of different technologies, across different locations/areas within the study area to identify where development could occur without having potential likely significant adverse effects on the environment. The findings from the assessment are then reviewed in terms of achieving the three scenarios set out in the OREDP.

Full detail of the conclusions from the assessment of the development scenarios is presented in Chapter 12: Cumulative Assessment – Testing OREDP Development Scenarios.

3.4 Summary of Assessment of Alternatives

In terms of determining the need for the OREDP, there are a number of potential environmental effects associated with developing, and not developing, a plan for the development of offshore renewable energy.

In terms of not developing the OREDP, the main environmental implications include the potential adverse effects on landscape, visual amenity and ecology associated with the increased development of onshore wind in order to meet EU targets for reducing carbon emissions and generating electricity from renewable sources. There would also be longer term adverse effects associated with a continued reliance on the use of fossil fuels in terms of security of supply, the economic and social impacts of increased fuel prices and the wider environmental effects of fossil fuels. These potential effects could be significantly reduced should it be possible to develop offshore renewable energy to a level that would enable Ireland to become a net exporter of renewable energy.

However, as discussed in Chapters 11, 12 and 13, there are also likely to be a number of environmental implications associated with offshore renewable energy developments. However, with increased knowledge and data in relation to certain SEA subjects and the implementation of appropriate controls and management of future developments, including the careful siting of future developments within particular locations it is likely that the majority of these potential environmental effects can be avoided or minimised.

When considering the potential risks of not implementing the OREDP (environmentally and economically) against the main conclusion from the assessment of the OREDP as presented in Chapter 10, 11 and 12 it is concluded that it would be appropriate to pursue the implementation of the OREDP.

Chapter 4: Scoping Summary

4 Scoping Summary

4.1 Introduction

The following chapter provides an overview of the approach taken to consulting on the scope of the Strategic Environmental Assessment (SEA) of the Offshore Renewable Energy Development Plan (OREDP) for Ireland and the main responses received as part of that consultation exercise.

4.2 SEA Scoping Consultation Process

4.2.1 SEA Scoping Report

In July 2009, the Sustainable Energy Authority of Ireland (SEAI), formerly Sustainable Energy Ireland (SEI), produced a scoping report as part of the SEA of the OREDP. The main focus of this scoping report was to establish the scope of the SEA. This included:

- Setting the context of the SEA;
- Providing an introduction to the OREDP;
- Identifying the key topics to be assessed as part of the SEA;
- Presenting the sources of baseline data and information to be reviewed as part of the main assessment; and
- Providing detail on the approach and method to be used to strategically assess the effects of offshore wind and marine renewable energy on the marine environment.

The scoping report was issued to the environmental authorities for formal consultation on the 17th July 2009. It was also made available to a wide range of stakeholders via the SEAI website. The main consultees/stakeholders included:

- Environmental authorities:
  - Environmental Protection Agency (EPA);
  - Department of Environment, Heritage and Local Government (DEHLG); and
  - Department of Communications, Energy and Natural Resources (DCENR).
- Other interested organisations e.g. Coastal Concern Alliance and Eirgrid.
- Offshore renewable energy developers e.g. Tonn Energy, Fred Olsen Renewables.
- Other marine user groups.
- The public.

All consultees were invited to submit their comments on the scope of the SEA by 12th October 2009. A summary of the main written comments received as part of this consultation exercise is presented in Table 4.1 below. In total, responses on the scope of the SEA were received from 14 organisations. The main respondents are listed below:

4.2.1.1 <u>Scoping Respondents</u>

- BirdWatch
- Coastal Concern Alliance

- Department of Environment (DOE Northern Ireland)
- Department of the Environment, Heritage and Local Government
- EirGrid
- Environmental Protection Agency (EPA)
- Fred Olsen Renewables on behalf of Codling Wind Park
- Hydraulics & Maritime Research Centre, University College Cork (UCC)
- J Woods
- Northern Ireland Environment Agency (NIEA)
- National Offshore Wind Association of Ireland (NOW)
- Pelorus Energy Limited
- Tonn Energy

Full details of the responses received from each of the respondents listed above are available to view on the SEAI Website http://www.seai.ie/Renewables/Ocean_Energy/Offshore_Renewable_SEA.

4.2.2 SEA Scoping Workshop

In addition to the preparation of the scoping report, a scoping workshop was held in Dublin on 25th November 2009 as part of wider consultation on the scope of the SEA. The workshop was attended by approximately 50 delegates from a range of stakeholder groups including environmental authorities, marine (wave and tidal) and offshore wind developers and other interested organisations.

The format of the scoping workshop included presentations on the OREDP, the wider SEA process, and the proposed scope of the SEA followed by two separate workshop sessions. The workshop sessions included:

- Workshop Session 1: SEA Topics, Baseline Data, Devices and Resources
- Workshop Session 2: Approach, Alternatives and Method

The main focus of the workshop sessions was to invite delegates to discuss within groups, and then provide feedback on, specific questions relating to the scope of the SEA. These questions included:

Workshop Session 1: SEA Topics, Baseline Data, Devices and Resources
Q1: Do you agree with the SEA 'Directive Topics' and 'Relevant Marine SEA Topics' presented in Chapter 6 of the Scoping Report?
Q2: Do you agree that Local Air Quality should be scoped out of the SEA of the OREDP?
Q3: Have the main device characteristics been identified for offshore wind and marine renewable energy technologies (Section 7.4 of the SEA Scoping Report)?
Q4: Do you agree with the wind, wave and tidal resource information set out in Section 7.3.4 of the SEA Scoping Report?
Q5: Baseline data will be collected at an appropriate scale/level to inform the environmental assessment. Please suggest any data/datasets that could be used in the SEA.

Workshop Session 2: Approach, Alternatives and Method

Q6: Do you agree with the potential environmental effects identified in the Table in the Handout?

Q7: It is proposed that the assessment will consider up to 4500 MW generation from wind and 1500 MW from wave and tidal by 2030. Do you agree with this approach? What alternative scenarios would you suggest?

Q8: A three part assessment method is proposed as follows:

1. Part 1 Generic Assessment
2. Part 2 Locational Specific Assessment
3. Part 3 Cumulative Assessment

Do you agree with this approach?

Q9: Are there any other comments that you have on the scope of the SEA including the specific items listed in Chapter 2?

4.2.3 Summary of Scoping Responses

A summary of the written responses received on the scoping report and the feedback received during the scoping workshop sessions is presented in Table 4.1 below.

The comments received during the workshop generally reiterated the key points that were raised in the written responses received from individual groups and organisations To avoid duplication, both sets of comments have been combined in the summary of responses presented in Table 4.1 below. This is an overview of the main comments received. Not all detailed comments are included in this summary, although they will, where appropriate, be addressed within the Environmental Report.

Further detail on the specific feedback received in relation to each of the workshop questions listed above is provided in Annex A. Copies of the written responses received are available to download from the SEAI website: http://www.seai.ie/Renewables/Ocean_Energy/Offshore_Renewable_SEA.

4.2.4 Dealing with Existing Projects and Applications for Offshore Renewable Energy Projects

One of the key concerns raised during scoping was in relation to how offshore renewable energy projects that are currently in the process of applying for Foreshore Lease applications will be dealt with by the SEA. In response to these concerns being raised Eamon Ryan, Minister of DCENR, made a Parliamentary Statement confirming that the SEA should not influence or affect the processing of existing Foreshore Lease applications. The full statement provided is presented in Chapter 1, Section 1.6.

In terms of the SEA, the following response was also provided regarding the scope and approach to the cumulative assessment '*it is acknowledged that the potential cumulative effects of existing developments and developments in the planning system must be considered in the in the assessment. This includes applications which have been consented as well as those currently within the planning system and are awaiting a decision. It is proposed that for these to be taken into account, the SEA will consider the potential capacity within a given area without any existing applications and then overlay existing projects and applications within the planning system to assess what potential capacity has already been taken up by these developments. This will help to provide guidance on how much development could potentially be accommodated in a certain location, taking account of existing and proposed developments'.*

Further detail and information on the approach to the assessment of cumulative effects, taking into account existing project and applications, is provided in Chapter 6: Approach and Method and Chapter 12: Cumulative Effects – Testing OREDP Development Scenarios.

Table 4.1: Summary of Scoping Responses

Topic	Summary of Comments Received	Response
Scope of the OREDP	1. It is unclear how the OREDP will influence future planning decisions. For example, it is not known if the OREDP will exclude certain areas from development due to environmental sensitivities. 2. Opinions regarding the 2020 time horizon for the OREDP have been mixed, with some stating that this is appropriate due to links with existing national renewables targets. A smaller number have noted that, with technology being at a relatively early stage for wave and tidal, a shorter time horizon of 2015 would be more appropriate, to reduce uncertainty regarding environmental effects. The majority of respondents recommended an extension to 2025 or 2030. 3. Responses regarding proposed generation levels have been varied, with some stating they are unrealistically high and others noting they could be more ambitious given Ireland's intention to become a major energy exporter.	1. One of the outputs of this SEA will be to identify areas off the coast of Ireland where there are potential significant environmental constraints on commercial scale development of offshore renewables. The SEA will examine how these constraints will influence the potential capacity for development in the areas of greatest resource. The SEA will then make recommendations to assist in the development of the OREDP in terms of whether it is possible to achieve the development scenarios set out in the OREDP without significant adverse effects on the environment. Ultimately the aim of the SEA is to identify what opportunities there are for development across broad areas where environmental effects are minimal or can be avoided. The SEA also highlights the fact that more detailed surveys and assessments will still need to be carried out for individual projects as part of the consenting process. 2. The time horizon for the OREDP has been extended to 2030. The development scenarios presented in the OREDP cover the period to 2030. However, a phased approach will be adopted to the implementation of the OREDP, with a review in 2020 to take account of technological developments and changes in environmental information e.g. increased understanding on specific environmental effects or collection of more detailed baseline data. 3. With regard to generation levels SEA will take account of relevant information published in official documents only.

Topic	Summary of Comments Received	Response
Scope of the SEA	1. The relationship between EIA and SEA should be clarified. 2. A number of respondents have noted that terrestrial effects would occur and the SEA should therefore address them. There has been a request for clarity regarding the landward extent of the Plan in the ER. 3. A separate 'climate impact assessment' of the OREDP may be required. 4. Numerous suggestions have been made regarding potential effects. 5. It has been noted that due to a lack of seabird data and knowledge, the effects of offshore renewables developments are uncertain.	1. Further information on the relationship between the EIA and the SEA processes is presented in Chapter 1: Introduction of this Environmental Report. 2. Where appropriate the SEA takes into consideration potential terrestrial effects in relation to onshore grid connections. However, this is only be considered at a generic level as the specific locations for these connections are not be known at the time of the SEA. 3. The SEA also takes into account the positive effects of renewables with respect to climate change. However, this is only carried out at a strategic level and is based on current information relating to the contribution of offshore renewable energy to combating the effects of climate change, rather than providing a detailed climate impact assessment. The need for a more detailed assessment of the potential effects on climate change could be reviewed in 2020 as part of phased approach to SEA (based on plan timescale up to 2030) when more/different information may have become available. 4. Suggestions made regarding potential effects have been noted and have been taken into account within the assessment and presented in this ER where appropriate. 5. It is acknowledged that there are notable gaps in baseline data and limited understanding the potential effects of offshore renewable energy developments (particularly wave and tidal) on a range of receptor including seabirds. This is discussed in Chapter 1, Chapter 9: Baseline Data, Chapters 11 and 12 (assessment chapters) and Chapter 14: Data Gaps. Where there is uncertainty over potential effects, this has also been taken into account in identifying the potential development opportunities in certain areas. Where available information from similar SEAs e.g. Northern Ireland Marine Renewable Energy and Offshore Wind SEA and DECC UK Offshore Energy SEA has also been used to help inform the assessment of potential effects.
Scoping Report Structure	1. The Scoping Report does not include baseline data, an assessment method, identification of existing environmental problems or linkages with other plans and programmes.	1. Baseline data, assessment methods, environmental problems and links with other plans/programmes have been considered in detail and recorded in the Environmental Report.

Topic	Summary of Comments Received	Response
SEA Issues/Subjects	1. Clarity is needed on whether effects on socioeconomics will be assessed through the SEA. 2. The Scoping Report stated that effects on local air quality would not be assessed through the SEA and the majority of respondents agreed. However, one consultee stated that this should be included. 3. Developers have requested that the technical steering group should pay great attention the wording of the ER given how it might impact on subsequent permitting and zoning policy decisions. Regardless of the strict role of the SEA, the language and findings (even if tentative) would likely inform subsequent decisions.	1. The role of the SEA is to assess the potential effects of the OREPD against the environmental issues/subjects listed in the SEA Directive. Whilst this covers population and human health it does not extend to the local economy. However, it is considered that, through avoiding any significant adverse effects on key activities and other sea users considered under population e.g. fishing or navigation (e.g. disruption or displacement), any related/resulting socio-economic effects will also be avoided. 2. Local air quality has been scoped out of the assessment as significant effects are not likely to occur as a result of the OREDP. Further detail on the justification for scoping out local air quality is provided in Chapter 1 of this report. 3. As part of the SEA process, the SEA consultants have worked closely with the Technical Steering Group (TSG) in the assessment of effects and the preparation of the ER. This has includes a technical and quality review of all ER chapters including a review the wording and language used to describe effects and in the development of recommendations etc.
Baseline data and data gaps	1. It was noted that the resource data set out in the Scoping Report is out of date; particularly the wave resource data. 2. Various baseline datasets and sources have been recommended these will be included in the ER where appropriate. Further detail on the baseline data sources suggested is included in original versions of the scoping responses which can be accessed by the SEAI website. 3. Information from assessments (EIAs) carried out for individual projects should also be used in the SEA.	1. The availability of additional resource data has been reviewed as part identification of Assessment Areas. Whilst it is accepted that there are a number of different sources of resource data/information available, for consistency purposes, the SEA is required to only use the best available data that has been published in official documents. However, findings from other data sources will be taken into consideration in the SEA where appropriate. It should be noted that, in order to reflect future changes in technology and variations in the quality and accuracy of resource data, the Assessment Areas identified in the SEA include a 'buffer area' to ensure that all potential areas of resource are taken into account. 2. Recommended baseline data sources have been explored for the SEA and this report. Details on all sources of baseline data used in the SEA are listed in Chapter 9 of this report. This ER also provides a summary of all baseline data/information that was made available for the SEA but for certain reasons may not have been used in the assessment. Reasons why certain data/information has not been used will is also included in this report. 3. Where available, the SEA has taken into account baseline, and other, data and information contained within other assessments (e.g. EIAs) carried out for existing projects and projects that are in the planning system. However, it should be noted that this data has only been used at a strategic level appropriate to the SEA and level of detail within the OREDP.

Topic	Summary of Comments Received	Response
Other plans and programmes	1. The Environmental Report should clarify the relationship between the OREDP SEA and the Grid SEA. 2. The relationship between the OREDP and the Northern Ireland Offshore Renewable Energy Plan (SAP) should be clarified, along with the relationship between their respective SEAs. 3. Various plans and programmes were suggested that should be considered in the SEA. These include, for example, Local County Development Plans, Landscape Character Assessments, National Biodiversity Plans, Marine Strategy Framework Directive (MSFD), OSPAR, Habitats and Birds Directives, GRID25 etc. Further information on all plans and programmes suggested is included in the detailed scoping responses.	1. Information on the relationship between the OREDP and the SEA is provided in Chapter 1. 2. Information on the relationship between the Northern Ireland Offshore Renewable Energy SEA and Strategic Action Plan (SAP) and other plans and programmes is provided in Chapter 5: Policy Context and is also included in the assessment of cumulative effects and in-combination effects (Chapter 13). 3. A full review of all relevant plans and programmes (International to local level) including relevant statutory regulatory and obligatory instruments is included in Chapter 5: Policy Context.
Alternatives	1. It has been noted that the SEA should include an assessment of alternatives including alternatives to the plan (OREDP) and alternative development scenarios. A number of suggestions were made in terms of development or generation scenarios such as high, medium and low scenarios which may or may not be time-linked.	1. As part of the assessment of alternatives (Chapter 3) the SEA considers alternatives to the OREDP and the development of offshore renewable energy in the context of the wider energy mix for Ireland. The SEA also considers alternative scenarios for development including different levels (MW) of development for different technologies in different locations. As well as being an assessment of alternatives, this will also be an integral part of the overall assessment of cumulative effects.
Assessment method	1. The proposed three-part SEA assessment method (generic – location specific – cumulative) received broad support from consultees.	1. Full details of the SEA assessment method are presented in Chapter 6 of this report. 2. More detail on the approach to the cumulative assessment is provided below.
Cumulative effects in relation to existing developments and developments in the planning system.	1. It is not clear how the SEA will address cumulative effects e.g. whether this will include or exclude existing developments, consented developments, or those within the planning systems.	1. It is acknowledged that the potential cumulative effects of existing developments and developments in the planning system must be considered in the assessment. This includes applications which have been consented as well as those that are currently within the planning system and are awaiting a decision. The approach taken to addressing these developments has been to consider the potential capacity within a given area without any existing applications and then overlay existing projects and applications within the planning system to assess what potential capacity has already been taken up by these developments. This will help to provide guidance on how much development could potentially be accommodated in a certain location, taking account of existing and proposed developments.

Topic	Summary of Comments Received	Response
Transboundary effects	1. It has been noted that the SEA should assess transboundary effects, in particular the areas around Lough Foyle and Carlingford Lough on the border with Northern Ireland.	1. Transboundary effects have been assessed as part of this SEA. The results of this assessment are presented in Chapter 13. This is a key aspect of the assessment of cumulative effects and will also be important in determining the in-combination effects associated with other plans and programmes.
Habitats Directive and Appropriate Assessment	1. The potential need for an Appropriate Assessment of effects on Natura sites has been raised by various respondents.	2. The need for an Appropriate Assessment of the OREDP has been acknowledged and is being progressed in parallel to the SEA. Screening and scoping will be carried out as various scenarios for development and potential resource areas are identified. Further detail on the links between the SEA and AA process is provided in Chapter 1: Introduction.
Technologies and device characteristics	1. In addition to those set out in the scoping report, it was suggested that the following types of device are considered for inclusion: - OWC; - tidal barrage; - run of river; - hydro-kinetic; and - future device combinations. 2. The ER should justify the exclusion of any devices or technologies from the SEA. 3. Whilst many consultees agreed with the proposed depths for devices set out in the scoping report, a number suggested that should the OREDP be extended beyond 2020, these proposed depths could increase.	1. The technologies identified were examined for their inclusion in the SEA. Where certain technologies have not been included in the SEA, an explanation for their exclusion has been provided in Chapter 7: Technologies. 2. As noted above, this report includes an explanation as to why certain device types have not been included in the SEA. 3. It is proposed that OREDP will be extended to 2030, but with a phased approach to the delivery of the development scenarios with a review of progress in 2020. Any additional baseline information and technological developments will be taken into account as part of that review.

Topic	Summary of Comments Received	Response
Planning issues	1. Clarity is needed regarding how existing, consented and proposed offshore developments will be addressed by the OREDP. 2. As a result of the above, it is not known if, or how, the effects of existing, consented or proposed developments will be assessed by the SEA. 3. It is uncertain at which point proposed infrastructure should be considered to 'exist'. For example, when assessing effects on material assets the SEA would consider effects on sub-sea cables but it is not clear whether effects on planned cables would be considered or at what point in the planning process it would be deemed appropriate to do so. **4.** There is the potential for conflict should the Plan identify suitable areas for development which are not consistent with existing applications. Developers have sought legal advice on this issue due to concerns regarding the potential for delays caused by the SEA and OREDP.	1. The purpose of the OREDP and the SEA is to provide guidance at a strategic level. This guidance will be a material consideration in the determination of individual development applications. Where there is conflict between findings of the SEA and existing individual development applications it will ultimately be the decision of the Minister as to whether development should be permitted taking into account the SEA and OREDP. However, as noted in the Parliamentary Statement issued by Eamon Ryan on the 20th January 2010 it is not the role of the SEA to determine approvals for individual developments. 2. See comment above. 3. Available information on approved, proposed (e.g. awaiting planning approval or waiting to be formally submitted for planning approval) and existing infrastructure has been taken into account in this SEA. The SEA also highlights a potential for conflict with 'speculative' infrastructure developments in an area but does not recommend exclusion or avoidance of that area, particularly as certain infrastructure does not always need to be avoided and therefore it is not always necessary to exclude areas containing this infrastructure from development. 4. See point 1 above.

Chapter 5: Policy Context

5 Policy Context

5.1 Introduction

Currently Ireland has no integrated regulatory framework for marine/coastal management and protection. The focus of Offshore Renewable Energy Development Plan (OREDP) is on the future development of offshore wind and marine renewable energy (wave and tidal). In developing the OREDP and undertaking the SEA, it will therefore be necessary to understand how it will relate to the existing framework of international, European and domestic obligations and agreements that currently influence the use, and protection of, the coastal and marine environment. It will also be necessary to consider the OREDP in the context of the emerging Irish framework for the future management of the marine and coastal environment.

5.2 Marine Environment

The marine environment is, contrary to its appearance, heavily used for shipping and navigation and commercial fishing activities. It is also used for military testing, aggregate mining, contains a plethora of telecommunication links, sub-sea electricity cables and gas pipelines and is used for the dumping of waste in some controlled locations. The marine and coastal environment is also a major resource in terms of recreation and tourism. Its scenic value and wealth of wildlife, geological and historical features make it a key visitor destination whilst also supporting a range of water based activities such as surfing, diving and recreational sailing.

The marine environment and activities that occur within it (or in association with it) is currently subject to a number of controls and protection measures that have been established under a variety of International, European and domestic obligations and agreements. These obligations and agreements are discussed below in terms of their implications to this SEA and the OREDP.

These obligations and agreements are necessary for ensuring the ongoing protection of the various users of the sea, their permitted activities, and health and quality of the environment in which they operate. These obligations and agreements are implemented through a framework of regulatory instruments which include Directives, Acts, and Regulations and associated licensing procedures. Table 5.1 lists the current key obligations, agreements and regulatory instruments that apply to the waters in Ireland.

The following section includes a review under three broad headings, planning, environment and grid of the existing marine obligations and regulatory context in Ireland. It also looks at the future protection and management as a consequence of the Marine Strategy Framework Directive (MSFD) 2008 and the implications of these regulatory instruments on the SEA and the OREDP.

5.2.1 Planning in the Marine Environment

The Foreshores Act and the Planning and Development (Strategic Infrastructure) Act are the main regulatory instruments with regards to offshore applications, and a number of pieces of legislation cover specific aspects of the marine environment. These are described in more detail below.

5.2.1.1 Foreshore and Dumping at Sea (Amendment) Act 2009

The Foreshore Act, introduced in 1933 and most recently amended in 2009 under the Foreshore and Dumping at Sea (Amendment) Act 2009, require that a lease or licence is obtained from the Minister of Environment, Heritage and Local Government for the carrying out of works or placing structures or materials on, or for the occupation of, or removal of material from State-owned foreshore which represents the greater part of the Foreshore[9]. Developments on privately owned foreshore also require the prior permission of the minister under the Foreshore Acts9.

The Foreshore is the seabed and shore below the line of high water or ordinary or medium tides and extends outwards to the limit of 12nm (approximately 22.24 km)9.

Following introduction of the Foreshore and Dumping at Sea (Amendment) Act 2009 responsibility for certain foreshore functions has transferred to the Minister for the Environment, Heritage and Local Government with effect from 15th January 2010. This will streamline the consenting process for offshore developments including phased implementation of offshore wind, wave and tidal technologies. This will involve a four phase approach by amending the Strategic Infrastructure Act (2006) so that major renewable projects can be fast tracked; transfer of power for non strategic foreshore infrastructure to local authorities; development of a Marine Spatial Strategy which will set out clarification on the type and location of development on and beyond foreshore limits; and a regional approach to integrated coastal area management.

5.2.1.2 Planning and Development (Strategic Infrastructure) Act 2006

This Act makes provision for applications of developments of strategic importance to the state. Under the Act any development that is categorised as strategic infrastructure will be subject to a specialised planning application to the Board rather than the planning authority. Developments which fall under the title of strategic infrastructure include energy, transport and environmental infrastructure that are of strategic, economic or social importance, contribute to the fulfilment of objectives set out within the National Spatial Strategy, and/or the development would have a significant effect on the area of more than one planning authority.

5.2.1.3 European Communities (Establishing an Infrastructure for Spatial Information in the European Community (Inspire)) Regulations 2010.

These regulations implement Directive 2007/2/EC (establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)). The regulations require that infrastructure for spatial information is made available and the data sets to be combined in order for services to interact without repetitive manual intervention. This will ensure a more coherent way of assessing data sets and services. The Regulations cover data sets that cover terrestrial and marine areas over which the State has jurisdiction, are in electronic format and are held on behalf of a public body.

The implementation of these Regulations will allow a more streamlined approach to the planning and environmental assessment of offshore renewable energy developments.

[9] http://www.environ.ie/en/Foreshore/

5.2.2 *Environmental Protection*

Table 5.1 provides an overview of the main obligations, instruments and legislation that apply to the conservation and protection of the marine environment. These all need to be taken into consideration in the SEA in terms of ensuring that the OREDP fulfils all its legal and statutory obligations.

Table 5.1: Current Marine Protection Obligations/Instruments (note this list is not definitive)

Obligation/Instrument	Main Aim
The MARPOL Convention	- Protection of the marine environment with a focus on preventing pollution from shipping from operational or accidental causes. - Whilst not directly connected to the development of offshore marine renewables this Convention will apply to a number of activities that relate to the construction and operation of offshore renewable developments such as the carriage of materials required for construction operations. - In addition the cumulative effects of offshore developments both as a consequence of OREDP and within neighbouring UK waters could result in the narrowing of shipping lanes therefore increasing the risk of accidents.

The OSPAR Convention 1992 (Convention for the Protection of the Marine Environment of the North East Atlantic)	- Protection of the marine environment of the North East Atlantic. Relates to pollution prevention e.g. from dumping at sea and protection and conservation of marine ecosystems.
	- Set requirements to determine pollution loads to the Marine Environment which are now embodied in the Water Framework Directive (WFD)
	- Led to the adoption of several long term strategies for protection of the marine environment of the North East Atlantic relating to:
	  - Hazardous substances
	  - Radioactive substances
	  - Eutrophication
	  - Protection of Ecosystems and biological diversity
	  - Environmental goals and management mechanisms for offshore activities
	- In 2000 OSPAR published its first comprehensive Quality Status Report (QSR) on the quality of the marine environment of the North-East Atlantic. Supported by five reports that will be updated in 2010
	- In 2002/3 OSPAR set a requirement for the identification of a network of Marine Protected Areas (MPAs) by 2010. This network will complement the Natura 2000 network (required under the Habitats Directive).

UNCLOS (United Nations Convention on the Law of the SEA) 1982	- Sets out a legal framework for use of the world's oceans. Covers navigation, over flight, resource exploration and exploitation, fishing, shipping and conservation and pollution all of which potentially interact with offshore renewable energy developments.
World Summit on Sustainable Development (WSSD)	- Sets challenging targets and goals for Governments - For oceans these are to promote integrated sustainable management at all levels in order to help maintain the productivity and biodiversity of marine and coastal areas and help to secure a significant reduction in biodiversity decline by 2010. - This will be achieved through the introduction of policies, measures and tools such as the ecosystem approach, marine protected areas and the incorporation of coastal interests in watershed management.

European Integrated Maritime Policy 2007	- Aims to deliver a sustainable development approach for Europe's oceans and seas
	- Includes:
	  - A comprehensive maritime transport strategy and new ports policy
	  - A European Strategy for Marine Research
	  - A European Marine Observation and Data Network
	  - A Strategy to mitigate the effects of climate change on coastal regions
	- The Marine Strategy Framework Directive (MSFD) provides the environmental pillar of the sustainable development approach

Obligation/Instrument	Main Aim

Water Framework Directive (WFD) 2000	- Legal framework for the protection, improvement and sustainable use of surface waters, transitional waters and coastal waters and groundwater across Europe.
	- Main aims of the WFD include:
	  - Prevent deterioration and enhance status of aquatic ecosystems, including groundwater
	  - Promote sustainable water use
	  - Reduce pollution
	  - Contribute to the mitigation of floods and droughts

The RAMSAR Convention (The Convention of Wetlands of International Importance (1971 and amendments)	- Protection and conservation of wetlands, particularly those of importance to waterfowl and waterfowl habitat.
Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979)	- Conservation of wild flora and fauna and their natural habitats.
Bonn Convention on the Conservation of Migratory Species and Wild Animals (1979)	- Conservation of terrestrial, marine and avian species and wildlife on a global scale, in particular migratory species.
Directive 79/923/EEC the Shellfish Waters Directive	- Protects the aquatic habitat of bivalve and gastropod molluscs and aims to protect and improve the quality of shellfish waters.
Habitats Directive 1992 (Directive 92/43/EEC Conservation of Habitats and Wild Flora and Fauna)	- Sets out the framework for the establishment of Special Areas of Conservation (SACs) for areas containing habitats of conservation importance (listed under Annex I of the Directive) or species of conservation importance listed under Annex II of the Directive. - Requires the establishment of a network of protected (Natura 2000) sites which include SACs and SPAs (see Birds Directive below). - Network of Natura 2000 sites also now includes the designation of offshore areas for protection.
Birds Directive 1979 (Directive 79/409/EEC on the Conservation of Wild Birds)	- Sets out the framework for the establishment of Special Protection Areas (SPAs) for areas containing rare or vulnerable birds (listed under Annex I of the Directive) or for regularly occurring migratory species.
EU (Natural Habitats) Regulations SI 94/1997 (as amended by SI 233/1998 and SI 378/2005)	- Implements the EU Habitats Directive in Ireland.
EU (Birds and Natural Habitats) (Control of Recreational Activities) Regulations 2010	- Sets out the control of recreational activities under the Habitats Directive
Wildlife Act 1976 as amended in 2000	- Principle legislation in Ireland for the protection of wildlife making provision to protect wildlife species and habitats in Ireland. - Establishes designated areas of national conservation value for ecological and/or geomorphology heritage. - The amendments in 2000 further strengthened the regulatory powers of the 1976 Act and broadened the scope to include species excluded from the 1976 Act.
Draft European Communities (Birds and Natural Habitats) Regulations 2010	- Set out the grounds, as provided in the Habitats Directive, for the selection of sites of community importance (sites that in most cases will ultimately be designated as special areas of conservation SACs). - Regulation also provides for the identification of sites that need to be considered for classification as special protection areas for birds. - This is a new provision to the EC based on the judgement that Ireland failed to transpose correctly Article 4 of the Birds Directive.

Obligation/Instrument	Main Aim
The European Communities (Quality of Shellfish Waters) Regulations 2006 (SI 268/2006)	- Implements the Shellfish Waters Directive in Ireland and set out pollution reduction programmes for the then 14 designated shellfish waters sites. Amendments to these regulations in 2009 (SI55/2009) set out provision for a further 49 sites to be designated within Irish waters under these Regulations.
The European Communities (Water Policy) Regulations 2003 (SI 722/2003) as amended in 2005 (SI 413/2005)	- Implements the Water Framework Directive in Ireland. The protection of waters and water management is regulated by the Water Pollution Act 1977 as amended 1990.
Foreshore Acts 1993-2005	- Requires the acquisition of leases or licences for undertaking any works or placing structures or material on, or for the occupation of or removal of material from foreshore.

5.2.2.1 Marine Strategy Framework Directive (MSFD)

The Marine Strategy Framework Directive (MSFD) forms the environmental pillar of the EU's Integrated European Maritime Policy 2007, which aims to deliver sustainable development approach for Europe's oceans and seas through creating a coherent framework for joined up maritime governance. The European Integrated Maritime Policy 2007 also includes a comprehensive maritime transport strategy and new ports policy, a European Strategy for Marine Research, a European Marine Observation and data network and a strategy to mitigate the effects of climate change on coastal regions.

In the context of the Integrated European Maritime Policy the objective of the MSFD, which was adopted on 17th June 2008, and has now been transposed into domestic legislation, is to enable the sustainable use of marine goods and services and to ensure the marine environment is safeguarded for the use of future generations.

This Directive aims to achieve good environmental status of the EU's marine waters by 2020. Under this directive each member state is required to develop strategies for their marine waters which will define Good Ecological Status (GES), a detailed assessment of the state of the environment and the presentation of environmental targets (by 2012) and the implementation of a monitoring programme by 2014. From the above a programme of measures or management actions will be developed by 2015 and implemented by 2016. This is designated to line up with Directive 2000/60/EC (Water Framework Directive). The MSFD extends and builds on the requirements of the Water Framework Directive (WFD) into seas beyond the current WFD limit. Under the WFD member states are required to GES of all controlled waters including estuarine, transitional and coastal waters. Consequently where the MSFD overlaps with the WFD in coastal areas, the latter will continue to take precedence except where the MSFD introduces additional requirements.

The MSFD sets out a number of qualitative descriptors that will be used for determining GES. Table 5.2 presents some of the key GES descriptors from the Directive that have been identified as being most relevant to offshore renewable energy and the OREDP and the focus of this SEA.

Table 5.2: Relevant MSFD Qualitative GES Descriptors

GES Descriptor	Description
GES Descriptor 1	Biological Diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions**.**
GES Descriptor 2	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems**.**

GES Descriptor	Description
GES Descriptor 4	All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
GES Descriptor 6	Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
GES Descriptor 7	Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
GES Descriptor 8	Concentrations of contaminants are at levels not giving rise to pollution effects.
GES Descriptor 9	Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
GES Descriptor 11	Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

5.2.2.2 MSFD in Ireland

As part of the transposition of the MSFD into Irish legislation there is a required to identify the competent authorities including their roles, responsibilities and timeframes, set out the objectives and define GES. The Department of Environment, Heritage and Local Government (DoEHLG) are leading the implementation of this Directive into national law. Other national pieces of national legislation are also being reviewed to ensure consistency with the requirements of the MSFD.

The MSDF requires co-operation between Member States as well as non-EU countries who share a marine region to develop coordinated strategies. The OSPAR Regional Seas Convention is promoted as the mechanism by which Member States will co-operate to achieve GES. The British/ Irish Council is likely to be used as a vehicle to achieve regional co-operation between the UK and Ireland.

The implementation of the MSFD will line up with Directive 2000/6/EC (Water Framework Directive) which sets the legal framework for the protection, improvement and sustainable use of surface, transitional, coastal, marine and groundwater across Europe. The main aims of the WFD include, the preventing the deterioration and enhancing the status of aquatic ecosystems, promoting the sustainable use of water, reducing pollution and contributing the mitigation of floods and droughts.

5.3 Electricity Grid

The following section provides an overview of the legislative and regulatory framework relating to grid infrastructure. It should be noted that there is no single piece of legislation detailing all the requirements related to energy grids in Ireland. At present, there is a large range of primary and secondary legislation that together form the legal context for electricity grids in the country. However, the main focus on the information presented below relates to the development of offshore renewable energy and is therefore covered at a very generic level. A full list of all primary and secondary legislation relating to electricity networks in Ireland is provided in the National Renewable Energy Action Plan (NREAP).

Table 5.3: Relevant Electricity Related Obligations

Obligation/Instrument	Main Aim
Renewables Directive 2009/28/EC	- Promotes the generation of electricity produced from renewable energy sources in the internal electricity market.
Sustainable Energy Act 2002	- Regulatory framework for the generation of energy from the renewable sources Ireland. Under this Act the Sustainable Energy Authority of Ireland (SEAI) is required to promote and assist the development of energy from renewable sources, promote the redirection in greenhouse gas emissions, and promote research into renewable technologies.
Electricity Regulation Act 1999	- Gives the Commission for Electricity Regulation the power to grant licences to generate and supply electricity; - Gives the Commission the power to grant authorisations for the construction of generating stations; and - Provides for the access to the transmission or distribution system by licence holders, holders of authorisations and eligible customers

It should also be noted that the SEA does not explicitly assess the potential effect of onshore grid connections or transmission upgrades required to support offshore renewable energy developments as this is covered by the SEA of the Grid 25 Implementation Programme which is currently being prepared by Eirgrid. However, this SEA does take into account, albeit at a generic level, the requirement to connect offshore developments onshore via export cables and other supporting infrastructure.

Additionally, as part of the longer term growth of the renewable energy industry there are plans to examine the feasibility of developing grid infrastructure offshore. Further information on this is provided below.

5.3.1 Relevant Plans and Programmes (Electricity)

In addition to this legislation and regulatory requirements there are a number of grid initiatives and studies that have recently been undertaken to ensure the efficient implementation of renewables within Ireland including connections to the UK and the rest of Europe. A brief summary of these relevant studies and initiatives is set out below.

5.3.1.1 <u>All Island Grid Study</u>

The All Island Grid Study was a joint study between Ireland and Northern Ireland which looked at the grid network across the island and how this could be further developed in a cost effective manner in order to facilitate electricity generation from renewable sources. This study looked at four workstreams. Workstream 1 looked the renewable resource availability from wind, biomass, wave, tidal, wood co-combustion and small hydro and solar photovoltaic[10]. Workstream 2 investigated the extent to which electricity generated from renewable energy sources could be accommodated on the grid system with regard to variability and predictability.

[10] http://www.dcenr.gov.ie/NR/rdonlyres/1CC7BE35-C821-4E2A-8433-7B7826E9B9CF/0/Workstream1.pdf

Workstream 2 was split into two stages the first involved a high level modelling study to determine the portfolios to be studied and the second is a detailed modelling study of the impact of renewable generation on grid operation, cost and emissions[11]. Workstream 3 looked at the engineering implications for the grid, in terms of the extent and cost of the likely network reinforcements to accommodate the specified renewable energy[12]. Workstream 4 takes the outputs from the previous three workstreams to determine the relative economic cost of and benefits of the various renewable energy generation levels for sociality as a whole[13].

5.3.1.2 The Grid25 Study

The Grid25 strategy addresses the upgrade and investment in the high voltage system and over the period up to 2025. The strategy aims to support growth in the regions and continually secure the reliability of the supply. In addition the strategy looks at exploiting energy from renewable sources, reducing carbon emissions and increasing the connectivity to the European Grid[14].

5.3.1.3 Further Connection Study

The Further Connection Study is a study that EirGrid have recently undertaken that investigates the need for further interconnection between Ireland and the UK and potentially further into Europe based on a number of different future scenarios which includes a high renewables electricity generation scenario.

5.3.1.4 Offshore Grid Study

The Offshore Grid Study, undertaken by EirGrid, looks at how electricity generation from offshore renewable sources will be integrated into the existing transmission system or whether a second (off shore) transmission grid would develop. The study also explores options for an offshore grid in terms of how and where this would be developed.

5.3.1.5 Irish Scottish Links Energy Study (ISLES)

The Irish Scottish Links Energy Study (ISLES) is a feasibility study conducted by the Department of Energy, Communications and Natural Resources (DECNR), the Department of Enterprise, Trade and Investment (DETI) and the Scottish Government into the development of an offshore transmission electricity grid around the west coast of Ireland, Irish Sea, north east coast of Northern Ireland and the west coast of Scotland.

The project looks at linking potential offshore sites for renewable energy generation of which there is huge potential in these locations. This will offer a wide range of economic, environmental and technical opportunities from harvesting electricity generation from renewable sources which in turn will aid the achievement of carbon reduction targets. The study will help in influencing the development of renewable energy generation and the development of an offshore grid.

[11] http://www.dcenr.gov.ie/NR/rdonlyres/27E755FE-EFB7-41CE-8828-2BB3A8EF6FE5/0/WS2AReport.pdf
[12] http://www.dcenr.gov.ie/NR/rdonlyres/C76CFBB9-67DC-493A-B869-A5D3B20E81C7/0/WS3Report.pdf
[13] http://www.dcenr.gov.ie/NR/rdonlyres/43CF090D-22AD-40FC-9C7E-02948122D35F/0/AllIslandGridStudyAnalysisofImpactsandBenefitsJan08a.pdf
[14] http://www.eirgrid.com/media/Grid%2025.pdf

5.3.1.6 North Seas Offshore Grid Initiative

The North Seas Offshore Grid Initiative was identified by the European Commission as a priority infrastructure action in Europe and act as a building block for the future. The North Seas Offshore Grid would allow for bulk transfers and exports from the 9 EU Member States and Norway that are participating in this initiative allowing for more efficient energy production and distribution across northern Europe.

5.4 Other Offshore Wind, Marine Renewable Energy and Other Offshore Plans, Programmes and Developments

In addition to the relevant legislation the OREDP and this SEA also needs to take into consideration other offshore plans and programmes that could have in-combination effects with this plan.

There are a number of ongoing initiatives, plans and programmes relating to offshore wind and marine renewable energy within Irish and UK waters. These include:

- Petroleum Affairs Division – Ireland Offshore Strategic Environmental Assessments (IOSEAs) 1-4
- Northern Ireland Offshore Renewable Energy Strategic Action Plan (ORESAP)
- Department of Energy and Climate Change (DECC) Energy Plan for Offshore Wind, Oil and Gas 2009.
- The Crown Estate (TCE) Offshore Wind Licensing Rounds 1, 2 and 3 including extensions to Rounds 1 and 2.
- The Crown Estate (TCE) Scottish Offshore Wind Licensing Round.
- Welsh Assembly Government (WAG) Ministerial Policy Statement on Marine Energy in Wales July 2009.
- Europe's Onshore and Offshore Wind Energy Potential: An Assessment of Environmental and Economic Constraints (European Environmental Agency EEA).

All of the plans and programmes listed above could potentially influence, or affect, the proposals presented within the OREDP. A summary of these plans and programmes is provided below. Further detail on the potential interactions between these plans and programmes and the OREDP and associated environmental implications are discussed in Chapter 13: Cumulative Effects Associated with Other Plans and Programmes.

5.4.1 Relevant Plans and Programmes

5.4.1.1 Ireland Oil and Gas Offshore Strategic Environmental Assessments (IOSEAs) 1-4

The Oil and Gas IOSEA1 is the first in a series of SEAs that are currently being undertaken on future plans to issue oil and gas exploration licences for the entire offshore area which falls under the Irish Jurisdiction.

The IOSEA1 area is located off the northwest coast of Ireland in the Slyne, Erris and Donegal Basin. Other activities within this area include commercial fishing, with a number of fish and shellfish farms lying adjacent and major shipping routes to the north and south. In addition there are military exercise areas and the submarine transit route to Faslane Naval Base in Scotland within the IOSEA1 area and marine disposal sites for munitions within 10km of this area. With regards to the drilling within this area a maximum of 8.7km^2 would be unavailable to other sea users in any one year, with the addition of seismic surveys which excludes other sea users from up to 490km^2 per day resulting in a total of less than 2% of the IOSEA1 area[15] that is unavailable to other sea users.

IOSEA2 is the second in the series to issue exploration licenses in 2007. The IOSEA2 area is off the west and south west coasts of Ireland in the Porcupine Basin.

[15] http://www.dcenr.gov.ie/NR/rdonlyres/A4AB262E-037B-487E-B16F-3BD3E7AE280B/0/1445R002Nontechnicalsummary.pdf

The area is in one of the most productive fishing grounds in the world and a number of transatlantic sailings. In addition there are submarine exercise areas in both the north and the east of IOSEA2. The physical presence of the well sites and the associated drilling infrastructure will result in less than 5km^2 of the IOSEA2 marine area being made inaccessible for other marine activities. The associated seismic surveys would amount to 240km^2 per day being excluded to other users or 197 days per year over the period 2008-2014 which is less than 0.5% of the IOSEA2 area[16].

IOSEA3 is the third in the series of SEAs to issue exploration licenses in 2009 licensing round. The IOSEA3 area is off the west and north west coasts of Ireland in the Rockall Basin.

Other users of the marine environment within the IOSEA3 area include commercial fishing and shellfish farming. However, fishing is less intensive within this area compared to the shallower waters closer to the coast. There are a number of transatlantic shipping lanes through this area with estimated movements to be 37,291 vessels per year and on average 25 vessels within this area at any one time. A submarine exercise areas overlaps with the eastern half of the IOSEA3 area and a munitions dump site within the north eastern Trough.

With regards to the exclusion of other sea users the seismic surveys would result in 240km^2 per day being excluded to other sea users for 413 days over the period 2010 to 2016 which is a total of 0.2% of the IOSEA3 area per day. With the addition of the physical presence of the wells and associate infrastructure this increases to 245km^2 or 0.5% of the total area[17].

IOSEA4 is currently being prepared to issue exploration licences in the 2010 licensing round. The area covered by IOSEA4 is the Kish, Fastnet, Cockburn and the North and South Celtic Seas Basin[18].

Whist drilling activities will be in operation within all of the above areas these operations will only be temporary in nature. Development of offshore renewables within these strategic areas could affect the exploitation potential of these areas and result in cumulative impacts on fishing, shipping and military activities by further excluding these other sea users within these areas.

5.4.2 Northern Ireland Offshore Renewable Energy Strategic Action Plan (ORESAP)

The Department of Enterprise, Trade and Investment (DETI) is currently in the process of finalising the preparation of its Offshore Renewable Energy Strategic Action Plan (ORESAP). This plan sets out the framework for the development of offshore wind and marine renewable energy in Northern Ireland[19]. The plan aims to enhance diversity and security of supply and reduce carbon emissions as well as to take into account the protection of the environment and the needs and interests of other users.

The draft ORESAP includes targets that reflect the extent to which offshore wind and marine renewable energy could contribute towards achieving the proposed target for Northern Ireland of meeting 40% of Northern Ireland's electricity consumption from renewable sources by 2020.

The draft plan proposed targets to develop at least 600MW of offshore wind and 300MW from tidal resources in Northern Ireland waters by 2020. However, in order to achieve these targets there are a number of additional actions which need to be addressed, but which are not deliverables of the plan. These include strengthening of the electricity grid, increased investment in infrastructure, improved regulatory and legislative framework to ensure a co-ordinated approach to offshore renewables with Ireland and continued development of support mechanisms placing an obligation on the energy suppliers to supply an increased proportion from renewable sources.

16 http://www.dcenr.gov.ie/NR/rdonlyres/A99E48AE-530B-4FD8-BA8E-0F78C72311C2/0/1673R002Nontechnicalsummary_final.pdf

17 http://www.dcenr.gov.ie/NR/rdonlyres/08B835C8-1360-4381-BF73-DE9991849FD0/0/1919R004Nontechnicalsummary_f.pdf

18 http://www.dcenr.gov.ie/NR/rdonlyres/F5135C4A-11A6-4B05-849D-FEF11FEB4294/0/IOSEA4StudyArea.pdf

19 Department of Enterprise, Trade and Investment Consultation on an Offshore Renewable Energy Strategic Action Plan 2009-2020, October 2009

Given the geographical positioning of Northern Ireland and Ireland, it is likely that the main areas of offshore renewable energy resource for each area will overlap where they are located around and adjacent to the country boundaries near Loughs Foyle and Carlingford. The development of the this plan (OREDP) and the SAP should develop appropriate and integrated approach to exploiting the renewable resource potential in these areas in order to efficiently exploit the natural resource which does not deter developers, taking into account the findings of the all island grid study.

5.4.3 DECC Offshore Energy Plan for Offshore Wind, Oil and Gas (June 2009)

In January 2009, DECC published their draft plan for the development of up to 25GW of energy from further rounds of offshore wind farm leasing in the UK Renewable Energy Area (REZ) and the territorial waters of England and Wales up to a depth of 60m by 2020. The plan does not include Northern Ireland or Scottish territorial waters. The plan was subject to an SEA.

The plan, which was finalised and published in June 2009 identifies from the SEA a number of potential areas where offshore wind developments, subject to appropriate mitigation measures and the application of site selection criteria, could be taken forward for development. A number of the potential areas are now being taken forward as part of The Crown Estate 3rd Offshore Wind licensing round. All three licensing rounds are discussed further below. However, the majority of areas that have been identified as having potential for development are located off the east coast of England and Scotland beyond the 12nm limit and are therefore are unlikely to interact with any development within Irish Waters.

In addition to identifying potential offshore wind energy areas, the SEA also made a number of recommendations regarding the selection of specific sites for development. These included the application of a 12nm buffer area from the coastline around large (>100 MW) offshore wind farms.

Whilst it is acknowledged that the basis for the 12nm buffer is to safeguard sensitive coastal areas and minimise adverse effects on seascape, the potential wider implications of this recommendation could imply that no offshore wind developments should be taken forward within the 12nm limit. This specific SEA recommendation has, however, been reviewed by DECC and it is now proposed, within the finalised Energy Plan that the application of a 12nm buffer should be examined on a case by case basis depending on the proposed scale of development and the sensitivity of the surrounding seascape.

5.4.4 The Crown Estate Offshore Wind Round 1(UK Waters)

Seventeen offshore sites were awarded in first of the Crown Estates Licensing Rounds. It was estimated that these sites would generate a combined capacity of up to 1.5GW. To date eleven of the Round 1 sites have been developed generating 962 MW a further site has got full consent and the remaining five have been withdrawn. Of the 11 Round 1 sites, six have the potential to interact with the OREDP as these are situated off the west coast of England and the north coast of Wales. These include Robin Rigg on the Scottish Border, Ormonde, Barrow, Burbo Banks, North Hoyle and Rhyl Flats. Of these a further extension has been proposed to Burbo Bank.

Whilst all of the Round one sites are within the UK 12 Nautical mile limit there is the potential for in-combination effects from the implementation of the OREDP on seascape and other sea users including the narrowing of shipping lanes and the reduction in fishing grounds.

5.4.5 Crown Estates Round 2 (UK Waters)

During the second round of The Crown Estate lease applications for offshore windfarm developments, fifteen sites were allocated that have the potential to generate up to 7.2GW. To date only one Round 2 site is operational (Gunfleet 2), this is off the Essex Coast in eastern England, with a further three site are under construction off the east coast of England. However, due to the location of these sites in-combination effects with this plan are unlikely to occur. Three of the Round 2 sites are proposed off the west coast of northern England and the north coast of Wales which could result in in-combination effects with OREDP. These include Walney, plus extension, West Diddon and Gwynt-y-Mor.

As with the Round 1 sites all are within the UK 12 nautical mile territorial limit. However, there is still potential for in-combination effects from the implementation of the OREDP on seascape and other sea users including the narrowing of shipping lanes and the reduction in fishing grounds.

5.4.6 Crown Estates Round 3 (UK Offshore Waters up to and beyond 12nm Territorial Limit)

Round 3 aims to deliver a quarter of the UK electricity needs by 2020. This licensing round focuses on nine areas, the majority of which are located off the east and south coats of the UK and are unlikely to have any in-combinations effects with this plan. However, two of the nine areas are located off the west coast of the UK and do have the potential for in combination effects in terms of the OREDP. These are Areas 8 and 9, the Bristol Channel and Irish Sea respectively.

Within Area 8 (Bristol Channel) the intention is to develop a wind farm that will generate up to 1500MW.

Area 9 (Irish Sea) situated off the north west coast of England, north coast of Wales and the south and east coasts of the Isle of Man has the potential capacity to generate over 4GW. This area extends west towards the UK territorial limit and therefore has a large potential for in-combination effects with future developments in Irish Waters.

5.4.7 The Crown Estate Licensing Round for Wave and Tidal Energy in the Pentland Firth

Following completion of the Scottish Marine Renewable SEA (2007) and preparation of the Scottish Governments Scottish Marine Energy Policy Statement, the Crown Estate launched the world's first leasing round for wave and tidal developments. The successful bids for the leasing round were announced in March 2010. These include a total of ten lease agreements which in total will provide up to 1.2GW of installed capacity by 2020, with 600MW from each of the technologies (wave and tidal). The leasing round applies to the Pentland Firth, which is the stretch of water that flows between the north coast of Scotland and the Island of Orkney, and waters around the Orkney Isles.

Given the location of this leasing round in relation to Ireland it is unlikely that there would be any interaction between this plan/programme and the OREDP.

5.4.8 The Crown Estate Licensing Round for Offshore Wind Developments in Scottish Waters

On the 16th February 2009 The Crown Estate announced awards for the development of offshore wind farms within Scottish Territorial Waters. In total 10 sites for development have been identified, five of which are located in off the west coast of Scotland. Included within the five sites are two sites in the Solway Firth, one site off the southern end of the Rhinns of Kintyre (north coast), one off the west of Islay and one off south west tip of Tiree. This licensing round is currently the subject of an SEA that is being carried out by the Scottish Government.

As with the UK Offshore Wind Rounds 1, 2 and 3, there is potential for in-combination effects with this leasing round, in particular offshore wind developments located off the west coast of Scotland and any potential developments off the north and east coast of Ireland. These interactions and in-combination effects include possible effects on seascape and effects on narrowing navigation channels and possible effects on migration routes for marine mammals, migratory birds, seabirds and fish.

5.4.9 Welsh Assembly Government: Ministerial Policy Statement on Marine Energy in Wales (July 2009)

The Welsh Assembly Government (WAG) recently issued its Ministerial Policy Statement on Marine Energy in Wales. This policy statement sets out how the Welsh Assembly Government proposes to maximise the exploitation of the marine energy resource around the Welsh coast as soon as possible and with the minimum of local environmental impacts. It also recognises the importance of the Severn Barrage for which a number of feasibility studies have been undertaken and highlights the value of the offshore wind and marine energy industry in terms of opportunities for economic investment and employment across Wales.

In exploiting the marine energy resource, the policy statement outlines a range of actions that the Welsh Assembly Government will undertake in conjunction with other key stakeholders. These actions, which will be underpinned by more coordinated and joined up working with DECC, The Crown Estate, regulatory authorities and other public sector bodies and private sector enterprises include investment in a number of additional research studies (technical and environmental) and further studies into consenting and licensing.

The policy statement also supports continuation of a number of ongoing initiatives and studies including the Wales marine energy report which looks at the technical practicalities of exploiting the marine energy resource and the Marine Renewable Energy Strategy Framework (MRESF) which examines potential environmental and geographical constraints. It is proposed that an SEA will be conducted in 2011-2012.

5.4.10 Europe's Onshore and Offshore Wind Energy Potential: An Assessment of Environmental and Economic Constraints (European Environmental Agency EEA)

In 2009, the EEA issued its report into the onshore and offshore wind potential of Europe. The study, upon which the report was based, focused on examining the 'raw' and 'constrained' wind resource potential in a geographically explicit manner. The 'constrained' wind potential takes into account a range of environmental and social factors including for example impacts on visual amenity and seascape.

The study found that the raw potential wind resource for Europe (onshore and offshore) is massive and could be more than 20 times the total energy demand in 2020. A large proportion of this raw wind resource is located in the northern and western regions including the UK.

However, whilst the study identified a large proportion of the raw potential wind resource in the offshore areas, it also identified that this total raw resource is likely to be reduced by more than 90% when environmental and social factors are taken into account e.g. Natura 2000 sites and other designations, navigation, fishing, oil and gas exploration, seascape impacts and effects on visual amenity. By comparison when the same environmental and social factors are taken into account in calculating the onshore wind potential resource, the total raw wind potential is only reduced by 13.7% illustrating that potential constraints to offshore wind are much greater than those for onshore wind.

5.4.11 Current and Proposed Offshore Renewable Energy Developments in Irish Waters

5.4.12 Offshore Wind Developments

There are a large number of applications for offshore wind developments in Irish Waters at various stages of the foreshore consenting process. However, of those, only two have been consented, and a further three, as of autumn 2010, are due to receive a grid connection offer in the Gate 3 process. The developments include:

- Consented: Arklow Bank (520 MW) – Phase 1 (25 MW) operational in June 2004.
- Consented: Codling Bank Wind Farm (1100 MW)
- Awaiting approval: Dublin Array (Kish and Bray Bank) (364 MW)
- Awaiting approval: Oriel Wind Farm (320 MW)
- Awaiting approval: Sceirde Wind Farm (Fuinneamh Sceirde Teo (FST)) (100 MW)

Of the offshore wind developments listed above, all except Sceirde Wind Farm are located off the east coast of Ireland. Scierde Wind Farm is located off the West Coast, just to the north of Galway Bay.

Arklow Bank Wind Park is located off the east coast to the south east of Wicklow. This site is currently generating power (25MW from 7 turbines[20]) and is used as a test facility to learn more about offshore wind power generation. The area covered by this development is 76km^2 and is located approximately 10km offshore. With regards to the power generation this site powers the equivalent of 14,091 homes per year and is equivalent to a CO_2 reduction of 28,477 tonnes per year[21.]

Consent has been authorised for Codling Wind Park for the generation of up to 1100MW from 220 turbines off the east coast of Ireland between Greystones and Wicklow. Codling Wind Park will cover an area of 55km^2 and is located approximately 16.8km offshore. This wind park once operational will be able to power the equivalent of 615,064 homes per year and a CO_2 reduction of 1,243,044 tonnes[22]. There is also a proposed extension to this wind farm which would include an additional 200 turbines and have installed capacity of 1000MW.

Consent application has been submitted for the Dublin Array wind farm which would comprise 145 turbines, power 203,530 homes and reduce CO_2 by 411,335 tonnes per year[23] contributing to 10% of the additional wind capacity required to achieve Ireland's 2020 renewable targets. The Dublin Array wind farm is due to receive a grid connection offer in the Gate 3 process of 364MW[24] on the Kish and Bray Banks within the Irish Sea. This development is located approximately 3km off the coast of Dublin and Wicklow and it is anticipated that energy production will commence in 2015.

A further consent application has been submitted for Sceirde (Skerd) Rocks off the west coast to generate 100MW from 20 turbines. This site is located approximately 5.9km offshore covering an area of approximately 4km^2. The energy generated from this site will power the equivalent of 55,915 homes per year with a 113,004 tonne reduction in CO_2 per year[25].

A Consent application has been submitted for Oriel Wind Farm which proposes to develop 55 turbines that will generate 300MW[26] within the North West Irish Sea near to the town on Dundalk. The windfarm will cover an area of 28km^2 and is approximately 7.8km offshore. This site will generate energy to power the equivalent of 184,519 homes resulting in annual CO_2 reduction of 372,913 tonnes per year[27].

5.4.13 Wave and Tidal Developments

In addition to the offshore wind developments above, a wave testing centre, for scaled prototypes, has been set up as part of the Ocean Energy Strategy at a location on the north side of Galway Bay, one mile south east of An Spideal. There are also plans to develop a test site for full scale prototypes off the northwest coast of Ireland, near Belmullet. This site will be up to 15 km offshore. The first devices are expected to be installed in the next three years.

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[20] http://www.gepower.com/businesses/ge_wind_energy/en/downloads/arklow_infosheet.pdf
[21] http://www.4coffshore.com/windfarms/windfarms.aspx?windfarmId=IE01
[22] http://www.4coffshore.com/windfarms/windfarms.aspx?windfarmId=IE02
[23] http://www.4coffshore.com/windfarms/windfarms.aspx?windfarmId=IE04
[24] http://www.dublinarray.com/
[25] http://www.4coffshore.com/windfarms/windfarms.aspx?windfarmId=IE05
[26] http://www.orielwind.com/
[27] http://www.4coffshore.com/windfarms/windfarms.aspx?windfarmId=IE03

Section 6: SEA Assessment Method

6 SEA Assessment Method

6.1 Approach to the Assessment of Effects

The approach applied to the assessment of the effects of offshore wind (fixed and floating) and marine renewable energy (wave and tidal) developments on the marine and coastal environment of Ireland comprises three parts:

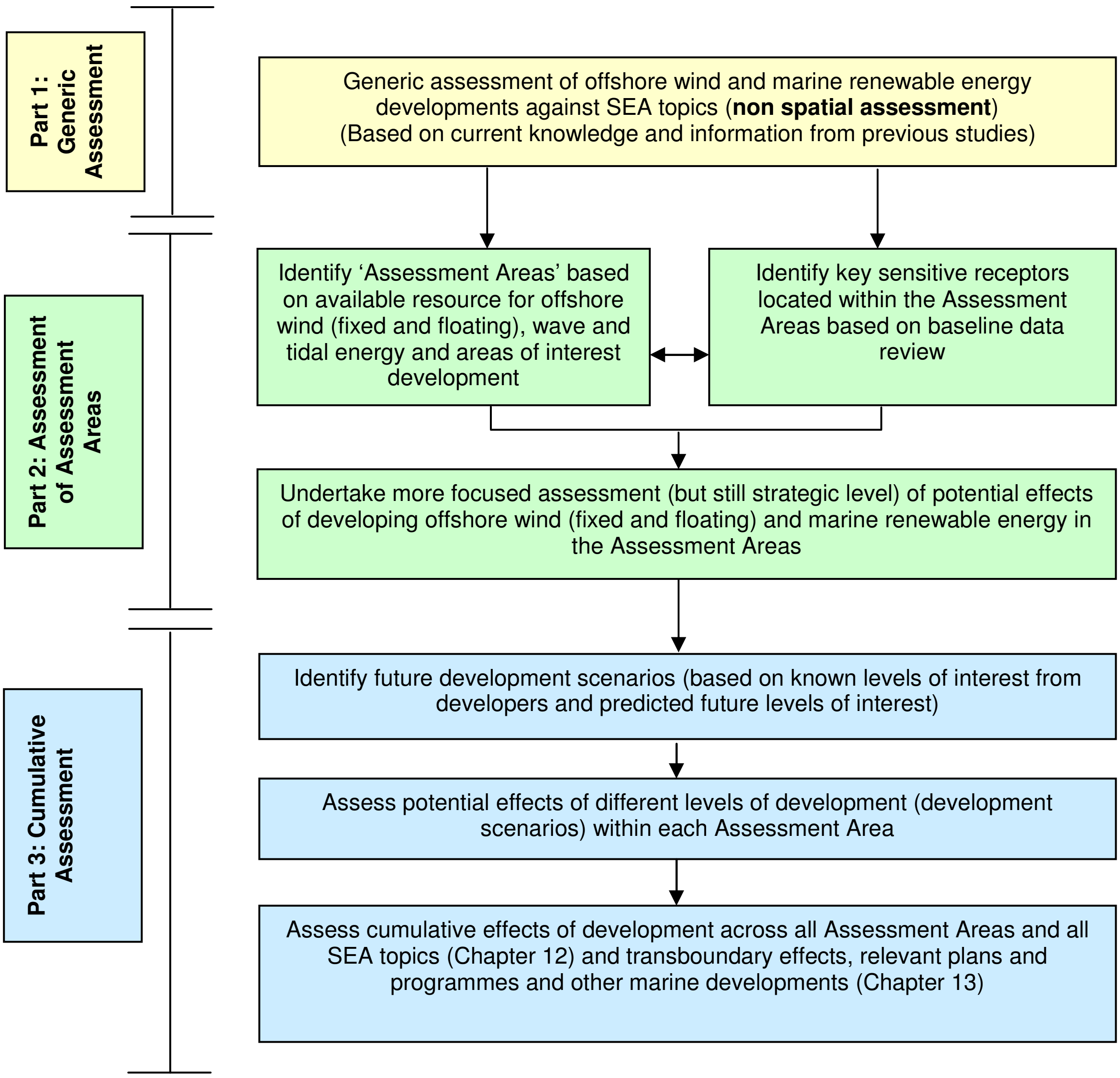
Part 1: Generic environmental effects (Chapter 10).

Part 2: Detailed assessment of specific Assessment Areas (Chapter 11).

Part 3: Cumulative assessment (Chapters 12 and 13).

This approach is illustrated in Diagram 6.1 and discussed in greater detail in Sections 6.3 and 6.4 below:

Diagram 6.1: Approach to Assessment of Effects



6.2 Key Points on the Approach to the Assessment and Assessment Method

In terms of the assessment method applied to the SEA there are a number of factors that need to be taken into account:

1. Part 1 of the assessment – the **Generic Assessment** is non spatial. The assessment focuses on a review of existing information and knowledge on the potential effects that different device types or characteristics of certain devices could have on the main environmental receptors assessed as part of the SEA (under each of the SEA topics). The assessment focuses specifically on key environmental receptors that are likely to be present within Irish waters. However, during this first part of the assessment is does not attempt to identify the location or distribution of these specific receptors. This is carried out in Part 2: Assessment of the Assessment Areas.
2. Part 2 of the assessment focuses on assessing the potential effects of the different technologies on the key environmental receptors (based on SEA topics) that have been identified as being present/or associated with specific 'Assessment Areas'. The purpose of the 'Assessment Areas' is to increase the manageability of the assessment by breaking the wider study area (as defined in Chapter 1: Introduction) into smaller areas. These areas reflect the main areas of resource (offshore wind, wave and tidal) and current and future developer interest within Irish waters. However, it is recognised that developers may seek to develop smaller areas of resource located outside the main Assessment Areas. **Although these areas have not been included in the specific Assessment Areas, the SEA does not preclude development in other areas outside these Assessment Areas**, as the potential effects of offshore wind, wave and tidal developments in these areas are covered, albeit at a lower level of detail, in Part 1: Generic Assessment.
3. Additionally it should also be noted that any development within the study area (within or out with the main Assessment Areas) would still have to be considered on a case by case basis and project level consenting requirements will still apply e.g. EIA. This is applicable to demonstration projects as well as commercial developments.
4. A separate assessment method has been developed for the Seascape Assessment.
5. **Project level mitigation measures** have been taken into account in the assessment of potential effects and likely significance of residual effects. Although the measures identified will not necessary incorporated into the plan (OREDP) they are recognised as good practice and it is therefore assumed that these would be incorporated into future projects. It is recognised that the plan (OREDP) cannot guarantee that these measures will be implemented (hence the use of the words could and should in the assessment as opposed to will). However, it is considered to be reasonable to assume that they would be implemented by a responsible developer and they are likely to be necessary in order to achieve consent at the project level e.g. as part of the EIA process.
6. As part of the assessment of **cumulative effects** (Chapter 12) it is necessary to take into consideration the potential cumulative effects of existing developments and developments in the planning system. Further detail on the approach to the cumulative assessment is provided in Section 6.5 below.

6.2.1 Objective and Subjective Assessment Methodologies

It is recognised that, although the majority of SEA topics included in this SEA will be assessed objectively (e.g. assessment will be based on specific quantifiable facts and figures), seascape assessments tend to be more subjective. However, it is important to note that judgements on the significance of an effect in the seascape assessment are impartial and based on professional experience and opinion informed by best practice guidance.

In reflecting these differences between objective and subjective types of assessment, two assessment methodologies have been developed for the purpose of this SEA:

- General SEA Assessment Method (applied to all SEA topics except seascape)
- Seascape Assessment Method

6.3 General SEA Assessment Method (applies to Parts 1 and 2)

6.3.1 Part 1: Generic Assessment

Part 1 of the assessment is a non-spatial assessment and involves a review and examination of information obtained from a range of sources including the Northern Ireland Offshore Renewables SEA, the Irish Offshore Strategic Environmental Assessments (SEAs) for Oil and Gas (DCENR), the Scottish Marine Renewables SEA, the SEA of the third round of offshore wind development in UK waters prepared by the Department of Energy and Climate Change (DECC) and the report by ABPmer on Wet Renewable Energy and Marine Nature Conservation: Developing Strategies for Management (March 2009), prepared as part of the npower Juice Fund project. This information has been used to assist in the identification of <u>generic</u> potential effects of offshore wind, wave and tidal developments on the SEA topics.

6.3.2 Part 2: Assessment of Assessment Areas

Part 2 of the assessment focuses specifically on assessing the potential effects of the different technologies (offshore wind, wave and tidal) on the receptors (based on SEA topics) presented or associated with each of the Assessment Areas identified within the study area. The identification of the Assessment Areas is based on the following:

- Main areas of resource for offshore wind, wave and tidal energy identified from a review of information presented in Chapter 8: Resource Areas.
- Main areas of interest for future development based on feedback from consultation with offshore wind developers through NOW (National Offshore Wind Association of Ireland), marine renewable energy developers through MRIA (Marine Renewable Industry Association) and environmental authorities.
- Operational parameters – average operational parameters based on feedback from developer questionnaires and subsequent discussions with offshore wind and marine renewable energy developers. Operational parameters included, for example, average water depths, wind speeds, tidal velocity etc for each technology (offshore wind (fixed and floating), wave and tidal. Further information on the average operational parameters are provided in Chapter 7: Technologies.

For each of the Assessment Areas, focused, but strategic level assessments were undertaken to determine the potential environmental effects that could occur in these areas.

These assessments focused specifically on assessing the potential effects of offshore wind (fixed and floating), wave and tidal developments on the sensitive receptors (identified from the baseline review) that are either present within, or associated with, each of the assessment areas. This has provided a more focused and detailed (however, still strategic) assessment of potential effects in relation to the main areas of resource for specific technology types. A key focus for this part of the assessment has been the identification of competing interests within certain locations and examining solutions for resolving those competing interests (environmental and marine users) or identifying appropriate mitigation measures that can be implemented as part of the OREDP to prevent, reduce or offset any significant adverse effects that may occur within those areas.

6.3.2.1 Assessment Method (Assessment Area Specific)

The method used to assess the potential effects within each of the assessment areas is outlined in Diagram 6.2 below.

Diagram 6.2: Method for Assessing Potential Effects in Assessment Areas

Identification of how offshore wind (fixed and floating), wave and tidal developments interact with the marine environment (based on generic effects identified in Part 1)

↓

Identification of key receptors (in relation to the SEA topics) located within the assessment areas that could potentially be affected by offshore wind (fixed and floating), wave and tidal developments

↓

Assessment of **potential effects** of offshore wind (fixed and floating), wave and tidal developments **WITHOUT** mitigation

↓

Identification of mitigation measures that could be implemented to reduce, avoid or offset the overall significance of the effect

↓

Assessment of **residual effects** of offshore wind, wave and tidal devices **WITH** mitigation (based on assumption that mitigation would be implemented appropriately)

6.3.2.2 Assessment Criteria

The assessment criteria used as part of the assessment of the potential effects of offshore wind (fixed and floating), wave and tidal developments on each of the assessment areas within the study area reflects the strategic nature of this SEA.

As part of the SEA process there is a need to predict the potential effects of the plan and then evaluate the predicted effects (significance). The following provides detail on the criteria used for predicting and evaluating potential effects.

Predicting the Potential Effects of the Plan

In identifying changes to the baseline and describing the magnitude of these changes the following criteria have been applied to the prediction of potential effects:

- Whether a potential effect is positive or negative, temporary or permanent, short term or long term.
- Whether a potential effect will occur during construction/installation, operation, ongoing maintenance or during decommissioning.
- Geographical scale of a potential affect – local (area of development), regional or national.
- Whether a potential effect is direct or indirect, secondary, cumulative (Chapter 12 and 13) or synergistic.

Evaluating Potential Effects (Significance)

The general approach to SEA is to identify potentially significant adverse effects. Significance is a measure of the magnitude of a potential effect compared to/in relation to the sensitivity or importance of the receptor e.g. the SEA topics. An accurate and robust determination of effect magnitude or sensitivity of a receptor requires a certain level of qualification or quantification. This is generally based on the information contained within the plan, programme or strategy being assessed and the information contained within the baseline review.

It is recognised that, as a result of extensive research, data collation and monitoring of existing developments, the potential environmental effects of offshore wind developments are relatively well understood. However, by contrast, the potential environmental effects of marine renewable energy developments (wave and tidal) are still relatively unknown, although the general levels of understanding and knowledge of potential effects have increased during the last few years (see below).

As identified from the Northern Ireland Offshore Renewables SEA and the Scottish Marine Renewable SEA, there are two main factors that currently influence this limited understanding of potential environmental effects associated with wave and tidal devices:

- Lack of knowledge as to how wave and tidal devices interact with the marine environment and how key receptors respond to wave and tidal devices. This is due to the industry being relatively new with only a few devices having been deployed to date.
- Gaps in baseline data. This is mainly due to the size of the study area, the relative inaccessibility of the marine environment in comparison to the terrestrial environment, and the fact that there are generally fewer marine developments from which to obtain information from (e.g. surveys).

During the last five years our understanding of how marine renewable energy devices interact with, and effect the environment, has increased considerably. This has been mainly achieved through the ongoing monitoring of the various demonstration projects that have been deployed around the UK, in particular at the EMEC test centre (see Chapter 7 for more information on marine renewable energy devices). There is also an ongoing programme of monitoring as part of the consent for the SeaGen turbine in Strangford Lough (Northern Ireland). A particular focus of this monitoring is related to marine mammals (mainly seals) and the impacts of the device on the status of the Special Area of Conservation (SAC) within which it is located.

There has also been an increase in the amount of baseline data that is available. This increase mainly relates to the ongoing survey work that has been undertaken to inform the designation of the offshore Natura 2000 sites, as required under the Habitats Directive. However, there has also been an increase in the amount of information obtained from surveys carried out to inform offshore wind and marine renewable energy developments e.g. Strangford Lough and surveys carried out as part of the Offshore Wind Round 3 SEA (DECC 2008).

Whilst there have been increases in the amount baseline data available and reductions in knowledge gaps, it is still important to recognise that some gaps still exist. These knowledge and data gaps need to be reflected in the approach taken to this environment assessment as insufficient information could affect the overall accuracy and robustness of the assessment in terms of being able to determine effect magnitude, receptor sensitivity and effect significance.

Taking this into account it is proposed that the criteria will not attempt to qualify the assessment of ‘significance’ in any great detail. This includes any differentiation between high, medium or low significance as there may not be sufficient information available to accurately determine any variation between a measure of low, medium or high e.g. benthic ecology. The assessment undertaken in Part 2 will therefore be based on the criteria outlined in Table 6.1 below:

Table 6.1: Criteria for Evaluating Potential Effects (Significance Criteria)

Potential Effect	Significance Criteria
Significant Adverse	The precise measure for significant adverse effect varies across the different SEA topics. This is reflected in the results presented in Chapters 11 and 13. However, in general, the key factors influencing the potential for a significant adverse effect to occur generally include: ▪ Permanent, long term or irreversible change in baseline conditions e.g. reduction in quality of baseline environment or negative effect on baseline features (receptors). ▪ Direct and indirect negative effect on baseline features of international or European importance e.g. habitats, species and sites designated under the EU Habitats or Birds Directives, where habitats and species are known to be sensitive to interactions from marine devices/offshore wind developments. ▪ Direct and indirect negative effects on baseline features of national importance (e.g. habitats or species of national value/importance) where habitats and species are known to be sensitive to interactions from marine devices/offshore wind developments. ▪ Direct, long term or permanent exclusion from, or disruption to, recognised shipping/navigation channels or fishing grounds of international, European or national importance. It should be noted that each SEA topic, and the baseline environment/features (receptors) associated with that topic, have been considered on a case by case basis. The criteria listed above are generic and have been subject to modification during the assessment to reflect specific characteristics of the baseline environment within Irish waters. However, any modifications will be reflective of the main principles of an assessment of significant adverse effect listed above.
Negative	As above, the measure of negative effect varies across the different SEA topics. However, in general, the key factors influencing the potential for a negative effect to occur include: ▪ Temporary, short term or reversible change in baseline conditions e.g. reduction in quality of baseline environment or effect on baseline features (receptors). ▪ Direct effect on baseline features that are not designated under international, European or national legislation but which are known to be sensitive to interaction with marine devices/offshore wind developments. ▪ Indirect, temporary or short term, disruption to, or exclusion from, main (international, European and national) shipping and navigation channels and fishing grounds. ▪ Direct, long term or permanent disruption to, or exclusion from, local shipping and navigation routes and fishing areas.
Negligible (positive or negative)	Negligible effects are identified where there is likely to be change in baseline, or effect on a baseline feature (receptor), but the level of change/effect will be indiscernible/very slight. Negligible effects may be positive or negative.
Neutral	Neutral effects are identified where the potential effect on the baseline features (receptor) are both positive and negative, thus balancing the overall effect on an SEA topic.
No Effect	The development of marine renewable energy/offshore wind developments in Irish waters will have no effect (e.g. cause no change in baseline conditions).
Positive	The development of marine renewable energy/offshore wind will have a positive effect on the baseline environment/features.
Unknown	Where there is insufficient information available to accurately determine the level and type of potential effect these have be classed as 'unknown' effects. Unknown effects are likely to occur where there is: ▪ A lack of baseline data. ▪ Limited knowledge on how offshore wind (fixed and floating); wave and tidal developments interact with particular baseline features/characteristics. ▪ A lack of knowledge as to whether certain baseline features (receptors) are sensitive to interactions from offshore wind (fixed and floating), wave and tidal developments.

6.3.2.3 Mitigation Measures

As noted previously, project level mitigation measures have been taken into account in the assessment of the likely significance of residual effects. The mitigation measures that have been taken into account are based on recognised good practice and measures that would be required in order to fulfil regulatory and consenting requirements. Whilst it is acknowledged that the plan cannot guarantee that these measures will be implemented, mechanism for managing the implementation of these measures through appropriate licensing and permitting processes for individual projects will be integrated into the plan as plan level mitigation. Further detail on both the plan and project level mitigation measures taken into account in this SEA is provided in Chapter 15: Mitigation Measures.

6.3.2.4 Presentation of Results

The results from the assessment of the Assessment Areas are presented in a series of tables which are included in Chapter 11 (Tables 11.4 to 11.11). The information included in these tables reflects the method for assessing potential effects in the Assessment Areas illustrated in Diagram 6.2 above and includes:

- SEA topics where potential strategic environmental effects could occur
- Type of the potential effect
- Phase of the development during which potential effects are likely to occur e.g. installation, operation, maintenance and decommissioning
- Device characteristics that are likely to give rise to potential effects
- Device type (wind (fixed or floating), wave or tidal)
- Assessment of potential effect (effect without mitigation)
- Summary of key environmental sensitivities (from baseline data) and description of potential effect
- Description of possible project level mitigation that could be implemented to reduce, avoid or offset potential adverse effects
- Assessment of potential residual effect (effect with mitigation)

6.3.2.5 Confidence Levels

As discussed previously it is recognised that there are a number of known data and knowledge gaps in particular relating to baseline data for certain SEA topics and understanding of how wave and tidal devices will interact with certain environmental receptors/sea users.

As part of this SEA it is necessary to identify these data and knowledge gaps as they can affect the overall accuracy and robustness of the assessment results, both from the assessment of the assessment areas and cumulative assessment (see below).

To illustrate where the results of the assessment have been affected by a lack of data or a lack of understanding of how certain device characteristics interact with specific environmental receptors, confidence levels have been assigned to the assessment results (see Table 11.6 in Chapter 11). These confidence levels are summarised below:

Table 6.2: Confidence Levels

Confidence Level	Description
High	High levels of confidence occur where: ▪ There are no gaps or very limited gaps in baseline data. ▪ Interactions between the environment and marine devices are well understood (e.g. there is recognised guidance or well documented and peer reviewed evidence of potential effects that could occur (e.g. offshore wind developments).
Medium	Medium levels of confidence are likely to occur where: ▪ There are gaps in baseline data but knowledge and experience from related projects or fields of work leads to a greater level of confidence in the assessment of potential effects that could occur. ▪ There are limitations in understanding in how devices interact with the environment but greater certainty in available baseline data and supplementary evidence from related areas of work/similar projects.
Low	Low levels of confidence are likely to occur where: ▪ There are known gaps in baseline data and no available supplementary information to support assessment of effects. ▪ There are known gaps in understanding how devices interact with the environment and no available supplementary information to support assessment of effects.

6.3.2.6 Weighting of SEA Topics

This SEA does not involve any weighting of SEA topics. Each topic is considered in terms of its own value. This applies to the assessment of the assessment areas and the cumulative assessment.

In terms of the assessment of the assessment areas there is a certain degree of weighting within each of the individual SEA topics. This is required to determine varying levels of importance or sensitivity of key receptors across the study area and therefore the levels of significance of any potential effects. For example, in terms of seascape effects some areas of the Irish coastline are considered to be of greater seascape value than other areas and therefore more sensitive to potential effects. Consequently potential effects on these more sensitive areas are likely to be of greater significance.

With regard to the cumulative assessment the potential effects are assessed on a topic by topic basis and across individual SEA topics. When assessing across SEA topics the conclusions from the assessment are made on the basis that within a certain Assessment Area there could, for example, be a significant adverse cumulative effect on both shipping and navigation and marine mammals. However, the assessment does not apply any weighting to these topics. The main purpose of the SEA is to provide guidance and advice on where potentially significant adverse effects could occur and how these can be avoided or reduced. It is not the role of the SEA to determine which of the topics assessed are of greater or lesser value to the marine environment than others.

6.3.2.7 Weighting of Assessment Criteria

As noted above, each SEA topic is assessed on its own individual basis. It is recognised that for some topics it is possible to undertake quantitative assessments and for others the assessment is more subjective and that this could influence the accuracy and robustness of the final results. However, given that individual topics are not weighted against each other, the differences in the assessment methods do not influence how individual topics are compared against other topics. Where there is uncertainty over the results of an assessment due to the type of information that is available for the assessment, this is measured using confidence levels discussed above.

6.4 Cumulative Assessment (Part 3)

6.4.1 Overview of Cumulative Assessment

The cumulative assessment comprises six main elements:

- Identification of development scenarios for development of offshore wind (fixed and floating), wave and tidal energy in Irish waters.
- Identification of 'average' operating parameters for individual offshore wind (fixed and floating), wave and tidal developments.
- Assessment of cumulative effects associated with varying levels of development within each of the individual Assessment Areas.
- Assessment of cumulative effects associated with varying levels of development within a number of the different Assessment Areas throughout all Irish waters (whole Irish study area).
- Assessment of effects associated with implementation of the OREDP in combination with other marine developments implemented through other marine plans and programmes.
- Assessment of interactions between individual SEA subjects and how these are influenced by offshore renewable energy developments.

6.4.1.1 Development Scenarios

The main focus of the SEA is to test the development scenarios for up to 4,500MW of offshore wind and 1,500MW of wave and tidal energy within Irish waters as set out in the OREDP. There are three development scenarios presented in the OREDP. These range from low to high and summarised in Table 6.3 below:

- **Low**: This scenario consists of the 800MW of offshore wind to receive a grid connection offer under Gate 3. It also includes 75MW of wave and tidal development, which is included in the Table 10 modelled scenario in the National Renewable Energy Plan (NREAP).
- **Medium**: This scenario consists of 2,300MW of offshore wind, which comes from the Table 10 non-modelled scenario of the NREAP (broadly based on the combination of offshore wind projects with either foreshore lease or grid connection) and the 500MW of wave and tidal energy in the same table (the Government's 2020 ocean energy target).
- **High**: This scenario consists of 4500MW of offshore wind and 1500MW of wave and tidal current. These figures come from the SEA Scoping Report.

Table 6.3 Development Scenarios

Development Scenarios to 2030			
	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)
Wind	800	2,300	4,500
Wave and Tidal	75	500	1,500

6.4.1.2 Operating Parameters for Individual Technologies

In order to understand the likely scale/levels of development that could occur within each of the specific Assessment Areas it is necessary to define a set of operating parameters that reflect the likely size, character and generating capacity of commercial scale developments for offshore wind (fixed and floating), wave and tidal energy. Detail on the on the likely operating parameters for offshore wind, wave and tidal is presented in Chapter 7: Technologies. A summary of the main operating parameters is provided below:

Table 6.4: Operating Parameters

Operating Parameter	Offshore Wind (Fixed)	Offshore Wind (Floating)	Tidal	Wave
Average Water Depth	10m to 60m	60m to 200m	20m to 80m	10m to 100m
Maximum distance from shoreline – based on maximum distance for AC export cables.	100km	100km	100km	100km
Constraining Threshold	> 7.0 m/s mean annual wind speed at 100 m height	> 7.0 m/s mean annual wind speed at 100 m height	Peak Spring Current Flow >1.2 m/s	Mean annual wave power (kilowatts) per metre of wave crest (WC) >20 kW/mWC
Approximate MW/km^2	10	10	50	10
Average Turbine/Device Generating Capacity	5MW	2.3 – 5MW	1MW	0.5MW to 5MW
Average Scale of Commercial Development	300MW	300MW	50MW	30MW
	30km^2	30km^2	1km^2	3km^2

In addition to the operational parameters listed above, the assessment of potential cumulative effects also needs to take account of other factors including:

- Method of connection to the grid (hubs or individuals cables etc).
- Configuration of a development e.g. footprint, device arrangements, alignments and spacing.
- Installation, maintenance and decommissioning requirements.
- Spacing between developments.

6.4.1.3 Cumulative Effects in Specific Assessment Areas (Chapter 12)

This part of the assessment focuses on assessing the cumulative effects associated with the deployment of a number of developments (offshore wind, wave and tidal) within the different Assessment Areas. This part of the assessment builds on the results from the assessment of the Assessment Areas (Part 2 discussed above), and includes:

- Assessment of different levels of generating capacity (MW) for certain types of development (offshore wind (fixed and floating), wave and tidal) within each Assessment Area based on the development parameters identified above (average sizes (MW) and scales (e.g. footprints) of different types of development (offshore wind, wave and tidal)) e.g. development of two offshore winds of average size of 500 MW. Further detail is provided in the Cumulative Assessment Chapter (Chapter 12).
- Assessment of a combination of development types in each Assessment Area e.g. combinations of offshore wind and wave or offshore wind and tidal power. This is influenced by the dominant resource types within each Assessment Area.

The main output of this part of the assessment is to identify optimum numbers, sizes (MW), and types of development (including combinations) in certain locations, taking account of methods of attachment to the grid and development configurations. This part of the assessment also takes into account possible solutions for managing competing interests and the implementation of mitigation measures for a number of developments (see Diagram 6.2 and Chapter 11).

6.4.1.4 Assessment of Existing Projects and Applications

There are a large number of applications for offshore wind developments in Irish Waters at various stages of the foreshore consenting process. However, of those, only two have been consented, and a further three, as of autumn 2010, are due to receive a grid connection offer in the Gate 3 process. The developments include:

- Consented: Arklow Bank (520 MW) – Phase 1 (25 MW) operational in June 2004.
- Consented: Codling Bank Wind Farm (1100 MW)
- Awaiting approval: Dublin Array (Kish and Bray Bank) (364 MW)
- Awaiting approval: Oriel Wind Farm (320 MW)
- Awaiting approval: Sceirde Wind Farm (Fuinneamh Sceirde Teo (FST)) (100 MW)

Of the offshore wind developments listed above, all except Sceirde Wind Farm, are located off the east coast of Ireland. Scierde Wind Farm is located off the West Coast, just to the north of Galway Bay.

There is also a wave device testing centre located on the north side of Galway Bay, one mile south east of An Spideal and proposals for another wave test site at Belmullet, located on the northwest coast of Ireland. The Belmullet test site will be located between three and six miles offshore and will be able to accommodate up to three full scale prototype devices at any one time. It is anticipated that this test facility will be operational in the next three years e.g. by 2013.

The developments identified above have all been taken into account when assessing potential levels of development that could be accommodated within each of the assessment areas. As suggested in the Scoping Responses, the approach to the cumulative assessment in each area considers the potential amount of development that could occur within each assessment area (with and without technical and environmental constraints) without any existing projects and applications being present in the area. The assessment then calculates how much of the potential resource that could be developed (taking into account technical and environmental constraints) has already been taken up by the existing projects and applications. Further detail on the approach to dealing with existing projects and applications is provided in Chapter 12: Cumulative Effects: Testing OREDP Development Scenarios.

6.4.1.5 Cumulative Effects Across the Study Area (Chapter 12)

The main focus for this part of the assessment is the assessment of potential cumulative effects on the SEA topics and associated receptors that are likely to occur as a result of development occurring within all, or a selection of (depending on the results from the previous assessments), Assessment Areas within Irish waters. This part of the assessment also considers the varying levels of development that could occur within each of the Assessments Areas as identified in the previous assessment.

6.4.1.6 In-Combination Effects in Relation to Other Plans and Programmes and Development (Chapter 13)

In addition to the cumulative effects of varying levels of offshore wind (fixed and floating), wave and tidal development within the Assessment Areas across the study area, the assessment also considers the potential in-combination effects on SEA issues/subjects in relation to:

- Requirements for the implementation of the Marine Strategy Framework Directive (MSFD) in Ireland.
- Other existing and proposed developments, plans and programmes within Irish Waters.
- Transboundary effects with the Northern Ireland Offshore Renewable Energy Strategic Action Plan (ORESAP).
- Wider transboundary effects associated with other UK, Scottish, Wales and Isle of Man strategies for marine developments and marine renewable (offshore wind, wave and tidal) for example DECC Offshore Energy Plan and The Crown Estate Round 3 Offshore Wind.

6.4.1.7 Assessment of Interactions (Chapter 13)

In addition to the assessment of in-combination effects in relation to other plans and programmes, this part of the assessment also considers the interactions between individual SEA subjects and how these interactions are influenced or affected by offshore renewable energy developments.

6.4.1.8 Presentation of Results

The following system of colour coding has been used in the presentation of the results from the cumulative assessment (both for the varying levels of development within the assessment area and in relation to other plans and programmes). These colours reflect the criteria described in section 6.3.2.2 above.

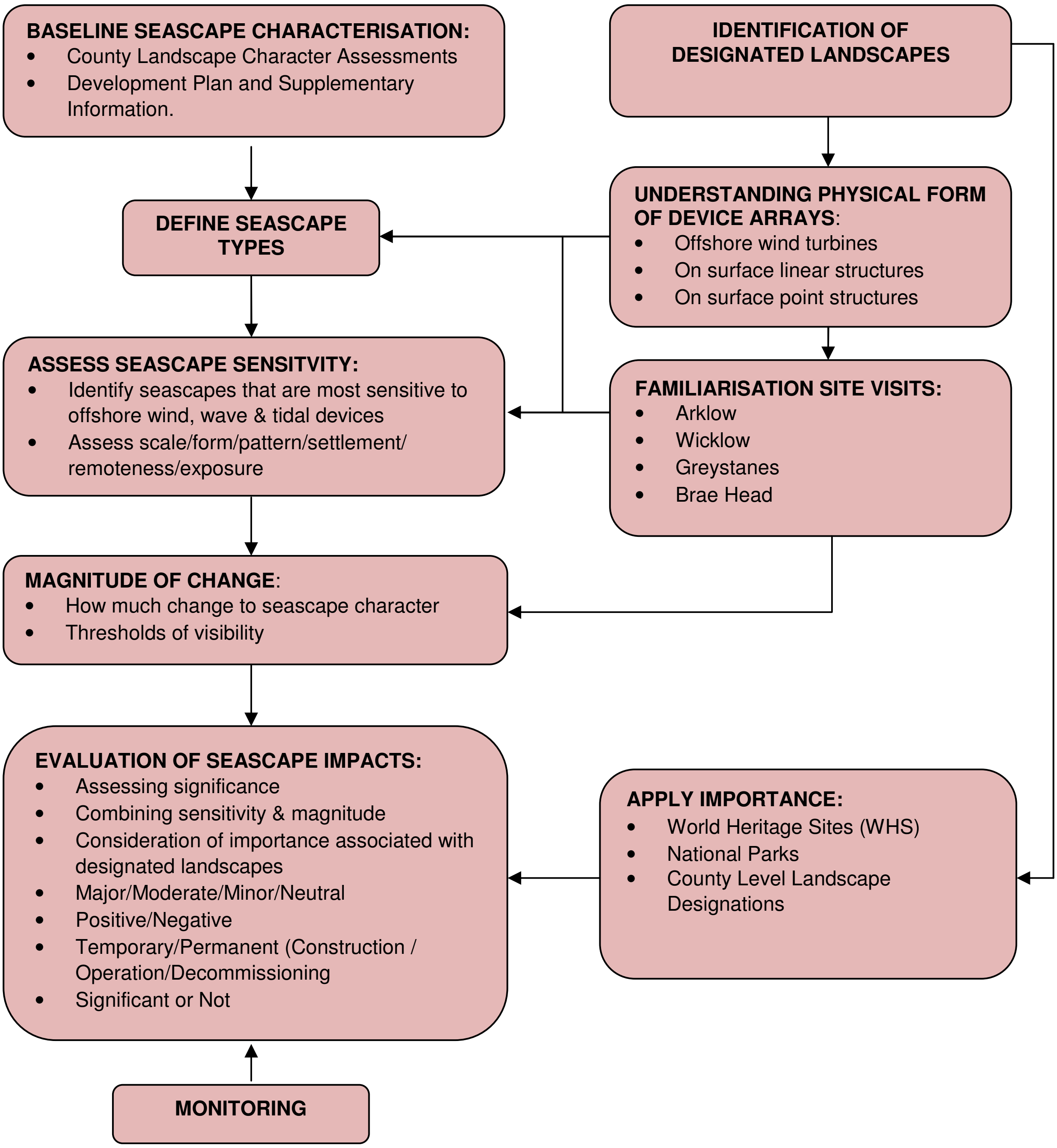
Table 6.5: Assessment Criteria Colour Codes

Assessment	Colour Coding
Significant Adverse	Significant Adverse
Negative	Negative
Negligible	Negligible
Neutral	Neutral
No Effect	No Effect
Positive	Positive
Unknown	Unknown

6.5 Seascape Assessment

The key stages involved in the seascape assessment are illustrated in Diagram 6.3 below. Further detail on the method used for the seascape and visual assessment is provided in Appendix A.

Diagram 6.3: Key Stages in the Seascape Assessment



6.5.1 Background Research

6.5.1.1 Review of Seascape Guidance and Good Practice

The seascape assessment has been prepared with reference to a number of guidance documents including:

- Heritage Council of Ireland: Landscape Character Assessment (LCA) in Ireland: Baseline Audit and Evaluation 2006
- Heritage Council of Ireland: Landscape Character Assessment (LCA) in Ireland: Update to the Baseline Audit and Evaluation 2010
- DTI Guidance on Seascape and Visual Impact Assessment of Offshore Wind Farms[28]
- SEA of Offshore Renewable Energy Developments in Northern Ireland (2009).
- Scottish Marine Renewables SEA, 2007[29].
- UK Offshore Energy SEA 2009[30].
- Scott et al Assessment of the Sensitivity and Capacity of the Scottish Seascape in relation to Offshore Wind Farms [31].
- Guide to Best Practice in Seascape Assessment (Hill et al., 2001)[32].
- Guidelines for Landscape and Visual Impact Assessment (GLVIA), published by the Landscape Institute and the Institute of Environmental Management and Assessment in 2002

It should be noted that there is currently no specific seascape assessment guidance available for wave and tidal devices. However, the DTI Guidance does encourage consistency and good practice in seascape assessment across a range of developments, and in combination with the Northern Ireland Offshore Renewable Energy SEA and the Scottish Marine Renewables SEA 2007 has provided a useful reference for refining the strategic approach taken to carrying out seascape assessments in relation to wave and tidal devices.

6.5.1.2 Determining Device Characteristics

Devices have been grouped by characteristics relevant to the assessment of seascape effects and these are described below. Reference should be made to Chapter 7 of this report for further information on offshore energy technology.

- Wave (On Surface Linear) Devices
  - Wave devices in open water;
  - Between 2 and 14 m in height above the water surface; and
  - Commercial arrays comprising up to 6.5 km^2.

- Oscillating Wave Surge Devices
  - Connected to an onshore generator comprising a fixed structure
  - Oscillating submerged structure in water depths of 10 -15m
  - The submerged structures will be intermittently visible as they break the surface,
  - Visible components of the semi submerged structures are likely to be linear in appearance
  - Commercial arrays comprising up to 2km^2

28 Guidance on the Assessment of the Impact of Offshore Wind Farms. Seascape and Visual Impact Report. (DTI, November 2005)
29 Scottish Marine Renewables Strategic Environmental Assessment 2007, Scottish Executive,
30 UK Offshore Energy Strategic Environmental Assessment 2009, DTI
31 Scott, K.E., Anderson, C. and Benson, J.F. (2005). An Assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Scottish Natural Heritage Commissioned Report No. 103 (ROAME No. F03AA06)
32 Hill, M. *et al*. (2001) Guide to Best Practice in Seascape Assessment. Countryside Council for Wales

- Wave or Tidal (On Surface Point) Devices
  - Wave or tidal devices in open water;
  - The extent of protrusion above the sea surface would vary considerably, with the smallest visible element comprising marker buoys and lighting beacons, ranging to vertical structure up to 14m in height;

Typical arrangements for wave devices are difficult to predict. For example a point absorber, which usually comprises buoys moored to the seabed, may have moorings that spread out over a significant distance thereby increasing the separation between devices in the array. For the purposes of this assessment the following arrangement has been considered: an array of approximately 50-100 tidal devices, generating 100-200MW, in coastal water would be expected to occupy 1-2 km^2.

- Off Shore Wind Devices:
  - Wind turbines in open water;
  - Typically consisting of 3-5 MW turbines (height to blade tip approximately 80-120 m); and
  - Typical arrangements would comprise approximately 300 MW array (60 turbines) of 30km^2.

It is important to note that the device features could change as the technology develops and should therefore not be considered as being definitive. The exact geometry of the array will also vary from location to location and will be very site and device specific. Also as the technology develops the footprint of individual devices could extend, corresponding to the increase in energy output.

6.5.2 Establishing the Baseline

6.5.2.1 Identifying Seascape Character Types

The first stage in defining seascape character types at a national scale (to reflect the strategic nature of this study), involved reviewing the available Landscape Character Assessments (LCAs) commissioned and published by Irish County Councils. This review was informed by a document commissioned by the Heritage Council of Ireland: Landscape Character Assessment (LCA) in Ireland: Baseline Audit and Evaluation 2006 and the 2010 update to this report. The baseline audit set out a review and appraisal of Landscape Character Assessments in Ireland in relation to DoEHLG Guidelines and European best practice. The audit looked at the quality, detail, relevance and availability of landscape character assessments in Ireland. The key findings of the report identified the considerable variation in content, length, presentation and methodology of available LCAs in Ireland. This has a significant bearing on the extent of usable baseline information to inform the seascape assessment for the SEA. Key sources of baseline data are provided in Chapter 9.

6.5.2.2 Confidence Levels

Based on the criteria and assessments set out in the Baseline Audit and Evaluation report, confidence levels for the currently available Irish LCAs within the study area were established. This enabled a judgement to be made on where adequate baseline information existed. The Confidence Levels are set out below and presented in Table 6.6.

Table 6.6 Landscape Character Assessment Confidence Levels

Landscape Character Assessment Confidence Levels	Very Low	Minimal or no landscape information available; no assessment has taken place.
	Low	Some landscape information is available; a partial or poor quality landscape character assessment has taken place.
	Medium	Landscape character assessment is available but may be outdated or lack detail.
	High	Landscape character assessment is available that meets contemporary standards and best practice.

The amount of information describing the coastal or seascape character within the different LCAs also varies considerably. Therefore in order to aid the identification of data gaps an assessment of confidence levels in relation to coastal or seascape information was derived during the process of review. These confidence levels are outlined below and presented in Table 6.7.

Table 6.7: Seascape / Coastal Information Confidence Levels

Seascape / coastal information Confidence Levels	Very Low	No coastal landscape or seascape assessment has taken place; Minimal or no seascape or coastal landscape information available.
	Low	A partial or poor quality landscape assessment has taken place that includes some minimal coastal information.
	Medium	A coastal landscape or seascape character assessment is available but may be outdated or lack detail.
	High	Relevant coastal landscape and/ or seascape character assessment available that meet contemporary standards.

6.5.2.3 Defining Seascape Types

The audit identified the existence of forty nine separate landscape character assessments split over nine counties within the SEA study area. These were all reviewed in order to extract information on the coastal character of the study area and confidence levels applied to ascertain the validity of the data (refer to Table 6.#). Whilst the majority of these LCAs defined coastal types or areas on the basis of the characteristics of the coastline, rather than the character of the marine element or relationship of land and sea, sufficient information on coastal character was generally available to form the basis of defining seascape character types across the study area.

The many defined coastal landscape character types from the LCA review were then grouped according to shared characteristics. The geographical spread of these dominant characteristics was evaluated in conjunction with aerial photographs and Ordinance Survey maps of the study area. These new groupings of amalgamated and slightly simplified coastal types were then reviewed in the context of their relationship with coastline and sea to formulate ten draft seascape types with shared dominant characteristics. These seascape types are presented on Figure 9.7.1.

In defining the seascape types it was important that the strategic scale of the assessment was considered. Ireland has a dramatic, varied and constantly changing coastline. Broad judgements have had to be made regarding the component parts of each seascape and a rationale developed in order to generalise and hence incorporate minor character areas set within a generic description of seascape type. Consequently, where a seascape has been deemed for example, to be Seascape Type 6 - Complex Indented Coast, Small Bays and Offshore Islands, there may be the occasional occurrence of a larger bay within the coastline. At a strategic level, this level of detail cannot be mapped without detracting from the clarity of baseline understanding of the study area.

6.5.2.4 Data Gaps

Where either no Landscape Character Assessments are available (Donegal, Sligo, Kerry and Waterford) or where the applied Confidence Levels were considered to be 'Very Low' alternative source material was reviewed to understand the characteristics of the coastal landscape to enable the data gaps to be filled and seascape character types to be defined.

In such instances a desk based assessment was undertaken drawing on development plan information, aerial photographs, OS maps and descriptions of nature conservation designations. The coastal characteristics of the four remaining counties were then determined based on this information and seascape types were subsequently defined. It is recognised that the confidence in these judgements is lower than where Landscape Character Assessment information is available as the LCAs are derived from detailed site based analysis. Due to the strategic nature of this appraisal it is not feasible or appropriate to undertake site survey of these areas. Further information on baseline data used in this assessment can be found in Appendix A Table A15: Landscape Character Assessment Review.

6.5.2.5 Designated Landscapes

For the purpose of the seascape assessment, the importance of certain landscape areas has been addressed by reference to national, regional and local landscape designations. However, the absence of a designation in relation to other landscapes does not infer a lack of quality or importance. For example, some landscapes, whilst they may not be identified as being of national importance or value may be very important a local scale e.g. to local communities. The main landscape designations considered in this SEA include:

- World Heritage Sites (WHS)
- National Parks
- County Level Landscape Designations including:
  - Areas of Especially High Scenic Amenity (EHSA)
  - Areas of High Visual Amenity (AHVA)
  - Normal Rural Landscape
  - Sensitive Rural Landscape
  - Visually Vulnerable Landscape
  - Scenic Routes

Further detail on these designations is provided as part of the baseline review in Chapter 9.

6.5.3 Assessment of Effects on Seascape

6.5.3.1 Public Attitudes to Wind Energy Developments

Environmental effects can be beneficial (positive) or neutral as well as adverse (negative). It is generally recognised that there are varying public attitude to the potential effects of wind energy developments. These different attitudes tend to depend on a) the type and nature of impact and b) the perception/opinion of the observer, with the latter being particularly pertinent to the assessment of wind farms.

Wind farm development generates a variety of responses ranging from strongly adverse to strongly positive. Experience of individual responses to proposed wind turbine development is that opinions can differ not only between close (i.e. adjacent) neighbours but also between members of the same family living in the same house. Surveys of public opinion relating to renewable energy development including wind farms, like the one referred to below, are helpful in understanding these different attitudes to wind energy developments.

In order to address the issue of different attitudes to wind energy developments only the degree of significance of effect is recorded in this assessment; judgements as to whether the landscape and visual effects identified are adverse (negative), neutral or beneficial (positive) are deferred to the discretion of the determining authority, which is best placed to judge this question based on feedback from consultees and the local public. However, for the avoidance of doubt, in this Seascape SEA, the default position on impact significance is neutral unless stated otherwise.

It is important to note that judgements on impact significance in this Seascape SEA, including those on differing public opinions of whether an effect is positive or negative, are impartial and based on professional experience and opinion informed by best practice guidance.

6.5.3.2 Sensitivity to Change

Sensitivity refers to the sensitivity of the seascape character type to the change induced by the presence of an offshore wind or marine renewable energy development. The assessment of seascape sensitivity is therefore specifically related to the three types of offshore renewable energy developments and their associated characteristics.

Renewable energy technology is a rapidly evolving field, appearance and scale of potential future development is accordingly difficult to predict with accuracy. When considering the potential effects of device characteristics on the existing seascape we have taken a precautionary view, basing assessment of the sensitivity to change, magnitude and on effects prior to mitigation.

Some of the seascape character types identified as part of this seascape assessment (Chapter 9) are more sensitive to offshore wind and marine renewable energy developments than others. The sensitivity of a particular seascape type to the presence of an offshore wind, wave or tidal development is one of the criteria used in the overall assessment of the potential significance of the effect (see section 6.5.3.4 below).

The extent to which the device array would affect the seascape varies depending on the various stages of the development and the capacity of the existing seascape to absorb these components. The construction and decommissioning phases of the development would involve temporary and relatively short periods of change and as a result the impacts on the seascape are not considered to be significant and are consequently not considered below.

The operational phases of the development when the devices are installed in the water would, however, result in more permanent and potentially significant effects and it is these operational effects on the seascape, which are described below. It should be noted that whilst submerged devices are not considered to result in potential significant impacts the buoys and lighting associated with these device arrays have been assessed as there is the potential for them to affect the seascape.

The sensitivity of different seascape character type to offshore renewable energy developments depends on the capacity of the different elements that comprise that character type, to accommodate change. Table 6.8 below provides a summary of criteria used to determine the different levels of sensitivity of specific seascape elements to offshore wind and marine renewable energy developments.

It should be noted that this table has been included to help aid transparency to the approach taken and does not represent a complete account of the various judgements and considerations that were undertaken when determining sensitivity.

Table 6.8: Criteria for Seascape Sensitivity

Criterion	Increase in Sensitivity	Decrease in Sensitivity
Scale (e.g. horizontal or vertical plane, linear or non linear, open or enclosed, large or small)	Small scale, enclosed Views extend out past enclosing land mass across sea to horizon Elevated views from coastal edge Absence of scaling elements	Large scale, open
Coastal topography/form /pattern (e.g. flat and simple, complex and intricate)	Intricate, complex, rugged Important focal points – Mountains, headlands, offshore islands	Flat, horizontal, simple, lack of natural focal points
Settlement/infrastructure (e.g. linear developments, urban forms, presence of large scale infrastructure or small, clustered nucleated villages or scattered settlements)	Traditional coastal and rural, scattered settlements Lack of visually prominent infrastructure.	Larger scale, urban mass and linear settlements Visually prominent infrastructure and busy navigational routes
Scenic quality (e.g. inherent distinctive visual qualities, condition and completeness of inherent natural characteristics, traditional landscape patterns, wilderness, tranquillity)	Seascape of high scenic quality with distinctive visual qualities, and inherent natural characteristics or traditional landscape patterns intact, or in good state of repair, or well looked after.	Degraded set of landscape features contributing to a less intact visual quality within the landscape. Visually prominent industrialisation of the landscape.
Exposure (linked to scale and topography e.g. exposed cliff faces and escarpments or sheltered bays)	Sheltered, calm coastal areas	Exposed, dramatic seascapes

Criterion	Increase in Sensitivity	Decrease in Sensitivity
Protected Areas (designated landscapes)	Areas protected by specific designations that include protection of landscape character or scenic quality such as WHS, AONB, MNR, EHSA	No designations relating to the area that include protection of landscape character or scenic quality

The following provides a brief definition of the criteria listed above:

- **Scale:** the scale of the seascape takes into consideration whether the emphasis is horizontal or vertical, linear, open, large or small. Sensitivity to devices will generally increase with small scale enclosed seascapes and decrease with large open scale areas.
- **Coastal topography/form/pattern:** Where seascape form is relatively, flat and simple such as low lying agricultural coastal land, low lying linear devices could relate to this characteristic. Where the seascape form is more complex and intricate, the straight linear lines of the device arrays may conflict with the inherent pattern, forms and focal points. Topography of associated land form, even when distant, will also inform the sensitivity of seascape to change, especially, when in the case of off shore wind, the landmass is prominent within the setting. Where the accessible coastal edge or immediate hinterland provides elevated views the distance at which effects would be considered low or negligible, would increase proportionally creating a higher level of sensitivity.
- **Settlement/infrastructure:** Device arrays are more likely to relate to linear developments, urban forms and areas where larger scale infrastructure exists than to small clustered, nucleated villages or scattered settlement where scale and character contrasts are greater. It should be noted that settlement and infrastructure is only considered in relation to the seascape and not the importance of visibility and views from them.
- **Scenic quality:** The scenic quality of a landscape relates to its inherent distinctive visual qualities, and to the condition and completeness of inherent natural characteristics or traditional landscape patterns.
- **Exposure:** Exposure to the elements is linked to the scale of the seascape but is also affected by topography. As waves crashing against rocks can seem dramatic and heighten the sense of wildness of the sea, so a distinction has been made on whether an area is calm, sheltered (higher sensitivity) or exposed, wild (lower sensitivity) and what effect the elements could have on each of the device characteristics.
- **Protected Areas:** For the purposes of the seascape assessment, landscape value has been addressed by reference to national, regional and local landscape designations. Absence of such a designation, however, does not infer a lack of quality or importance. Factors such as accessibility and local scarcity can render areas of nationally unremarkable quality, highly valuable as a local resource.

The sensitivities of the nine seascape character types are then evaluated and described using the following three point scale as follows:

- High sensitivity - a seascape of unique character and particularly high scenic quality, where the key characteristics are fragile and susceptible to small changes of the type proposed;
- Medium sensitivity – a seascape where the key characteristics are vulnerable but with some capacity to tolerate change of the type proposed; and
- Low sensitivity – a seascape where the key characteristics are potentially tolerant of substantial change of the type proposed.

The sensitivities of the individual seascape character types are described in the baseline review (Chapter 9).

6.5.3.3 Magnitude of Change

The issues which influence magnitude of change are complex, and comprise a number of quantifiable and less quantifiable parameters. More quantifiable parameters include, the distance from the development and the number and proportion of devices visible in the array. Less quantifiable parameters include the scale of change with respect to the loss or addition of key components, features and characteristics of the seascape; the nature of the effect – whether adverse, beneficial or neutral; and the effects of aspect, lighting and weather on the changing perception of the seascape character.

Visibility and Atmospheric Conditions

Visibility is influenced by atmospheric conditions such as visual clarity and light quality. Visual clarity is influenced by humidity, temperature and the presence or absence of air pollution. The Scott, K.E (2005) publication noted that levels of visibility are higher in Scotland (or at certain places in Scotland) and the potential visual range significantly higher than other parts of the UK e.g. England and Wales. The report 'Welsh Seascapes and Sensitivity to Offshore Development' 2009 states that the prevailing moist westerly winds along the Welsh coastline result in a lower level of visual clarity in comparison to the colder, unpolluted atmosphere of western Scotland which has a higher level of visual clarity. There is no information currently available on levels of visibility for Irish seascape.

Thirty year mean values documented by the Irish Meteorological Office (see Table 6.9 below) indicate a higher level of haze along the south and east coast with an associated lower level of visual clarity (conditions may be similar to the Welsh coast). The lower level of haze and higher rainfall along the west and north coast along with low levels of air pollution suggest a higher level of visual clarity. These effects were verified by observations in the field. For the purposes of this assessment conditions of optimum visibility are assumed.

Table 6.9 Information on the Irish Climate drawn from the Irish Meteorological Office

1961 -1990	Annual mean values over 30 years				
Location	Relative Humidity %		Overcast days without sun	Days with more than 5mm Rain	Days of Fog
	9am	3pm			
Dublin (East Coast)	82	72	61	48	50.5
Rosslare (South East Coast)	84	78	61	59	38.5
Roche's Point (South Coast)	85	79	63	63	46.5
Valentia (South West Coast)	83	78	75	95	8.9
Belmullet (West Coast)	83	78	66	80	16.6
Malin Head (North Coast)	**82**	**78**	**67**	**76**	11.8

Visibility Thresholds

It is often, however, the distance from the receptor/seascape components, which tends to most strongly influence judgements on the magnitude of change to a seascape. The DTI guidance suggests that distance is a key parameter and one, which might offer some form of standardisation in the way that magnitude of change is considered. Whilst the guidance ultimately advises that a range of criteria should be considered when determining magnitude of change, the high level nature of this SEA and the lack of information on the location of the devices within the study area, has meant that visibility thresholds have been used as the determining factor when considering the magnitude of change.

The magnitude of change arising from wind device characteristics has been based on a review of the visibility thresholds documented in:

- The SEA of Offshore Wind and Marine Renewable Energy in Northern Ireland 2009,
- The UK Offshore Energy SEA 2009,
- Welsh Seascapes and sensitivity to Offshore Development 2009,
- Visual Assessment of Windfarms: Best Practice SNH, 2002,
- Wind Energy Development Guidelines DoEHLG 2004,
- Seascape and Visual Impact Assessment: Guidance for Offshore Wind Farm Developers, DTI, 2005, and
- Kish and Bray Banks Offshore Windfarm EIS 2005.

Visibility over distance is affected by the curvature of the Earth therefore an observer at sea level may be able to discern the hub of a turbine 150m in height at a distance of 25 - 30km while an observer at 100m above sea level would be able to see a similar view (reduced in scale) at 45-50km. Theoretically the blades of a turbine would be visible at sea level at a distance 43-53km although this would be difficult to perceive by the human eye.

The Wind Energy Development Guidelines (DoEHLG 2004) which is principally focused on land based windfarm development, recommends a 20km limit for Areas of Visual Influence (ZVI) and 25km limit for ZVI's in relation to landscapes of national importance. A ZVI or ZTV (Area of Theoretical Visibility) is defined as the area in which a specific development is visible or theoretically visible. The Environmental Statement prepared for the Dublin Array Offshore Windfarm Proposal uses a ZTV of 30km from the centre of the proposed development based on DoEHLG guidance of distance in relation to turbine height. The potential distance at which offshore wind development will be visible is greater than land based wind development, due to the larger scale of devices and lack of intervening topography.

For the purpose of assessing effects of offshore wind development a 35km seaward limit is recommended as the limit of visual components for seascape assessment by the DTI Visual Impact Assessment: Guidance for Offshore Wind Farm Developers 2005. Based on the most recent guidance on visual significance of wind device characteristics effects at a distance greater than 35km will be assumed to be negligible in most cases for the purposes of this assessment, as changes to the seascape will very minor or imperceptible to the human eye. Visibility may extend over longer distances for seascapes associated with high cliffs or steep hinterland although the scale of visible components will reduce proportionally resulting in slight to very minor changes in the seascape components.

Magnitude of Change Criteria

The magnitude of change arising from the wave and tidal device characteristics has been based on the visibility thresholds established during fieldwork documented in the Scottish Marine Renewables SEA, 2007 and verified by fieldwork documented in the SEA of Offshore Wind and Marine renewables Northern Ireland. These differ from thresholds developed for offshore windfarms in previous documented studies due to the very different scale and physical characteristics associated with wave and tidal devices.

The following visual thresholds for wind turbines have been applied based on the SEA of Offshore Wind and Marine Renewable Energy in Northern Ireland 2009, Scottish Marine Renewables SEA, 2007 and the UK Offshore Energy SEA 2009 These thresholds were tested and verified during the site visits within Ireland and fieldwork carried out as part of Wind and Marine Renewable Energy in Northern Ireland 2009

These visual thresholds are the basis for assessing magnitude of change using the following 4- point scale.

- For Wave (On Surface Linear) Arrays and Tidal (On Surface Point) Arrays
  - Large: 0 - 5km from the coast. Notable change in seascape characteristics over an extensive area ranging to a very intensive change over a more limited area;
  - Medium: 5 - 10km from the coast. Moderate change in localised areas;
  - Small: 10 - 15km from the coast. Small or imperceptible change in seascape components; and
  - Negligible. 15km + from the coast. No discernible change in any seascape component.

- For Offshore Wind Turbines 5-7MW
  - Large: 0-15km from the coast. Notable change in seascape characteristics over an extensive area ranging to a very intensive change over a more limited area;
  - Medium: 15-24km from the coast. Moderate change in localised areas;
  - Small: 24 - 35km from the coast. Minor change in localised areas
  - Negligible 35km + from the coast. No discernible change in any seascape component

- Wave (Oscillating Surge) devices require water depths of 10 -15 m along with fixed coastal structures, therefore all devices are within 0-5km of the coast and effects are site specific.

6.5.3.4 Significance of Effects

The two principal criteria determining the potential significance of an effect are the sensitivity of the seascape and the magnitude of change and it is the evaluation of these factors against clearly defined criteria, which enables a reasoned judgement to be made on significance of effect.

The findings are represented using a descriptive scale ranging from:

- Significant effect (positive or negative depending on individual judgement)
- Moderate effect (positive or negative depending on individual judgement)
- Slight effect (positive or negative depending on individual judgement)
- No effect
- Neutral (positive effect balances out negative effect)

Explanation of the significance criteria/ratings is provided in Table 6.10 below.

Table 6.10: Seascape Significance Criteria

Level of Significance	Rationale for Assessment of Significance
Significant effect (negative)	▪ The proposals are at considerable variance with the scale, form and pattern of the seascape; ▪ They are likely to degrade, diminish or even destroy the integrity of a range of characteristic features and elements or their setting; ▪ They would be substantially damaging to a high quality or highly vulnerable seascape; and ▪ They are in serious conflict with the landscape objectives of a designation.
Moderate effect (negative)	▪ The proposals are out of scale with the seascape, or at odds with the local pattern and form; ▪ They are likely to strongly contrast with or cause loss of characteristic features and elements or their setting; and ▪ They would compromise the landscape objectives of a designation.
Slight effect (negative)	▪ The proposals do not quite fit the form and scale of the seascape; ▪ They are likely to result in only small changes to characteristic features and seascape elements; and ▪ They would not compromise the landscape objectives of a designation.
Neutral effect (negative)	▪ The proposals are well designed to complement the scale, form and pattern of the seascape; ▪ They would integrate into the existing seascape through siting and design; ▪ They would not cause loss or change to characteristic features and seascape elements; and ▪ They would avoid conflict with landscape objectives of a designation.
Slight effect (positive)	▪ The proposals fit well with the scale, form and pattern of the seascape; and ▪ They would maintain or enhance existing seascape characteristics.

Level of Significance	Rationale for Assessment of Significance
Moderate effect (positive)	▪ The proposals considerably enhance the form and pattern of the seascape; and ▪ They would enable some sense of quality to be restored or enhanced to a seascape which is not of any formally recognised quality.
Significant effect (positive)	▪ The proposals constitute a major restructuring of a degraded seascape or one in poor condition.

The influence of the sensitivity of the seascape character types and the magnitude of the effect (degree of change) on the overall significance of an effect (positive or negative) is illustrated in Table 6.10 below.

Table 6.10: Determining Effect Significance

Sensitivity	Magnitude			
	Negligible	**Small**	**Medium**	**Large**
Low	Slight	Slight	Moderate	Moderate
Medium	Slight	Moderate	Moderate	Substantial
High	Moderate	Moderate	Substantial	Substantial

Further information on potential effects on seascape is provided in Chapter 10: Generic Effects.

6.5.3.5 Visual Impacts

Development can change people's direct experience and perception of the landscape/seascape depending on the existing context, the scale, form, colour and texture of the proposals, the nature of activity associated with the development and the distance and angle of view. However, for there to be a visual impact there is the need for a viewer, usually referred to as a receptor. Receptors can include residential properties, workplaces, recreational facilities, road users, pedestrians and other outdoor sites and viewpoints which would be likely to experience a change in existing view as a result of a development.

GLVIA acknowledges a relationship between the perception of landscape/seascape character and the experience of viewers or receptors. Although procedurally linked, they are separate and distinct assessments. Visual assessment differs from the assessment of potential changes to the landscape or seascape character in that it assess the change in relation to a specific development to a view from an identified viewpoint.

Given the strategic nature of this assessment it has been considered that it is not possible to effectively assess potential visual impacts associated with the device arrays as changes to visual amenity are a direct response to receptor locations. At a strategic level it is not possible to identify receptors (number or type) with any level of certainty therefore selected viewpoints are unlikely to be representative over a wider area. Furthermore the potential locations of developments in relation to a receptor will range widely from the nearest to the furthest point within each resource area. Visual assessment from selected viewpoints at a strategic level would therefore be likely to result in a range of effects (substantial to neutral for each viewpoint and would consequently not provide meaningful information for the SEA. Consequently visual impacts associated with the installation and operation of off-shore wind, wave and tidal devices within the study area have not been considered as part of this SEA.

Visual impact assessment is an important part of the EIA process and a full visual impact assessment should be undertaken when considering project specific off shore wind, wave and tidal developments. Visibility and key views of the sea from the landward, coastline and seaward components of the seascape should be identified and analysed as part of the visual impact assessment. Receptors are likely to be both land and marine based and could include the following:

Land Based Receptors:

- Residents;
- Visitors/tourists;
- Views from footpaths, cycleways and bridleways;
- Other outdoor recreation e.g. fishing, bird watching, golf, swimming etc;
- Coast road users;
- Minor road users;
- Arterial/trunk road users;
- Rail passengers; and
- Industrial and commercial activities.

Marine Based Receptors:

- Yachts and inshore recreational boating;
- Water base recreation e.g. surfing, wind surfing, sea kayaking, sea angling;
- Competitive or high speed watersports e.g. jet skiing, speed boating;
- Passenger ferries;
- Commercial shipping and fishing vessels; and
- Extractive oil or gas.

The above receptors have been broadly listed to reflect the decreasing sensitivity[33] for example views from residential properties are more sensitive than views from industrial or commercial activities. Equally views experienced from yachts and inshore recreational boating are more sensitive than views from commercial shipping and fishing vessels.

Various ambient conditions will affect the visibility of a device from the receptor and will include factors such as distance, direction and angle of view to the device, time of day, season, light and prevailing weather.

[33] Guidance on the Assessment of the Impact of Offshore Wind Farms. Seascape and Visual Impact Report. (DTI, November 2005)

Section 7: Technologies

7 Technologies

7.1 Introduction

Offshore energy can be extracted and converted into electrical energy by a variety of devices that make use of different sources of energy:

- Offshore wind
- Tidal stream energy
- Wave energy

In order to obtain up to date information about technologies currently in development, questionnaires were sent to a number of offshore wind and marine renewable developers in January 2010. Offshore wind developments and technologies are at a more advanced stage and relatively standardised compared to marine renewables, hence two different questionnaires were prepared, one for wind energy developers and the other for marine energy developers. The information synthesised in this section is based on answers to those questions supplemented by information from other studies undertaken by Metoc and AECOM, including a previous SEA of Offshore Wind and Marine Renewable Energy in Northern Ireland and information available in the public domain.

7.2 Device Types

7.2.1 Offshore Wind

Horizontal axis wind turbines, having a large generating capacity are the most common type of commercial scale offshore wind arrays. Offshore turbines are now each typically generating around 3MW and turbines of up to 5 MW have been deployed. A vertical axis turbine generating a rated power of 10MW has also been prototyped (VertAx Wind Ltd).

A typical offshore turbine has a height to tip of around 80-120m with the tower height of about 60-80m, and blades approximately 40m long. Offshore wind turbines have, to date, generally been built in relatively shallow water, less than 30 metres in depth. Most existing developments have been installed on either gravity foundations, steel monopiles or jacket structures. Gravity foundations are structures, normally concrete, which settle and are stabilised by sand or water, with the turbine tower fitted onto them. Monopiles are long steel tubes which are hammered, drilled or vibrated into the seabed until secure, and then platforms and towers are installed on top. Jacket structures have and are being used by companies such as Vattenfall for their Ormonde windfarm in UK waters and Alpha Ventus windfarm in German waters.

The majority offshore windfarms developments in European waters have used, monopile foundations for the shallower water areas. Demonstrator projects for 5MW turbines on a quadropod jacket structure base in waters of around 45m have been undertaken in the UK and pinned jacket structures have been used in Germany. Further reasearch is being undertaken to develop other foundation designs including suction piles and drilled monopoles. A floating offshore wind platform using a moored buoy platform is currently being tested at full scale (Statoil's Hywind project) which could enable windfarms to be developed in much deeper waters, up to 700m.The first phase of the Arklow bank offshore wind farm is currently the only one constructed in Ireland, although there are four other projects under consideration for development. The Arklow Bank scheme comprises 200 turbines of 2MW+ capacity in an area of just under $70km^2$ sitting 13km from the shore off Arklow.

Codling Wind Park – Codling Bank. Codling Wind Park successfully obtained consent for the construction of 220 turbines in September 2005 providing up to 1100MW of installed capacity offshore. The site is approximately 13 kilometres off the east coast of Ireland, between Greystones and Wicklow.

Oriel Wind Farm in the North West Irish Sea near Dundalk. This proposed 55 turbine wind farm are currently awaiting a foreshore lease decision from the Minister, however they are due to receive a grid connection offer under the Gate 3 process for a generation of 330MW.

Dublin Array – this scheme is being developed by developed by Saorgus Energy. It is located on the Kish and Bray Banks in the Irish Sea approximately 10 km to the east of the coasts of Dublin and Wicklow. The wind farm is due to receive a grid connection offer in the Gate 3 process of 364MW and are currently awaiting foreshore lease decision from the Minister.

Sceirde Rocks off the coast of Galway (Doolick) - Fuinneamh Sceirde Teoranta are developing an offshore wind farm at the Skerd Rocks, some 5km to 8km off the coast of Carna in County Galway. The wind farm is due to receive a grid connection offer in the Gate 3 process of 100MW and are currently awaiting foreshore lease decision from the Minister.

A number of European countries are developing significant Offshore Wind programmes. In the UK, with by far the largest offshore wind programme in Europe, two initial leasing rounds from 2001 onwards led to the leasing of sites with 8GW total generating capacity to offshore wind developers. A new “Round 3” has provided opportunities for leasing of an additional 25GW. Germany, Belgium, Denmark and Netherlands have existing offshore windfarms and further farms under construction.

Figure 7.1: Example of Offshore Horizontal Turbines

Arklow Bank, East Coast of Ireland

7.2.2 *Wave Energy*

Wave devices are at a much earlier stage in their development than offshore wind turbines, with only a small number of them currently at full-scale testing stage. However, the world’s first commercial wave farm, using the Pelamis device and able to generate up to 2.25MW, was commissioned in September 2008, off the coast of Portugal.

In April 2006 the Irish Government launched an Ocean Energy Strategy which proposes a four Phase programme of development for ocean energy in Ireland. As part of this strategy a 1:4 scale open sea test site was established in Galway Bay by SEAI and the Marine Institute. Further information on the Galway Bay test site can be found at www.marine.ie/home/aboutus/organisationstaff/researchfacilities/Ocean+Energy+Test+Site and the Ocean Energy Strategy may be downloaded from www.marine.ie/home/services/operational/oceanenergy/OceanEnergyStrategy.

Importantly, Ireland is now developing its own full scale grid connected test centre at Belmullet to supplement the existing quarter-scale test facility in Galway Bay. This full scale test site is to assess the performance of the wave energy machines under development in generating electricity and their survivability in open ocean conditions.

As noted above, there has only been a handful of full scale wave energy devices tested in the world. The development of a test site in Belmullet will be a major opportunity for Ireland. The proposed test site will operate for up to 20 years and will provide three separate test locations at various depths of water depending on the specific devices being tested:

1. Near-shore 10m to 25m water depth
2. Mid-water 50m water depth
3. Deep-water 100m water depth

Further information on the Belmullet wave test site can be obtained from the following website:

www.seai.ie/Renewables/Ocean_Energy/wave_energy_test_sites.

In the UK, the European Marine Energy Centre (EMEC) located in Orkney, Northern Scotland provides facilities to test tidal and wave devices including a connection to the UK electric grid. Devices that have been tested at EMEC include The Pelamis wave device, Open Hydro's tidal turbine and Aquamarine's Oyster nearshore wave device.

Other test centres include Wave Hub, located off the coast of Cornwall in the UK, for the demonstration and testing of arrays of wave energy devices. NaREC on the north east coast of England provides large scale controlled test facilities for wave and tidal prototype devices. In Canada, the Fundy Ocean Research Centre for Energy has been established in the Bay of Fundy with Open Hydro, Marine Current Turbines and Clean Current Power being the first to scheduled to occupy test berths.

SEAI and the Ocean Energy Development Unit have supported a number of Irish ocean energy projects, including:

- Wavebob
- Ocean Energy Buoy
- Open Hydro
- Cyan Technologies Ltd
- Waveberg Ireland
- Key Engineering Services Ltd
- Sea Power Ltd

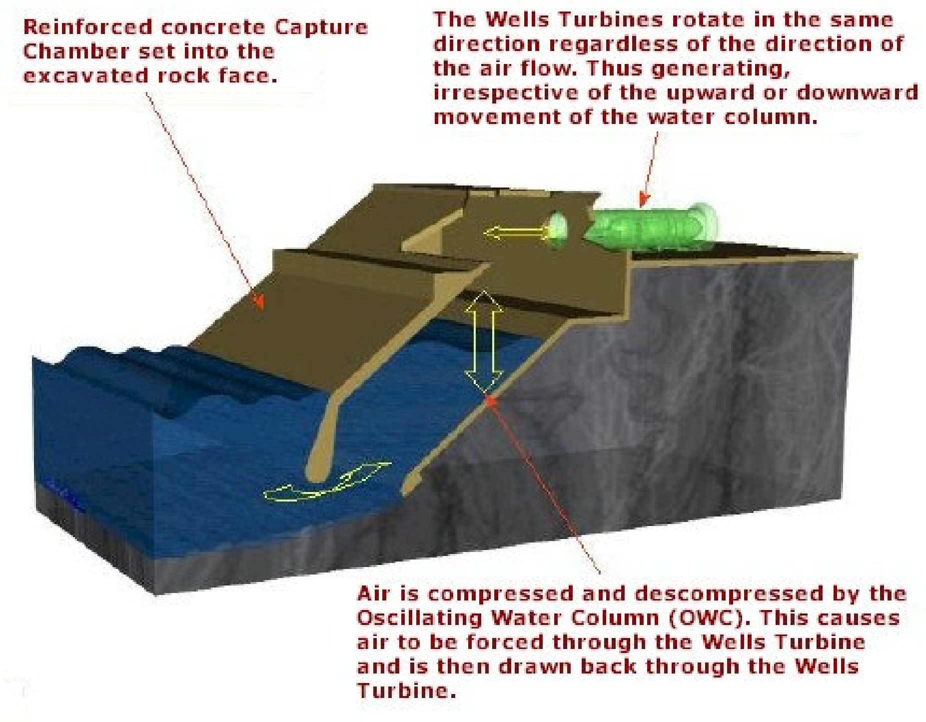
Offshore wave energy devices convert either the potential (wave height) or the kinetic (wave induced motion) energy of a wave into mechanical energy (turbine or rotor) which is then converted into electrical energy. One of the challenges for the extraction of wave energy is that wave power is available in low-speed and high forces, which the device has to resist. Moreover, the motion of forces is not in a single direction.

A brief description of some of the key device concepts used to extract wave energy is given below. The examples are illustrated by reference to some of the existing technologies, but are purely for illustrative purposes and are not intended to support any particular technology over another.

7.2.2.1 Oscillating Water Column (OWC)

These devices use changes in the height of the water surface that change the air pressure of a semi-enclosed chamber sitting above the water surface. The only exchange of air in and out of the chamber is through a turbine which is driven by changes in the air pressure of the chamber. This turbine is usually of the Wells type, which rotates on the same axis regardless of whether the air pressure increases or drops. An OWC can either be mounted on the shoreline, such as Wavegen's Limpet, or float offshore such as the quarter scale Ocean Energy Buoy tested over two and a half years by Ocean Energy Ltd at the test site in Galway Bay.

Figure 7.2: Example of Shoreline OWC



Source: Wavegen. (www.wavegen.co.uk/news_archives_limpet_for_press_release2.htm)

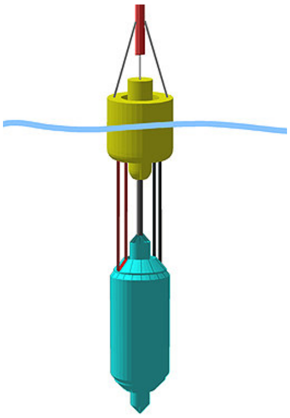
7.2.2.2 Point Absorber

Point absorbers are usually buoys moored to the seabed. The vertical motion of the water surface, hence of the buoy, moves a piston up and down. The piston is situated either within the mooring system or in the buoy system. An example of this technology is the Wavebob device tested at the Galway Bay 1/4 Scale Wave Power Testing facility. It is also understood that this device may be tested at the Belmullet test site in partnership with Tonn Energy.

A variant of this device is the submerged pressure differential. Instead of moving up and down at the sea surface, the device sits closer to the bottom and moves up and down as a result from the change of pressure due to the wave.

Based on the inventory of wave developers established by EMEC, a significant proportion of the wave devices currently in development are of the point absorber type.

Figure 7.3: Example of a Wave Point Absorber

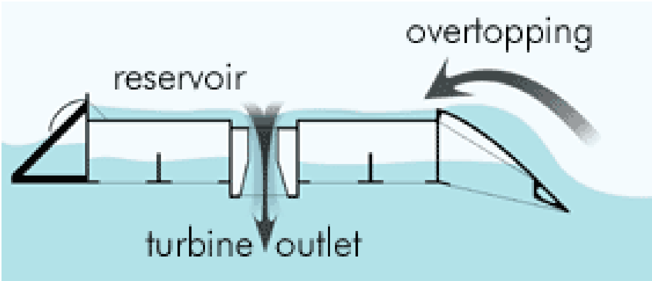


Source: WAVEBOB. (www.wavebob.com)

7.2.2.3 Overtopping/Collectors

Overtopping/collector devices are water reservoirs floating at the surface. Wave overtopping fills the reservoir, effectively storing the potential energy from the wave. The reservoir is then emptied through a turbine. Overtopping devices are usually moored and positioned offshore, in waters of depths 50-80m.

Figure 7.4: Sketch of an Overtopping Device



Source: Wikipedia. (http://en.wikipedia.org/wiki/Wave_Dragon)

7.2.2.4 Attenuators and Terminators

Energy can be extracted via the relative motion of parts of an extended structure, such as attenuators and terminators. Attenuators extract energy along the axis of propagation of the wave while terminators are perpendicular to the axis of propagation.

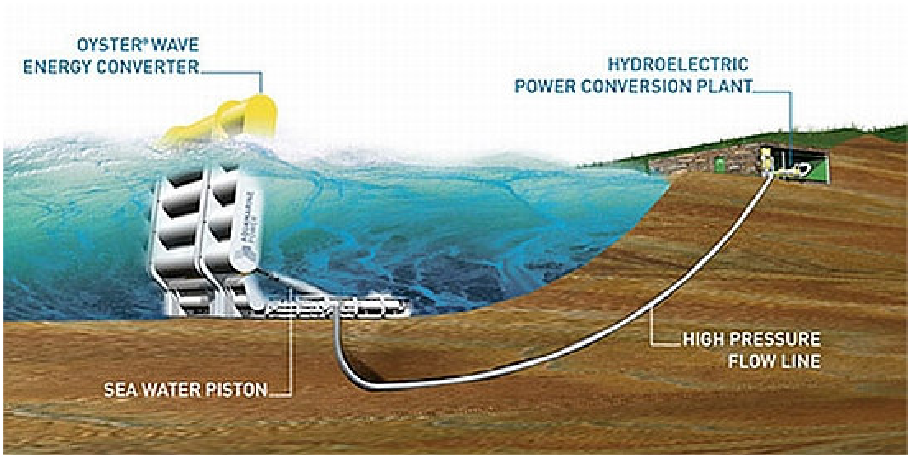
The Pelamis device is an example of attenuator whose efficiency has been demonstrated. It is the first device that has been deployed on a commercial scale, and will form part of the Wave Hub project offshore south west England. It is composed of cylindrical sections linked by hinged joints. The wave-induced motion of these joints is resisted by hydraulic rams, which pump high-pressure fluid through hydraulic motors. The hydraulic motors then drive electrical generators to produce electricity.

Figure 7.5: Example of Attenuator

Source: Pelamis Wave Power. (http://www.pelamiswave.com/galleryimages.php)

Oscillating wave surge converters can also be considered as a type of terminator. They use the wave induced horizontal motion beneath the surface. Aquamarine's Oyster device and the Wave Roller System are examples of such devices. The energy is extracted from the horizontal oscillating motion of a vertical or inclined board perpendicular to the direction of the wave. With the Oyster device, the motion is used to pump water round a closed loop system to an onshore generator.

Figure 7.6: Example of Oscillating Wave Surge Converter

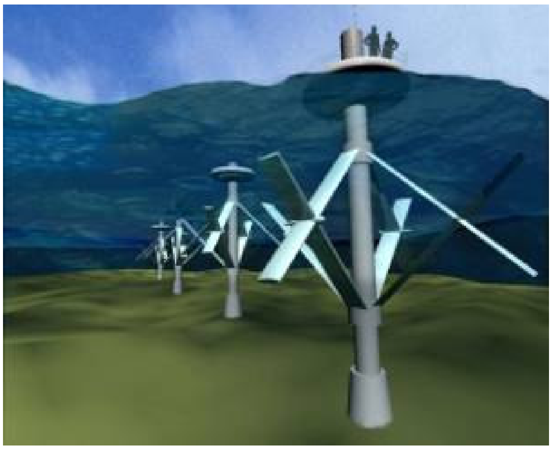


Source: Aquamarine Power.

7.2.2.5 Wave Rotors/Turbines

Wave rotors/turbines are generally bottom-mounted devices which are located in shallow waters nearshore. The rotational motion created by the wave drives a turbine or rotor. Ecofys has developed such a device by combining two types of rotors on the same axis of rotation: a Darrieus rotor and a Wells rotor. Those two types of rotor have been designed so that the turbine rotates in the same direction independently of the direction of the flow. A grid connected prototype was deployed in August 2002 off the Danish coast.

Figure 7.7: Example of Wave Rotor



Source: Ecofys. (www.ecofys.co.uk/uk/news/pressreleases2002/pressrelease02aug2002.htm)

7.2.2.6 Summary

Based on an inventory of wave devices compiled by EMEC, an estimate of the number of wave devices of each category currently under development has been made. The EMEC inventory is considered to be a representative sample of developers.

About half of the wave devices currently in development are of the point absorber type. Attenuators and terminators constitute 20.6% of the devices, and OWC 10.8%.

Table 7.1: Wave Devices

SEA Classification	EMEC Classification	Number of Devices in Category	Proportion [%]
OWC	OWC	11	10.8
Point Absorbers	Point absorber, Submerged pressure differential	47	46.1
Overtopping/Collectors	Overtopping	4	3.9
Attenuators, Terminators	Attenuators, Oscillating Wave Surge Converter	21	20.6
Wave Rotors/ Turbines and Others	Others	19	18.6
All	All	102	100.0

Source: Modified from EMEC (www.emec.org.uk)

7.2.3 Tidal Energy

Tidal resources are regular and predictable, which is one advantage over wind and wave energy. Moreover, areas of high elevation and strong flows are often situated in bathymetric constrictions, hence close to land and in areas of quieter wave and wind climate, which provide advantages when considering electric grid connection and maintenance.

A variety of generic tidal energy device types exist such as horizontal axis turbines, vertical axis turbines, venturi effect devices. They also employ a range of methods of attachment to the seabed, including gravity bases, moored tethered foundations and piled foundations.

7.2.3.1 Tidal Barrages and Lagoons

Tidal barrages and lagoons are not covered in this SEA. The focus of this SEA is on tidal stream technology only and does not include tidal range technology.

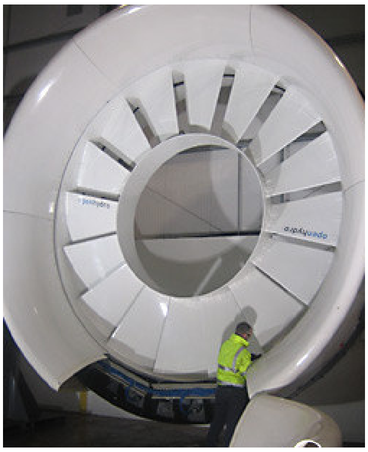
7.2.3.2 Horizontal Axis Turbines

Tidal stream energy presents similarities with wind energy, although the engineering constraints are different. As water is 800 times denser than air and has a much slower flow rate, water turbines experience much larger forces and moments than wind turbines. This leads to the development of turbines with smaller diameters and blades with different designs.

Horizontal axis turbines are currently a main area of development for tidal power. Some of these devices are shrouded to increase their efficiency through flow acceleration due to the constriction.

A small number of prototypes or pre-commercial devices have been installed around the UK coast including Marine Current Turbine's (MCT) full size prototype of horizontal tidal turbine, SeaGen, which was installed in Strangford Lough in April 2008. The turbine began to generate at full power of just over 1.2 MW in December 2008.

Figures 7.8 and 7.9: Examples of Horizontal Axis Turbines



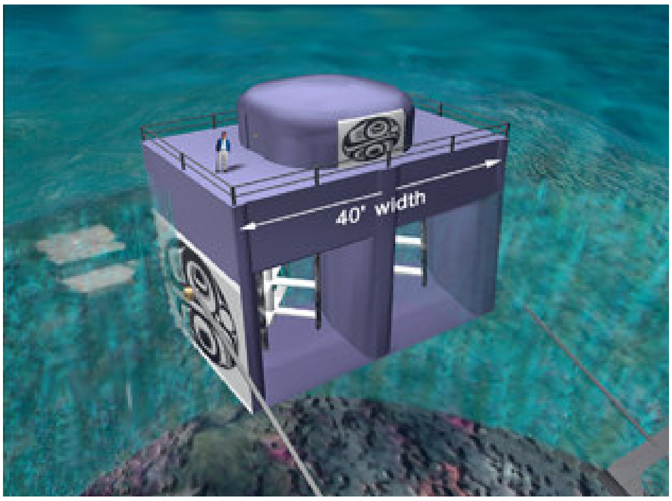
Source: Marine Current Turbines Ltd. Source: Open Hydro.

(www.marineturbines.com) www.openhydro.com/images.html)

7.2.3.3 Vertical Axis Turbines

Vertical axis turbines work in the same way as horizontal axis turbines, except that their axis of rotation is vertical. They are less common, and the differences in terms of performance between horizontal and vertical axis turbines are similar to offshore wind turbines. Vertical axis turbines can harness energy from flows in any direction and may be more efficient than horizontal axis turbines in low flow conditions. Horizontal axis turbines have a greater efficiency and survivability in strong flows.

Figure 7.10: Example of a Vertical Axis Turbine



Source: Blue Energy. (www.bluenergy.com)

7.2.3.4 Venturi Devices

Venturi devices use shrouding to constrict the flow, thus leading to a pressure low after the constriction. This pressure drop can be used to suck air through a turbine which drives the generator, so that there are therefore no moving parts in contact with water.

Shrouding can also be used to simply increase the water flow through a turbine (shrouded turbine). Shrouded devices with water turbines are classified as horizontal axis turbines in this SEA.

7.2.3.5 Hydroplanes and Oscillating Hydrofoils

Hydroplanes and oscillating hydrofoils extract energy from the oscillations created by the tidal flow. For example, Stingray is a totally submerged device that consists of a hydroplane (an underwater wing) fixed to a system of levers that operate a pump then used to drive a hydraulic generator.

Oscillating hydrofoils are similar to turbines in that the oscillating motion occurs around an axis of rotation. However, the rotation is not complete for oscillating hydrofoils as the device oscillates between two angles. As for tidal turbines, oscillating hydrofoils can either oscillate around either a vertical or a horizontal axis.

Figure 7.11: Example of a Hydroplane.

Source: British Broadcasting Corporation. (news.bbc.co.uk)

7.2.3.6 Summary

Based on the EMEC inventory of tidal developers, an estimate of the number of tidal devices currently under development has been made for each category. As stated previously, most of them fall into the horizontal axis turbine category (37.3%). It is also noted that a few of the technologies classified as 'others' and Venturi by EMEC could be classified as horizontal axis turbines, although they are usually based on more original designs.

Table 7.2: Tidal Devices

SEA Classification	EMEC Classification	Number of Devices in Category	Proportion [%]
Horizontal axis turbine	Horizontal turbine	19	37.3
Vertical axis turbine	Vertical axis turbine	8	15.7
Hydroplanes	Oscillating Hydrofoil	4	7.8
Venturi	Venturi	2	3.9
Others	Others	18	35.3
All	All	51	100.0

Source: Modified from EMEC (www.emec.org.uk).

7.3 Device Characteristics

In terms of the device characteristics, the following character areas have been identified:

- Location
  - Depth requirement
  - Space occupied by the device
  - Energy density and operability range
- Installation and maintenance
  - Installation (method of attachment to seabed)
  - Maintenance
  - Decommissioning
- Interactions with the environment
  - Moving parts in contact with the air and water
  - Chemicals
  - Noise
  - Electro-magnetic field (EMF)

7.3.1 Location

The geographical location of a device is constrained by:

- The depth in which the device can be deployed,
- The resource for which the device can generate energy,
- The connectivity to the Irish grid, which, with the depth requirements, largely set the constraints on the distance from the shore.

7.3.1.1 Depth Requirement

Offshore Wind

For offshore wind, the depth requirement depends on the foundation technique. Proven monopile technologies allow deployment in waters of up to 40m depths. Floating structures could potentially be deployed in much deeper areas (>100m). Floating turbines are currently in an early stage of development, and this technology might not be deployable at a commercial scale within the timescales of the OREDP (e.g. by 2030). A number of international companies have won research funding to develop deepwater foundations technologies (up to 60m) for funding. The final three winners will have their designs funded for large-scale demonstration projects in 2010-2012. This initiative is likely to accelerate the development of deepwater foundations; hence construction of wind farms in waters of depth up to 60m is considered a likely scenario for the next 20 years.

However to ensure all potential future developments are considered in the SEA, potential areas of wind resource within deeper water are considered in the assessment. Foundation structures are reviewed later in this section.

Wave Devices

Developers' answers to the questionnaire indicate that wave devices can operate in depths ranging between 4 and 200m, depending on the type of device. Shoreline oscillating water column devices operate in water depths of more than 4m, but require a sharp slope along the shore. Wave rotor devices operate in shallow waters of 10-15m depth. Point absorbers can be used for a wide range of water depths, between 5m and 200m depending on the design. Attenuators and overtopping devices generally require waters deeper than 50m to operate, and it is expected it will be possible to deploy them in waters up to 100m in the near future. Theoretically, using point absorbers as an example little has to be changed to the design of the device before it can be deployed in very deep waters. The main constraints are harsh wave climates, and distance from the shore.

High energy waves are associated with deeper waters (more than 50m). As water becomes shallower, the wave energy is attenuated by interaction with the seabed and, therefore, inshore arrays will comprise of devices that are designed to specifically maximise energy extraction from these lower energy environments. However, most wave devices are designed for deeper waters where it is possible to extract higher levels of energy.

Tidal Devices

Tidal devices vary in depth requirement based on their configuration, so surface-piercing piled devices are typically located in the 25 to 30m depth range, whereas bottom-founded devices can currently operate in depths of 40 to 50 m. Most devices can be scaled to shallower water depths if required. The extent of the high energy tidal streams will dictate locations and heavily influence the types of devices that are economic to deploy at a given location. For tidal devices, the incentive to deploy in deeper water is not as great as for wave devices because the resource is also available in shallow waters; hence the upper limit of 80m presently given by developers is likely to be a good indication of possible deployment depths in the next 10-20 years. Deploying in deeper water is unlikely to become economically attractive before the areas of strong currents close to shore have been exploited.

7.3.1.2 Space Occupied by the Device

The environmental impacts caused by a device on its environment partly depend on the space it occupies in the air and in the water column.

Offshore Wind

As offshore wind devices exploit a resource above the sea surface and are attached to the seabed, they occupy the entire water column. The horizontal extent occupied in the atmosphere depends on the diameter of the rotor. For example, standard 5MW commercial turbines can have a nacelle height of 120m and a rotor diameter of 126m, leading to a total height of 183m. Recent developments have seen the introduction of 7+MW horizontal axis turbines and plans for a 10MW vertical axis turbine. These achieve higher efficiencies with similar blade sizes through the optimisation of other parts of the wind turbine design. Consideration of wake effects, operational and maintenance workspace and supporting infrastructure requirements are significant influences on the overall footprint of an offshore wind farm.

Wave Devices

The majority of wave devices are driven by wave action at the sea surface and therefore the major components of the devices are located at or close to the sea surface. The devices are moored to the seabed resulting in most of the water column being occupied.

The majority of wave devices also break the sea surface with only a small proportion being fully submerged. Wave devices that do break the sea surface or that float typically have between 2 and 14 m of freeboard visible above the surface. The size of a device at the surface depends on its type and is often correlated with the water depth and the wave climate of the waters in which it is to be deployed. Overtopping, terminator and attenuator devices have sizes up to 200m by 200m. Point absorbers are much smaller and typically cover an area of 20m by 20m. The space occupied by the cable that links the device to the mooring is small compared to the area occupied at the surface and at the seabed.

The horizontal extent occupied by the device at the seabed is largely set by the mooring technique used. Most devices occupy a larger horizontal extent at the seabed than in the rest of the water column. It is expected that the mooring for one device covers an area of up to 100m^2.

Tidal Devices

Tidal stream resources are more equally distributed through the water column than wave resources. Therefore, tidal devices can be bottom-mounted and do not necessarily require structures at the sea surface to operate. However, some devices require surface structures to enable access for maintenance and repair and/or may need to be marked by buoyage or lights if they represent a hazard to navigation. Typically, devices that are bottom-mounted can be varied in size according to the water depth and tidal flow.

Most of the tidal devices currently in development are horizontal tidal stream devices. The turbine itself can be placed at different levels within the water column in order to exploit the strongest tidal current. Turbines for which it is possible to change the height in the water column (e.g. SeaGen) are generally attached to a column that protrudes slightly above the surface and the device occupies a horizontal extent of up to 500m^2 at the level of the turbine. Bottom-mounted turbines are only present near the seabed and are expected to be a solution considered more and more by developers in the future, as they allow deployment in deeper waters and impose less constraint on navigation.

7.3.2 Energy Density and Operability Range

Offshore Wind

Early adoption of offshore wind power in Europe was at a smaller scale, with a number of <30MW developments in the late 1990's, then scaling up to 100 to 200MW by 2008. Windfarms now under construction tend to be larger scale, such as the 400MW BARD farm in Germany and the 500MW Greater Gabbard farm in the UK. This increase in array size reflects changes in economies of scale, with larger arrays being more economically advantageous. Table 7.3 contains examples of consented wind farm projects with their size and power densities taken from the UK to provide a consistent and readily available source of data.

Power densities are dependent on the rated power of the turbines used and on the distance necessary between devices, which should be 5 to 10 times the turbine rotor diameter. About 1km is typically allowed between 5MW turbines. Currently, typical power densities achieved are in the 8-10 MW/km^2 range. However, the use of 5MW turbines can allow an array to achieve power densities of up to 22MW/km^2. By 2011, an array of 140 turbines of 3.6MW is expected to be operational at Greater Gabbard, the world's largest offshore wind farm currently in construction. More ambitious projects under consideration include the Atlantic Array, which would consist of 350 wind turbines generating 1.5GW off the coast of North Devon. The use of 10MW turbines would significantly increase the power density, although technologies under development that could deliver that much power have yet to be demonstrated.

Table 7.3: Examples of Wind Farm Sizes

	Name	Number of turbines	Power [MW]	Area [km2]	Power Density [MW/km2]
UK Round 1	Barrow	30	90	<10	9.00
	Burbo Bank	25	90	<10	9.00
	Gunfleet Sands	30	108	<10	10.80
	Inner Dowsing	27	90	<10	9.00
	Kentish Flats	30	20-90	<10	5.50
	Lynn	27	90	<10	9.00
	North Hoyle	30	60	<10	6.00
	Rhyl Flats	30	100	<10	10.00
	Robin Rigg	60	216	<10	21.60
	Scarweather Sands	30	20-108	<10	6.40
	Scroby Sands	30	60	<10	6.00
	Teesside	30	<90	<10	9.00
UK Round 2	Docking Shoal	100	375 - 500	74.9	5.84
	Dudgeon	60	230-300	34.97	7.58
	Greater Gabbard	<140	375 - 500	146.43	2.99
	Gunfleet Sands	20	48-64	4.99	11.22
	Gwynt Y Mor	<250	<750	124.17	6.04
	Humber Gateway	70	230-300	34.99	7.86
	Lincs	120	190-250	34.93	6.30
	London Array	~271	750-1000	245.29	3.57
	Race Bank	100	375-500	52.77	8.29
	Sheringham Shoal	45-108	240-315	34.99	7.93
	Thanet	60	230-300	34.99	7.57
	Triton Knoll	286	900-1200	206.99	5.07
	Walney	102	340-450	72.85	5.42
	West Duddon	140	375-500	66.68	6.56
	Westermost Rough	80	180 - 240	34.91	6.02
	Ormonde	30	108	<10	10.80
	Min	20.00	55.00	4.99	2.99
	Mean	81.66	271.77	47.67	7.87
	Max	286.00	1050.00	245.29	21.60

Source: Modified from www.thecrownestate.co.uk/interactive_map_offshore_windfarms_table

All wind turbines have a design point, i.e. an optimum wind speed at which they reach maximum efficiency. This efficiency, i.e. the ratio of the output electrical energy over the input wind energy, is theoretically less than 59.3% (Betz limit). According to the British Wind Energy Association, wind turbines start operating at wind speeds of 4 to 5 m/s and reach maximum power output at around 15 m/s (typical design point). They are shut down at very high wind speeds (25 m/s) to avoid being damaged.

Wave Devices

Wave energy developers responding to the questionnaire quoted numbers of devices between 10 and 250 for a full scale commercial array. However, it is very early in the development process for a number of these devices and it is most likely that the early commercial arrays will contain between 20 and 50 devices, built in stages over 2 to 3 years. The degree of interaction between devices is not yet fully understood and developers will look to evaluate this further in smaller pre-commercial arrays that may consist of 5 to 10 devices. A reasonable estimate for commercial array scale is that they will be formed of 20 to 50 devices each. It is noted that some devices, such as shoreline mounted OWC, will not necessarily be deployed as arrays. Rather, the devices will be joined in a continuous single structure containing for example 100 turbines generating 10MW over an area of 20m by 500m along the shore and reaching much higher power densities because spacing between devices is not an issue.

Similarly, devices such as offshore OWC and overtopping devices usually have larger sizes and generating power. For these, small arrays of 5 to 10 devices are considered although it might be more efficient to scale the device up than to deploy an array of them, depending on where they are to be located.

Analysis of the results from the developers' questionnaires for this study and for the recent SEA of Offshore Wind and Marine Renewable Energy in Northern Ireland indicates that a typical array is expected to generate a rated power of 10-25 MW/km^2. This figure is consistent across a range of devices. For example, an array of 30 devices each generating 750kW like the Pelamis wave energy converter (attenuator) over 1km^2 would generate a rated power of 22.5MW while an array of 40 point absorbers (e.g. Wavebob) each generating 500kW would generate 20MW. See Table 7.4 for different configurations of arrays. As mentioned, overtopping devices such as the Wave Dragon have lower power density and extends over larger areas. For example eight Wave Dragon devices deployed in an area of 8.6km^2 would generate a rated power of 56MW.

Table 7.4: Wave Array Size Assumptions

Type of device			Point absorber		Attenuator		Overtopping
Example			C5 (Wave Star Energy)		Pelamis		Wave Dragon
Generating capacity of one device		[MW]	0.5		0.75		7
Number of devices in an array*	Nx		5	5	4	5	2
	Ny		6	10	6	10	4
	Total		30	50	24	50	8
Generating capacity of an array		[MW]	15	25	18	37.5	56
Typical Separation	Nx	[m]	200		300		600
	Ny	[m]	200		10		700
Device Size	Nx	[m]	20		10		300
	Ny	[m]	20		150		200
Array size	Nx	[km]	1.1	1.1	1.24	1.55	1.8
	Ny	[km]	1.32	2.20	0.96	1.60	3.6
	Total	[km^2]	1.45	2.42	1.19	2.48	6.48
Power Density		[MW/km^2]	10.33		15.12		8.64

Note: Nx: characteristics along x-axis of the array. Ny: characteristics along y-axis of the array. * Different configurations were considered for attenuators (arrays of 24 or 50 devices)

For some wave devices, operability and performance depend not only on the wave height, but also on the wave period. Wave dragon (overtopping) is an example of device that can operate in any wave climate, although it becomes more efficient for a significant wave height above 5m. Consultation with developers also indicates that most devices start generating power from significant wave heights of 0.5m. It is also worth noting that some devices can be automatically tuned to convert more energy from the actual wave height and optimise their efficiency. Terminators and attenuators, such as Pelamis, are particularly sensitive to wave period, which is roughly proportional to the wave height at a given location. Only a few of the developers consulted for this SEA gave an operability range in terms of wave period. However, according to the answers gathered, peak periods between 6 seconds and 12 seconds are adapted for wave energy recuperation.

Tidal Devices

Developers consulted for this SEA and the recent SEA of Offshore Wind and Marine Renewable Energy in Northern Ireland are considering early commercial arrays of around 40 devices, generating a rated power of 50MW/km^2. Some even mention power densities of up to 100MW/km^2, although these may not be achievable in the near future as the wakes created by the tidal stream devices currently have a limiting effect on the achievable power density. However, if projects can be developed in deeper waters where currents are stronger, it is likely that tidal arrays will have larger horizontal scales and higher power densities. One developer indicates a power density of up to 300MW/km2 with a good tidal resource of 3.5m/s. In that case, there will also be technical constraints to overcome (installation, maintenance, access to electric national grid).

It is assumed that in the future tidal arrays will have two types of configuration, one of which will be adapted to coastal (near-shore) areas and the other to areas further offshore. In coastal areas, the tidal resource is localised, therefore relatively small scale arrays are to be expected. Due to its proximity to shore, it is likely to be the first resource that developers will look to exploit. As the spacing between devices is about 10 times larger in the direction of the flow than perpendicular to it, a typical configuration for early coastal arrays may be a small number of rows of devices. It is assumed that typical arrays will be formed of 1 or 2 rows of about 10 devices each. Such arrays would cover a typical area of 0.5 km^2, depending on the type of device, and generate an estimated 50-60 MW/km^2.

There is little information available to estimate the size of a future offshore array. They could be formed of up to 100 devices. As they will be deployed at greater depths where the tidal currents are stronger, the spacing between devices will probably be larger than for coastal arrays. An array of 50 to 100 devices, of dimensions 20m by 50m, such as MCT's SeaGen, and requiring 50m spacing perpendicular to the flow and 200m along the flow, would cover an area of 1.1 to 2.2km^2. The power density of this example array, if formed of devices generating each 1.5MW, would be 70MW/km^2.

Operability ranges depend on the design of a device and some devices can be scaled to adapt to the resource of the site where they are to be deployed. Typically, most horizontal axis devices reach their maximum efficiency at current speeds of 2-3m/s, although devices exist that can operate in tidal currents as strong as 5-6m/s. A typical average current speed across the tidal cycle of 1 to 2 m/s is sought by most site developers at present. The predictable nature of tidal current makes it easier to adapt the design of a device to the environmental conditions of a site than for wave energy devices. Devices such as hydrofoils or VIVACE, which extracts energy from the vortices created by a flow obstructed by a pole, could potentially efficiently harness energy from currents as weak as 1m/s.

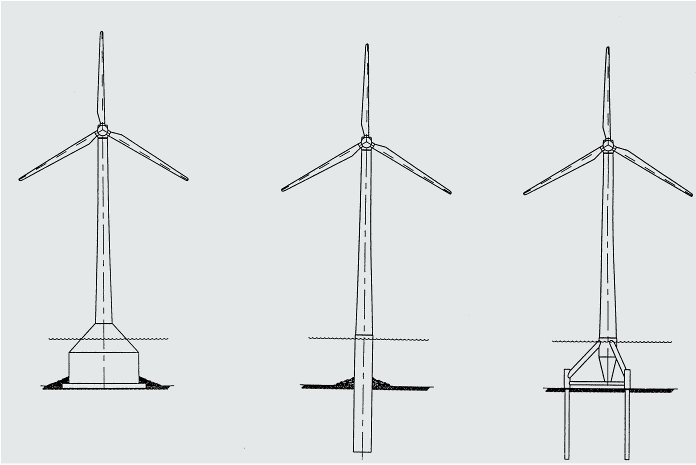
7.3.3 Installation and Maintenance

7.3.3.1 Installation

The constraints on the installation of a device are largely set by the mooring method. The key methods of attachment of devices to the sea-bed are as follows:

- Piling: monopiles (steel pile driven 10 to 20m into the seabed) and tripods (whose feet are driven into the seabed, as in the monopile case).
- Gravity structure (including caissons).
- Anchors and clump weighs.

Figure 7.12: Offshore Wind Turbine Foundations. Left: Gravity Structure; Centre: Monopile; Right: Tripod



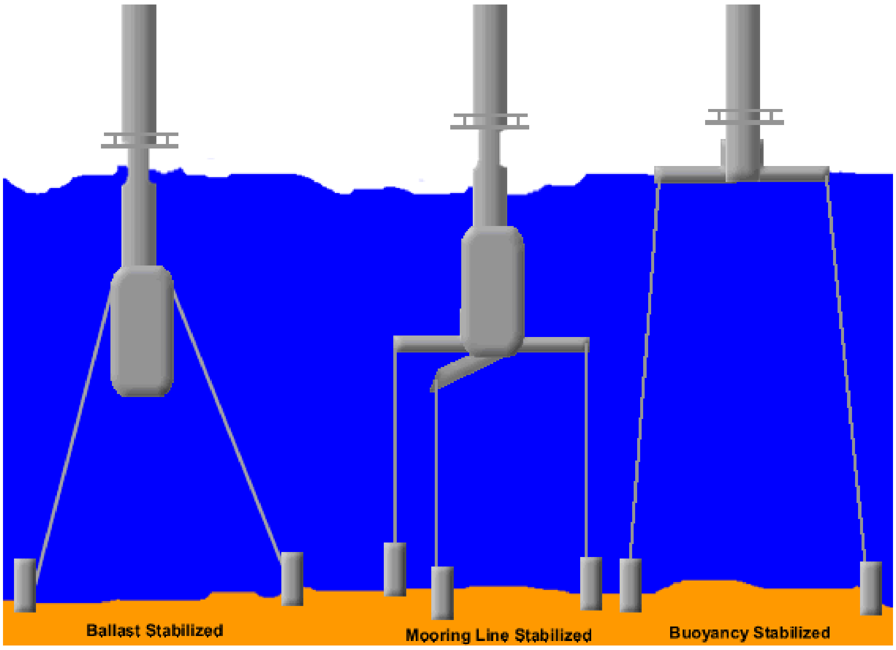
Source: www.ramboll-wind.com\PDF\OMAE99.pdf.

The complexity of the technique and invasive nature of the installation technique has potential to impact the timescales associated with installation of the devices. The choice of foundation is made based on the water depth, soil types, sediment movement, wind, current and wave loadings.

Recent developments have focused on foundations for turbines in deeper waters:

- Jacket foundations: They are four-legged platforms made from large tubular steel elements, whose design comes from the oil and gas industry. The wind turbine rests on the jacket platform, which is anchored to the seabed by pile foundations. The jacket is fabricated from steel pipes welded together in complex intersections, so as to resist loadings and vibrations. Such foundations have been used for the Beatrice Offshore wind farm in Scotland in water depths of up to 45m, and could be used to deploy offshore wind turbines in waters of 100m in the near future. Jacket foundations are treated in the piling category.
- Moored floating foundations: They come in various designs, and are still at the prototype stage. They could potentially be used for offshore wind farms on floating islands. As they are simply moored, they are adapted to virtually any seabed type and water depth. The main challenge and area of research is in stabilising them. It is expected that they could be deployed in depths in excess of 100m. For example, Statoil indicate that their Hywind design can be deployed in water depths between 120m and 700m, although the technology may not be used in commercial scale array by 2030.

Figure 7.13: Concepts for Floating Offshore Wind Turbine Foundations



Source: http://offshorewind.net/Other_Pages/Turbine-Foundations.html#future

Installation methods depend on the type of foundation used. The foundation is built first, then the turbine's tower is erected, and lastly the nacelle and rotor are put in place. The installation is done either from a jack-up barge, or a floating crane vessel.

Jack-up barges are mobile platforms. The supporting legs can be lowered to make the platform stable, resting on the seabed. At the end of the installation, the legs are raised above sea-level and the platform becomes mobile.

The time taken for full installation of a device varies between a few days to a few months. Consequently some commercial scale arrays can take a number of years for installation to be completed. It depends largely on the type of mooring, but also on the installation techniques. The devices assembled on shore and then towed to site take relatively little time at sea to install while for those that are constructed on site, more work is required on site. Some developers have designed their own vessel, adapted to their device, to install, maintain and decommission the device.

Figure 7.14: Jack-Up Barge

Source: news.bbc.co.uk

Piling

Mooring using piles is limited to one type of wave device (the wave rotor) but several tidal devices are set on monopiles. Most wind turbines are also mounted on monopiles or tripod. Piles used to secure and mount commercial-scale renewables devices tend to be approximately 4 m in diameter and, typically, are driven some 20 m into the seabed. They allow deployment in water depths up to about 40 m.

Piling location is surveyed to inform pile design, which usually involves drilling into the soil and rock layers below the sea-bed using a jack-up vessel. It may be necessary to prepare the seabed to level areas where the jack-up feet (spud cans) will sit on the seabed. The jack-up may take 3-7 days to drill, set, and cement a pile into position. Once the pile is set, the topside structure of the device has to be lifted on to the pile and secured. This is very dependent on the exact design of device and may take 1 to 4 days. Removal of the jack-up may involve waiting on suitable weather/tide conditions. In an array, the jack-up may move from site to site drilling and setting piles, then it or another vessel with a suitable crane will follow through lifting and setting topsides. The installation of rotors may be a subsequent operation or they may be lifted and fitted at the same time. This, again, depends on the exact design of the device.

Gravity Base

Gravity bases are used widely by both wave and tidal stream technologies. By their very nature they are bulky and heavy, although some designs may be ballasted down after they have been set on the seabed. They may be 20 to 40 m square or oblong with a variable aspect ratio from device to device. Good design of gravity bases involves inclusion of features that will assist removal of the gravity base at the end of its useful life.

Generally, following site survey and sea-bed preparation, the site will be marked with buoys and/or sonar devices and the gravity base (made buoyant by temporary closures of some elements, buoyancy bags or supported between barges) will be towed and positioned on site by tugs. The ballasting down operation will commence and be completed within, usually, a number of hours, so that the whole operation at site is completed within 1-2 days in a favourable weather window. These operations tend to be much quicker than monopile installation but are also more weather sensitive.

Anchors and Clump Weights

A large proportion of wave devices and a small number of tidal technologies are moored with anchors and chains or wires.

Generally, anchors are pre-set by a support vessel, which may be done over a period of 2 to 4 days. The device is then towed to the site, the anchor handler retrieves the anchor chains/wires and they are fastened to the device. It is highly desirable to complete the attachment of the device within daylight hours, so the duration of this stage of installation is very short.

Clump weights vary from being steel blocks at the smaller end of the size range to fabricated steel baskets that are loaded up with large link chain to provide weights of several tens of tonnes. They are pre-installed from a vessel with suitable lifting gear over 2 to 3 days. Subsequently the device is towed to site and attached to the chains or wires that are associated with each clump weight. The seabed disturbance is very similar to that for anchoring and is incurred only in the areas upon which the weights are placed.

7.3.3.2 Maintenance

Access to devices has safety implications and developers are responsible for ensuring that appropriate facilities are built into the device and proper procedures are developed for access and egress. Wherever possible, developers are planning to carry out most activities without actually accessing a device unless a properly designed platform is provided for that purpose. Developers are aware of the safety issues associated with device maintenance and will seek to comply with all safety requirements.

Ease of removal for repair and maintenance is an important factor in the overall concept of devices and the systems to facilitate removal in whole, or more frequently, in part, are key objectives of the design.

In general, device developers are seeking to design for minimum maintenance. Frequency and duration of maintenance can range from a few hours to a few days.

Planned interventions are arranged so that the minimum of offshore work is required. Some devices are taken off-site to a safe haven for maintenance to be carried out.

Access to devices for breakdown maintenance is likely to be limited by weather conditions. It is generally unlikely that operators will attempt to do other than inspection or minor work offshore for safety reasons.

Offshore Wind

Internal parts of the turbines, such as the gear box and the electro-magnetic generator may require maintenance. The submerged part of the turbine will also be subject to corrosion, so it is important that the turbine be monitored and maintained. It is estimated that scheduled maintenance operations will take 2 weeks every year, preferentially in summer. However, it has been learned from the onshore wind experience that faults and trips in the electrical and electronic control systems could create unplanned shut-down, so unscheduled maintenance operations should be expected. It is hoped that, with the development of more sophisticated condition monitoring systems, it will become easier to plan maintenance operations.

Access to the wind farm for these operations can be achieved by helicopter or boats, depending on the type of operation.

Wave Devices

A few wave devices require full removal of the device for repair and maintenance activities, whereas others require use of divers or remotely-operated vehicles to carry out on-site maintenance. Where removal is planned, design focus has been to minimise the specification of vessel required for the task to control costs as far as possible. Wave devices will be located in areas of rough wave climates, which makes the planning of in-situ maintenance operations sensitive to weather conditions. Planned maintenance operations are expected to be carried out 2 to 3 time a year, for period of a few days. Due to the early stage of development of some of the devices, some developers envisage additional visual inspection more often. For the same reasons, the estimated maintenance periods that have been given by developers are often an early estimate that will need to be updated after further testing of the devices.

Tidal Devices

Tidal technologies are, typically, fixed via piles or gravity bases and therefore rely on maintenance systems to remove or access the essential parts of the device where the turbine, gearbox or generator are located, rather than removing the whole device. These systems are quite specific and often a proprietary part of the technology. In-situ maintenance appears more adapted to tidal than to wave devices as tidal devices can be deployed in more sheltered areas. Developers indicate that expected maintenance operations should take place every 2 to 6 years and last between 4 and 6 weeks.

7.3.3.3 Decommissioning

Decommissioning of devices, from the tower to the blades, has similar constraints to the installation process, generally requiring the same methods. Decommissioning the foundations constitutes a more challenging problem and the methods for removing foundations will have to be taken into account in the development of a device. Gravity foundations would have to be refloated. Decommissioning such a structure would involve lifting/towing heavy loads.

Monopiles can be decommissioned by cutting them at or below the seabed. It is unlikely that the whole part of the pile which is under the seabed will be removed.

Decommissioning entails a similar scale of works undertaken by similar mechanical means to construction and installation.

Good design of offshore renewable energy devices involves inclusion of features to facilitate removal and decommissioning. For example, a gravity base may have internal piping installed that enables connection of an air pump to jet out the mud below the gravity base and allow it to be lifted more easily for removal.

7.3.4 Interactions with the Environment

7.3.4.1 Moving Parts in Contact with Air and Water

Offshore Wind

All offshore wind turbines have moving part in contact with air. There are no moving parts in contact with water. Only wave and tidal devices have moving parts on contact with water (see below).

Wave Devices

The majority of wave devices have no moving parts in contact with water. Those that do include wave rotors, which have blades in contact with water and may incorporate mesh protection to prevent fish, mammals etc from coming into contact with and being injured by the turbines. The blades are thought to rotate at approximately 25 revolutions per minute. Some wave devices have hinged sections which move with wave action, although these movements tend to be fairly slow.

Tidal Devices

All tidal devices apart from the air turbine Venturi type have moving turbine blades or hinges in contact with sea water. The turbine devices commonly operate at between 20 and 30 revolutions per minute and turbine diameters for commercial horizontal axis turbines are typically some 10 to 30 m but can be varied according to site characteristics. Information available on vertical axis turbines would suggest that turbine diameters also vary (from approximately 3 m to approximately 6 m in diameter and up to 6 m in height), depending upon the device configuration.

7.3.4.2 Chemicals

Coatings and Antifouling Chemicals

Fouling of offshore renewable devices by marine organisms such as algae and molluscs can reduce their efficiency. A small number of both wave and tidal device developers report that they use special antifouling coatings to prevent fouling of their devices by marine organisms, although most of them do not contain biocides. Most wave devices do not have any moving parts in contact with the water, hence reducing the need for antifouling chemicals.

Tidal devices do have moving parts in contact with the water, although they undergo strong currents, which limit marine growth. It is expected that the majority of developers will seek to use non-toxic antifouling materials as far as possible.

A method to prevent fouling that does not involve chemicals is to make the surfaces in contact with water smooth enough to prevent marine growth, and is used whenever possible on offshore wind turbines. Coating layers are used both to limit fouling and as a passive protection against corrosion. Among them, epoxy coating systems are the most popular in the offshore wind industry. Passive protection against corrosion such as coating systems is only sufficient in the atmospheric and splash areas, therefore active corrosion protection, such as using sacrificial anodes, is necessary for submerged and buried areas.

Sacrificial Anodes

It is usual to protect steel structures in corrosive environments (such as seawater) by attachment of sacrificial anodes.

A sacrificial anode is a piece of readily corrodible metal attached (by either an electrically conductive solid or liquid) to the metal being protected. This piece of metal (usually zinc or aluminium) corrodes first, and generally must dissolve nearly completely before the protected metal will corrode (hence the term “sacrificial”). They are classified as active corrosion protection because of the chemical reaction that results in their dissolution.

Based on a typical device installed in 50 m water depth, it is estimated that discharges of zinc or aluminium would add an extremely small percentage (1.31×10^{-5} % per year) to the ionic material that makes up the mean inorganic content of seawater.

Hydraulic Fluids

Devices that use hydraulic systems will normally be designed such that at least two seals or containment failures are required before a leaking fluid reaches the sea. It is not possible to be definitive for every device currently under consideration as a number of them are still at concept stage and this aspect is a matter for detailed design. However, best practice guidelines, if followed, would lead developers to minimise risks of hydraulic fluid leakage. Details of the risk of leakage would need to be considered for individual developments. The possibility of leakage of oil from mechanical equipment or lubricated joints in contact with sea water is difficult to quantify and determine.

Furthermore, design leakage rates will be small as part of the approach to creating low-maintenance devices which, in this context, means that device developers aim to design devices that do not require frequent oil replacement or grease injection into bearings. The general approach used by developers would be to select efficient containment systems that minimise leakage.

Where a device design will result in some unavoidable seepage to the sea, biodegradable options are likely to be selected for both hydraulic and lubricating oils and greases. As part of the questionnaire, some developers indicate that they are using biodegradable fluids or even water as hydraulic fluids.

7.3.4.3 Noise

Noise is generated during site investigation and device installation, operation and decommissioning. Noise generated during operation is of lower amplitude than noise generated at the other stages, but is generated on longer durations. A detailed noise study investigating the sources of noise during the different stages of deployment was undertaken to inform the Scottish SEA, whose conclusions are summarised here.

During site preparation and device installation, the main sources of noise are:

- Geophysical survey, shipping and machinery
- Dredging
- Pile driving or drilling

Pile driving generates high amplitude noise over a broad range of frequencies (20Hz to 20kHz) and is understood to be the greatest source of environmental impacts.

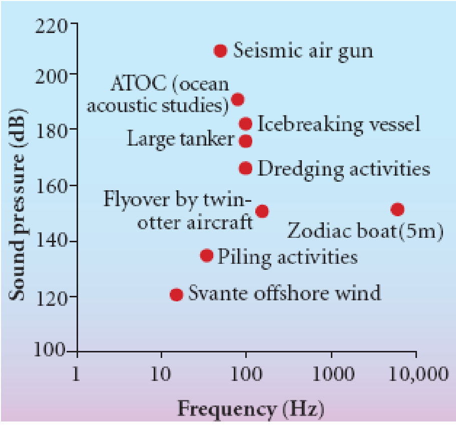
During operation, noise is generated by:

- Moving air or water (e.g. through a turbine)
- The device’s moving parts, including rotating machinery or flexing joints
- Structural noise
- Electrical noise
- Instrumentation noise

While developers will seek to minimise noise from their devices in operation, faults can significantly increase noise levels.

The noise study commissioned to inform the Scottish SEA indicates that the noise generated by an array of devices will depend on the geometry of the array, and more particularly on the spacing between devices.

Figure 7.15: Comparison of Selected Anthropogenic Noise Source



Source: Vella, Gero. 2001. The Environmental Implications of Offshore Wind.

7.3.4.4 Electro-Magnetic Field (EMF)

Any electric current generates an EMF whose magnitude depends on the intensity of that current. Although electric fields can be contained within a cable envelop, magnetic fields emanate from the cable in a plane perpendicular to the axis of the cable (along which the electric field is directed) and have a magnitude that depends on the electric current in the cable and that decrease with the distance from the cable. Charged particles such as ions moving in a magnetic field induce an electrical field, whose magnitude depends on that of the magnetic field and on the number of charged particles.

Most wave and tidal devices emit a small undersea EMF due to the generator. This EMF will be device specific and depend, for example, on the location of the power generating unit of the device within the water column. Little is known yet about the characteristics of this EMF.

EMFs are also generated by the inter-device and export cables and have magnitudes directly related to the intensity of the current circulating along cables. Inter-device cables collect power from all the devices of an array to collection points. Export cables connect collection points to shore, therefore transmit more power and generate EMFs of higher magnitudes than inter-device cables. Developers who answered the survey indicate that the EMFs generated by the cables may be of larger amplitude than those generated by the devices themselves.

It is noted that the EMFs generated by an array of devices will not only depend on the devices and cables used, but also on the design of the array itself. The spacing between devices and therefore cables will be a key issue as EMFs generated by closely spaced elements can interact to lead to a larger field.

7.3.5 Summary

Table 7.5 summarises the characteristics of the wave devices considered in this SEA. Table 7.6 summarises the characteristics of the wind and tidal devices considered.

Table 7.5: Summary of the Characteristics of Wave Devices Considered in the SEA

Device category		OWC shoreline	OWC nearshore/ offshore	Overtopping	Terminator (inc. Oscillation wave surge converter)	Attenuator	Point Absorber	Wave Rotor
Resource		wave						
Location	Water Depth	>4m, getting deeper rapidly	10-50m	50-80m	10-15m	50-80m	5-100m	10-15m
	In Water Column	Entire	Mainly at the surface (20m by 20m to 200m by 200m) + mooring (0.1km2 footprint) at the seabed					Mainly at the seabed
Installation	Mooring Method	Depends on seabed type and water depths.						
		Most widely used: anchors. Clump weights and gravity structures are also widely used.						Monopile
Maintenance	Where	On site						Offsite
	Frequency	Generally 1 to 2 times per year						
	Duration	Varies greatly between a few hours and 2 weeks						
Environmental Impacts	Noise	Yes, during operation, but mostly during installation and decommissioning.						
	EMF	Mainly from power cable						
	Anode	Some do (Zinc and aluminium)						
	Moving parts in contact with water	None	None	Turbines	Hinges		Piston	Turbines
	Shrouded	N/A	N/A	N/A	N/A	N/A	N/A	N/D
	Anti-fouling	Most of them use some, but mainly non-toxic chemicals.						
	Hydraulic fluids	Yes, but biodegradable ones. Some use water as hydraulic fluid.						
Commercial scale array	Extent	20m by 500m ($0.01km^2$)	~$2km^2$	~6-$8km^2$	~$2km^2$			N/D
	Number of devices	100 turbines joined in 1 structure	20	8	20-50			N/D
	Power density	~$1GW/km^2$	~$10MW/km^2$	~$9MW/km^2$	10-$25MW/km^2$			N/D
Number in category (EMEC)		11%		4%	21%		46%	N/D

Table 7.6: Summary of the Characteristics of Tidal and Offshore Wind Devices Considered in the SEA

Device category		Horizontal Axis Turbine	Vertical Axis Turbine	Oscillating Hydrofoils	Horizontal Axis Turbine
Resource		tidal			Wind
Location	Water Depth	10-80m	10-40m	N/D	0-60 (>100)* m
	In Water Column	Entire water column or seabed only.		Seabed only	Entire column
Installation	Mooring Method	Depends on seabed type and water depths.			
		Mainly monopile and gravity structures. Also anchors and clump weights.	Gravity Structures, anchors, clump weights.	N/D	Mainly monopiles
Maintenance	Where	On site	N/D	N/D	On site
	Frequency	Every 2 to 6 years	N/D	N/D	Yearly
	Duration	Between a few hours and 2 weeks.	N/D	N/D	2 weeks
Environmental Impacts	Underwater noise	Yes, during operation, but mostly during installation and decommissioning			
	Underwater EMF	Mainly from power cable			
	Anode	Some do (Zinc and aluminium)			
	Moving parts in contact with water	Turbines		Oscillating board	N/A
	Shrouded	Some	N/A	N/A	None
	Anti-fouling	Most of them use some, but mainly non-toxic chemicals.			
	Hydraulic fluids	Yes, but biodegradable ones. Some use water as hydraulic fluid.			N/A
Commercial scale array	Extent	Coastal: ~0.5 (0.1-1)* km^2 Offshore: 1-2km^2	N/D	N/D	50 (5-250)* km^2
	Number of devices	Coastal: 10 (5-20)* Offshore: 50-100	N/D	N/D	~100 (25-350)*
	Power density	50-70MW/km^2	N/D	N/D	~12 (3-22)* MW/km^2
Number in category (EMEC)		3%	16%	8%	N/A

Section 8: Resources Areas

8 Resources Areas

8.1 Introduction

The aim of this chapter is to outline the energy resource availability from marine renewables (wave and tidal stream) and offshore wind within the offshore area within the defined study area, around the coast of the Republic of Ireland.

This chapter has three objectives:

- Provide an overview of the theoretical energy resource availability for Ireland based on previous available research and data;
- Set out the technical constraints applied to each resource type with justifications for the limiting criteria; and
- Using Geographic Information System (GIS) based analysis to generate maps presenting spatial data for theoretical energy resource with specific ‘technical’ resource areas highlighted which merit further investigation.

This SEA follows previous resource assessments and makes reference to five specific energy resource categories. These are presented in Table 8.1.

Table 8.1: Resource Categories and Definitions

Effect	Development Phase
Theoretical	Gross energy content within the study area
Technical	Theoretical resource limited by existing technical limitations such as water depth and other parameters
Practical	Technical resource limited by marine conditions such as wave exposure, sea bed conditions, shipping lanes, military areas and disposal sites
Accessible	Practical resource limited by environmental constraints specific to each site.
Viable	Accessible resource limited by commercial constraints including development costs and market reward

This chapter focuses on the theoretical and technical resource. The technical resource areas and further assessed in terms of environmental and other constraints later in the report.

Throughout this chapter, reference is made to the 'study area', which is a defined region that covers the entire Republic of Ireland offshore region from Lough Foyle in the north around to Carlingford Lough in the east.

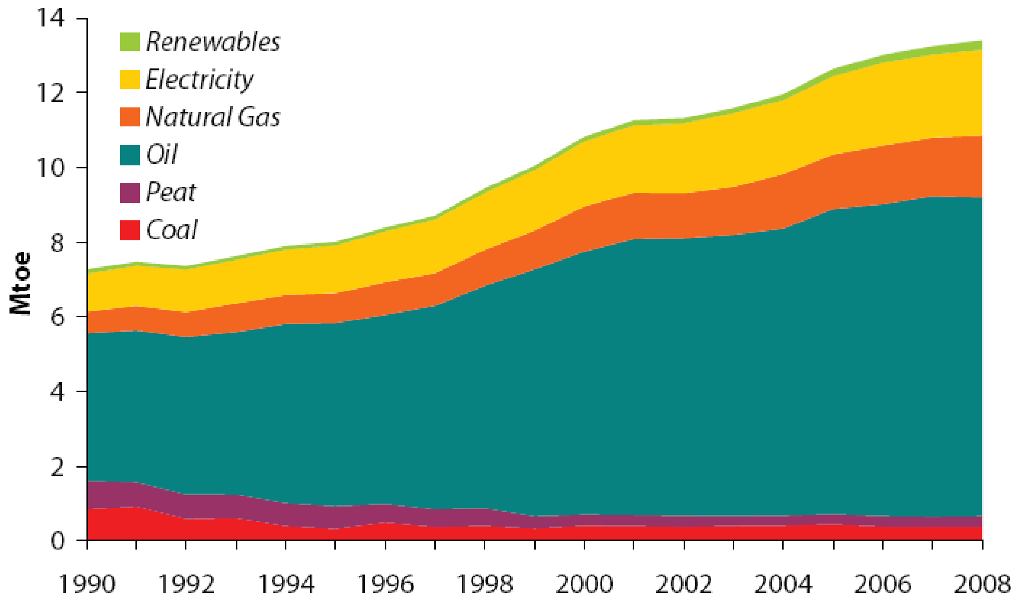
The theoretical resource and technical resource areas for offshore wind, wave and tidal energy are shown in **Figures 8.1 – 8.3 respectively**. All three figures present the boundary of the SEA study area.

8.2 Ireland's Current Energy Requirements

To place renewable energy in context, a brief summary of the current energy use by source is provided. The Sustainable Energy Authority Ireland (SEAI) through its Energy Policy Statistical Support Unit published summarised information on energy use in the report 'Energy in Ireland, Key Statistics 2009' (SEAI, 2009 A).

Figure 8.4 presents the total final energy consumption by Fuel between 1990 and 2008 in million tonnes of oil equivalent, (Mtoe).

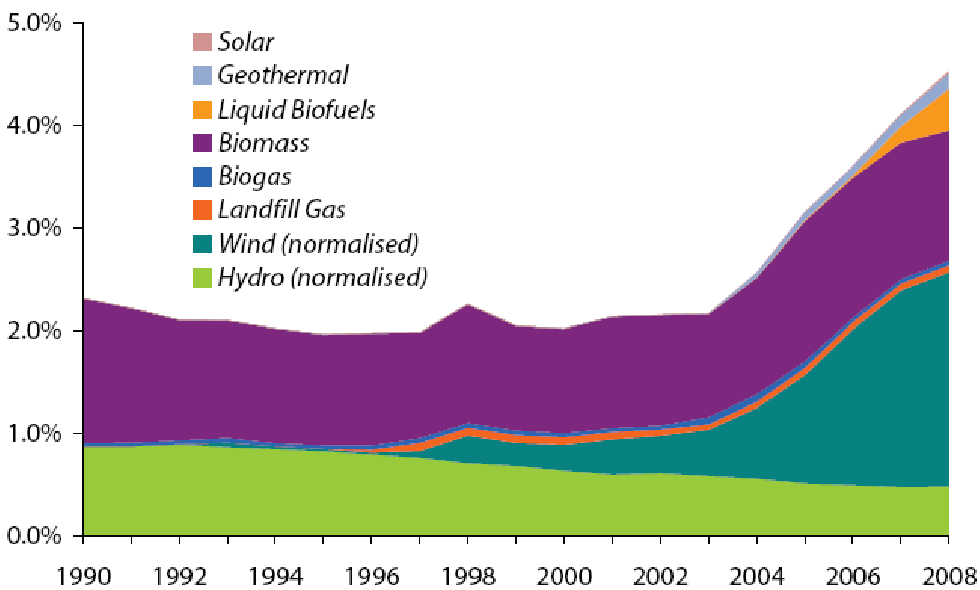
Figure 8.4: Ireland's Total Final Energy Consumption by Fuel, 1990 to 2008



(Source: SEAI 2009 A)

Figure 8.5 shows total energy consumption across all sectors, including electricity generation, transport and thermal (heating), fossil fuels dominate the fuel contribution. The contribution from renewable sources in 2008 amounted to 581 kilotonnes of oil equivalent (Ktoe), which accounts for 4.5% of gross final consumption (GFC). The breakdown of the 4.5% renewable contribution is provided in Figure 8.5.

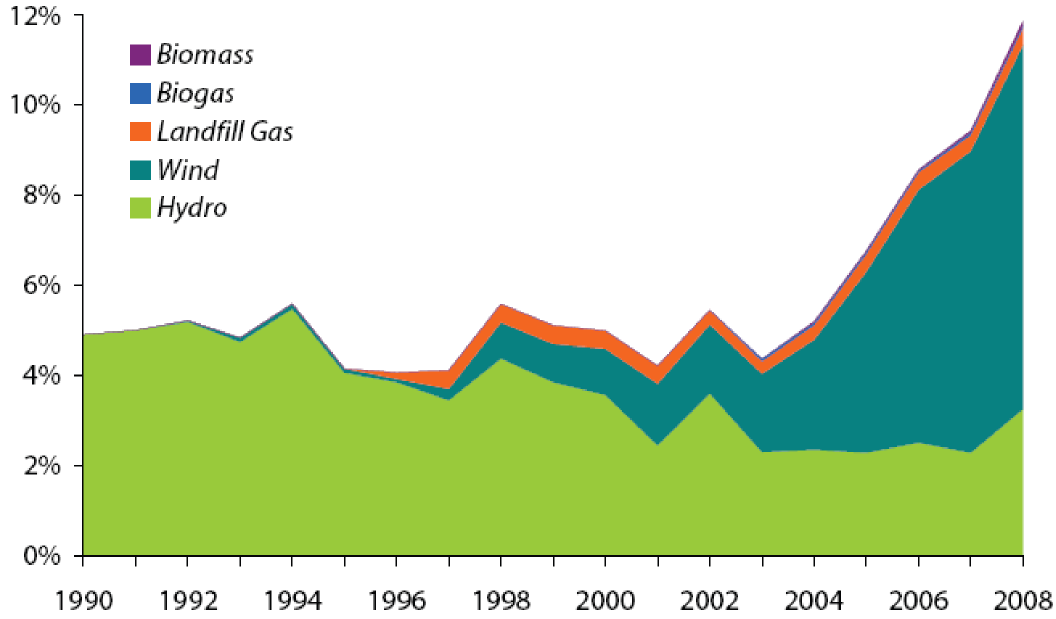
Figure 8.5: Ireland's Renewable Energy Contribution to GFC 1990 to 2008



(Source: SEAI 2009 A)

From Figure 8.5, wind energy now contributes the greatest share (36%) of the total renewable contribution to GFC which stands at 4.5%. The contribution from wind energy is also increasing rapidly. In terms of the renewable energy contribution to gross electricity generation (GEG), Figure 8.6 presents breakdown by renewable energy source.

Figure 8.6: Renewable Energy Contribution to Gross Electricity Consumption



(Source: SEAI 2009 A)

Renewable energy's contribution to GEG in 2008 is estimated to be 11.9%. In terms of absolute electricity generated (in gigawatt hours, GWh), the increase of 697 GWh in 1990 to 3,539 GWh in 2008, represents an increase of 408% (9% per annum on average).

8.3 Renewable Targets

In January 2008, the European Union (EU) committed to a binding target that 20% of the EU's energy consumption must come from renewable sources by 2020 (Department of Energy and Climate Change, DECC, 2008). The European Renewable Energy Directive (EU, 2009/28/EC) sets a renewable energy contribution from Ireland by 2020 of 16% of final energy consumption.

In 2007, the Irish Government through the Department of Communications, Energy and Natural Resources (DCENR) published a white paper, setting out the Energy Policy Framework 2007 to 2020. In the white paper, the Irish Government committed to delivering a significant growth in renewable energy as a contribution to fuel diversity in power generation with a 2020 target of 33% electricity consumption, with a target of 15% by 2010 (DCENR, 2007).

In addition, the white paper highlighted wind power from onshore and offshore sources as a key technology to meet the 2020 target with and biomass and ocean (wave and tidal) technology highlighted as important technologies contributing to power generation mix. Electricity generation from renewable ocean power has been set a target of 500 megawatts (MW) installed capacity by 2020.

In 2008, after the White Paper was released, the Irish Government increased the target contribution to electricity generation from renewable sources to 40%. This target was set out in the framework document 'Building Ireland's Smart Economy' (Government of Ireland, 2008). Ireland's National Renewable Energy Action Plan, published in July 2010, sets out how the 16% overall renewable energy consumption target will be reached – this will be done through 10% consumption of renewable energy in the transport sector, 12% in the heat sector and 42.5% in the electricity sector.

8.4 Offshore Wind Resource

8.4.1 Wind Resource Overview

In 2008, electricity generated from wind energy contributed the largest share of all the renewable energy sources both to GEG and GFC, although the vast majority of the installed wind generating capacity is from onshore sites.

The Irish government has clearly stated that it supports a long term development of offshore wind projects (DCENR, 2007), although highlights a number of challenges from planning, licensing and the capital cost of offshore projects that require addressing. No specific target for generating capacity from offshore wind has been set in Ireland.

The Irish Government through the SEAI, published the Wind Atlas Ireland in 2003 to support the development of offshore wind energy. The Wind Atlas formed a key part of the framework for identification of potential sites for development and was issued to the local authorities (SEAI, 2006).

The Renewable Energy Resource Assessment as part of the All Island Grid Study (DCENR, 2008) was published in 2008 (referred to as the "All Island Grid Study") and jointly commissioned by Northern Ireland's, Department for Enterprise, Trade and Investment, (DETI) and DCENR. The All Ireland Grid Study assessed six electricity generation portfolios as options for renewable energy delivery by 2020. The All Ireland Grid Study considered an upper limit of 1 GW generating capacity of offshore wind for the whole of Ireland by 2020.

There are a number of offshore wind projects at different stages of planning and operation in Irish Waters which are highlighted in Table 8.2, below. In summary, including the operational phase I Arklow Bank development, offshore wind developments presented in Table 8.2 represent up to 2400MW of installed capacity (However, as a number of these projects are still in the planning stages the actual estimates for installed capacity after installation may vary).

Table 8.2: Offshore Wind Projects in Ireland

Project Name		Developer	Project Status	Generating Capacity	Key Target Dates
Arklow Bank Wind Park	Phase 1	GE Energy and SSE Renewables (formally Airtricity)	Generating Power	25MW (7 turbines)	Installed
Arklow Bank Wind Park	Phase 2-4	GE Energy and SSE Renewables (formally Airtricity) and EHN	Planning	500MW (~200 turbines)	None available at this stage
Oriel Wind Farm		Oriel Windfarm Limited	Consent Application Submitted	330MW (~55 turbines)	Expected to be operational in 2017*
Codling Wind Farm		Codling Wind Park Limited	Phase 2 Consent Application Submitted	1100MW (~200 turbines)	No available at this stage
Dublin Array		Saorgus Energy Ltd	Awaiting Foreshore Lease Decision	364MW (~145 turbines)	Installation start in 2013*
Sceirde (Skerd) Offshore Wind Farm		Fuinneamh Sceirde Teoranta (FST)	Consent Application Submitted	100MW (~20 turbines)	Expected to be operational in 2015

Source: 4cOffshore, 2010

*Gate 3 ITC Results 2010-2023

8.4.2 Data Sources

The following data sources have been used to establish the wind resource in the study area:

- Republic of Ireland Wind Atlas, (SEAI 2003)
- UK Marine Resource Atlas, (BERR 2008)

8.4.2.1 Republic of Ireland Wind Atlas

The SEAI Wind Atlas, published in October 2003, offers theoretical wind resource mapping for the Irish marine region up to 20km offshore. The project was commissioned by the SEAI to inform strategic development of offshore wind resource in Ireland, and an online GIS of resource mapping results and technical report is available through the SEAI website.

The method of generating resource data for the Irish Wind Atlas involved using the MesoMap system which is driven by the MASS (Mesoscale Atmospheric Simulation System) numerical weather model. For the offshore area, wind power and wind speed outputs were produced for heights of 50m, 75m and 100m above mean sea level at a grid spacing resolution of 200m.

GIS files of contoured data for wind resource have been made available to this project and used to map the wind resource in the study area.

8.4.2.2 UK Marine Resource Atlas

In early 2007, the UK Department for Business, Enterprise and Regulatory Reform (BERR) commissioned an update to the Marine Resource Atlas (MRA) with revised data from the original version published in September 2004 (BERR, 2008).

Over the last five years, the UK MRA has provided the government, academic and private sectors with a good understanding of marine renewable and offshore wind energy resource for the UK continental shelf area with the view of development.

The MRA atlas provides useful wind resource data in the Irish Sea and Celtic Sea to the east and southeast of the study area, although no MRA data is available for Irish waters. The MRA provides predicted wind speed and power data as outputs from the Met Office UK Waters Wave model for wind and wave. The Met office Wave model describes the offshore wind resource for the UK continental shelf and nearshore areas at a resolution of 12 km. However, the MRA atlas notes that predictions for shallow nearshore areas may not robustly describe coastal effects. Consequently nearshore areas around the coast are not well resolved by the MRA data.

MRA GIS data files of wind resource are freely available for download and have been used in this SEA.

8.4.3 Theoretical Wind Energy Resource

This study has used the SEAI Wind Atlas GIS data and focused on mean annual wind speed at 100m height as the primary parameter for the assessment of wind resource. This parameter represents the theoretical wind energy resource in the Irish offshore area. Theoretical offshore wind resource for Ireland is presented in Figure 8.1, and demonstrates significant offshore wind energy resource available. The vast majority of the Irish offshore area where data is available is predicted to have a mean annual wind speed of between 7.0 and 11 m/s at 100m height above mean sea level (MSL). Generally, wind speed is predicted to increase with distance from the coast in all directions around Ireland. However, western and southern areas of the study area are predicted to see the greatest wind resource, as they face prevailing westerly winds that are unconstrained by land that arrive at the UK continental shelf from Atlantic weather systems.

There is a significant area where no data is available, as the ESBI Wind Atlas only assessed offshore areas within 20km of the Irish coastline. Both the Wind Atlas and the MRA demonstrate that wind resource increases with distance offshore, and therefore it is highly likely that wind resource greater than 9.5 m/s annual mean wind speed or higher will be observed in the outer study area not covered by the Wind Atlas.

8.4.4 Technical Wind Energy Resource

A detailed overview of the renewable sector technology is available in Chapter 7. However, in terms of technical constraints considered in developing offshore wind power, two parameters have been evaluated with threshold values presented Table 8.3.

Currently, fixed foundation offshore turbines are deployed in up to 40m of water, although future technology will potentially increase this water depth. Floating offshore wind turbines offer the possibility for deployment in much deeper waters. The most advanced prototype of a moored ballast stabilised turbine is the StatoilHydro Hywind project, located 10km offshore of Karmøy, Norway, which in August 2009, was connected to the Norwegian electricity grid and began generating power (Statoil, 2010). StatoilHydro make reference to floating devices that could theoretically be deployed in water depths of 120 to 700 m (StatoilHydro, 2009). However, it is recognised that the potential for development of deeper water areas may not take place until later than 2020 and that early stage developments are likely to pursue site selection based on economic criteria until such time as the deeper water installations become established.

Based on the technical advances in floating/moored wind energy converters and the depth limit at the edge of the study area (up to 200m), no upper water depth constraint has been applied to offshore wind. The technical resource both taking into account the 40 m depth limit, and with no depth limit has therefore been mapped. For the purposes of this SEA, the focus has been given to the potential for, and impacts of developing offshore wind water depths of up to 60m.

Table 8.3: Technical Constraints for Offshore Wind Energy Resource

Parameter	Constraining Threshold
Water depth m to chart datum (CD) approximately equivalent to Lowest Astronomical Tide (LAT): Existing monopile/ technology: Future jacket/tripod technology: Future moored/floating technology:	 10m – 40m 10m – 60m 60m – 200m
Annual Mean Wind Speed at 100m height a MSL (m/s)	> 7.0 m/s mean annual wind speed at 100 m height

Figure 8.1 demonstrates that the majority of the offshore study area within the boundary of the SEAI Wind Atlas has a mean annual wind speed of > 7 m/s and water depth >10 m, which satisfies the technical constraint criteria applied. When accounting for the available resource and lack of restrictions on water depth, a large area of technical wind energy resource is available for practical and accessible resource assessment.

8.5 Wave Energy Resource

8.5.1 Resource Overview

The wave climate of the west coast of the UK is dominated by the prevailing North Atlantic weather systems, and the Republic of Ireland is generally regarded as having the some of the best wave energy resource in Europe.

Power generation from wave energy is yet to be developed on a commercial scale and is still in an early stage of development compared with the offshore wind industry. The Irish government has targeted ocean energy as a key technology to diversify its electricity generating capacity. The Ocean Energy Development Unit (OEDU) has been established by the Irish government to implement this policy in a phased approach between 2006 and 2020. The Irish government through the MI and the SEAI have promoted wave energy development through the 1:4 scale open sea testing facility in Galway Bay (Galway Bay Test Site) for developers of pre-commercial scale prototype devices. Further wave technology research and development (R&D) by other developers is planned at the full scale text site which is currently being developed off Belmullet in County Mayo.

This SEA draws wave resource data provided as outputs of the Accessible Wave Energy Atlas that was mapped the Irish coastal wave resource in detail. Also, for areas outside the Wave Energy Atlas study area, the SEA has drawn on the UK's MRA that provides estimates of wave resource adjacent to any data gap areas.

The project is aware of more recent detailed estimations of wave resource around Ireland, which are still under development during 2010. These data are not yet available in the public domain and therefore have not been used in this assessment.

8.5.2 Data Sources

The following data sources have been used to establish the wave resource in the study area:

- Accessible Wave Energy Resource Atlas Ireland, (Irish Marine Institute or, IMI, 2005)
- UK Marine Resource Atlas, (BERR, 2008)

8.5.2.1 Accessible Wave Energy Resource Atlas Ireland 2005

The accessible Wave Energy Resource Atlas of Ireland was published in 2005 with the aim of providing a comprehensive assessment of wave power potential in the waters off the Republic of Ireland. The report states that the bulk of the annual incident wave energy arriving on the Atlantic Irish coast approaches from sectors of 240° to 300°, with 270° predominating. There is little seasonal difference in directionality. The same report makes reference to the Irish Sea wave climate, demonstrating that swell arrives from all directions but predominantly from the south-west. The Irish Sea coast of Ireland is sheltered from the north Atlantic swell, and generally exhibits north-south directionality, influenced by the prevailing tidal streams and fetch.

The wave atlas assessment was based on a combination of the widely used National Ocean and Atmospheric Administration model, WAM (Wave Analysis Model), and measurements from six recording buoys around the Irish coast, which provided outputs as wave power and significant wave height contoured around the coast of Ireland.

8.5.2.2 UK Marine Resource Atlas

The MRA atlas provides the only publicly available predicted wave resource data for the UK continental shelf (UKCS). The MRA provides wave power and significant wave height (Hs) as outputs from the Met Office UK Waters wave model for wind and wave. The Met office Wave model describes the offshore wave resource across the entire UK continental shelf at a resolution of 12 km. However, similarly with the MRA wind resource outputs, there are nearshore limitations due to resolution and the transformation of deepwater offshore waves to towards shallower nearshore areas.

MRA GIS data files of wind resource is freely available for download (BERR, 2008), and have been used in this SEA.

8.5.3 Theoretical Wave Energy Resource

The parameter used to evaluate theoretical resource is mean annual wave power in kilowatts per metre of wave crest (kW/m). Unconstrained theoretical wave power for the majority of the study area is presented in Figure 8.2.

Figure 8.2 demonstrates that the wave energy resource varies considerably within the study area. In shallow nearshore areas, less than 10km from the coast, wave resource varies from low resource of 0-10 kW/m in the Irish Sea to 40-50 kW/m at the tip of the Dingle Peninsula in the southwest. The coast of County Kerry in the northwest also sees high wave resource in the 40-50 kW/m range predicted in nearshore areas.

Wave energy resource generally increases with distance from land in marine areas that are exposed to the open waters, unconstrained by land. Due to general westerly track of low pressure systems across the North Atlantic, large magnitude waves are frequent in western Ireland. There is also a significant seasonality to the wave resource with winter seeing the largest magnitude waves across the year due to more intense depressions in the North Atlantic (MI, 2005).

The greatest wave energy resource within the study area is in the band of 60-70 kW/m, which is found at the western and southern boundaries of the study area.

8.5.4 Technical Wave Energy Resource

Technical constraints have been derived from the literature on available technologies, information from developers and feedback from the technical steering group, with threshold values presented in Table 8.4.

Table 8.4: Technical Constraints for Wave Energy Resource

Parameter	Constraining Threshold
Water depth m to chart datum (CD) approximately equivalent to Lowest Astronomical Tide (LAT)	10 m to 100 m
Mean annual wave power (kilowatts) per metre of wave crest (WC)	>20 kW/mWC*

*A minimum wave power of 15 kW/mWC was considered an appropriate threshold value. However, the Wave Atlas data provided was divided into 10 kw/mWC bins, therefore a minimum threshold of 20 kW/mWC was used.

Figure 8.2 presents the technical area that satisfies the criteria in Table 8.4 above. Due to the significant theoretical resource available and a wide water depth range that is submissible, large areas of wave resource are available for further evaluation with other baseline parameters. It can be seen that there is a gap in the theoretical wave resource data as the wave atlas assessment area does not cover the full SEA study area. Some technical wave resource areas have been included within this 'gap' area, as it is highly likely that wave power of >50 kW/mWC will occur here, due to its unconstrained position to the north Atlantic ocean.

8.6 Tidal Resource

8.6.1 Tidal Energy Overview

The capturing of tidal energy resources can broadly be divided into two types; tidal range and tidal stream. This SEA focuses on the potential availability of tidal streams, i.e. the energy that can be derived from the kinetic movement of water that result in tidal currents in the marine environment around Ireland.

Northwest Europe again benefits from its physical environment in terms of tidal energy availability. The semi-diurnal tidal wave propagates from the Atlantic onto the European continental shelf which increases the tidal range in coastal waters. The bathymetry, seabed composition and the configuration of the coastline in shelf basins and estuaries all affect the propagation of the tides, and many areas around Ireland and the UK can favourably generate strong tidal current flow patterns or tidal streams.

In 2004, the SEAI commissioned the "Tidal and marine current energy in Ireland" study, with the objective of characterising tidal resource potential in the marine area of the entire island of Ireland (SEAI, 2004). This collaborative project published its final report in December 2004, which informed the Irish Governments renewable energy policy, and provided the best available information and data for development of commercial tidal energy in Ireland.

Few examples of commercial scale energy generation from tidal stream technology exist. However, there is a burgeoning development and research base in Europe with world leading developers based in the UK and Ireland. The European Marine Energy Centre (EMEC) based at Orkney, Scotland provides a testing and research facility for wave and tidal developers. For tidal energy converters, so far four developers have secured testing permits at the Fall or Warness Tidal Test Site, with the first, Dublin based Open Hydro to successfully supply the UK electricity grid from their open centred turbine in 2006 (EMEC, 2010).

The most advanced test facility for tidal stream technology exists in Strangford Lough, Northern Ireland, where a single device horizontal axis turbine tidal stream converter (SeaGen) was installed in April 2008 in Strangford Narrows which connect Strangford Lough to the Irish Sea. Strangford Narrows experiences a high tidal current velocity, has a suitable water depth, and is relatively sheltered from adverse sea and weather conditions than the Irish Sea proper. The converter, is owned and operated by a subsidiary of Marine Current Turbines (MCT), and is rated at 1.2 MW. SeaGen delivers electricity to the grid, and is being tested over a five year period.

8.6.2 Data Sources

This SEA has made reference to the following sources of data:

- Tidal & Marine Current Energy Resource in Ireland, (SEAI 2004)
- Review of engineering & specialist support requirements for ocean energy sector, (SEAI 2009 B)
- UK Marine Resource Atlas, (BERR 2008)

8.6.2.1 <u>Tidal & Marine Current Energy Resource in Ireland Study</u>

A collaborative study was commissioned by the SEAI to assess tidal and marine current energy resource for coastal waters of the Republic of Ireland and Northern Ireland. The final report was published in December 2004 and was used to inform the Irish Government's policy on renewable energy.

The study provided detailed analysis of tidal energy resource around the Irish coastline using a combination of data analysis and numerical hydrodynamic models to provide:

- Estimated total energy potential for the assessment study area under varying resource scenarios i.e. theoretical, technical, etc.
- Evaluations of potential sites for arrays of first and second generation tidal energy converters, constrained by a variety of parameters including water depth, current speed.
- A financial analysis outputting potential tidal energy developer selling prices to assess financial return.

The SEAI report assessed in detail the tidal resource at 11 key sites around the entire coast of the island of Ireland; these are identified in Table 8.5 below.

From the SEAI 2004 and SEAI 2009 reports, only model output images of peak current flow on a spring tide have been used, as no geospatial data (GIS or model output) was available.

Table 8.5: Tidal Stream Energy Potential for Ireland based on SEAI, 2004

Site Name	Practical* Tidal Energy Resource (GWh/yr)	Viable*Tidal Energy Resource (GWh/yr)
Inishtrahull Sound	514	15
Lough Foyle	2	2
Codling & Arklow Banks	791	70
Tuskar Rock & Carnsore Point	420	177
Gascanane Sound	1	1
Dursey Sound	4	1
Shannon Estuary	367	111
Bulls Mouth & Achill Island	**6**	6

*Within the SEAI study, the following definitions of energy resource are given:

- **Practical Resource:** Technical resource limited by existing turbine support structure technology, water depth, sufficient current speed.
- **Viable Resource:** Practical resource limited by commercial constraints including development costs and market reward.

8.6.2.2 Review of Engineering & Specialist Support Requirements for Ocean Energy Sector

This study was commissioned by SEAI in 2009 (SEAI 2009 B), and focused on engineering challenges and opportunities related to ocean power technology development. Within an appendix of this report, a brief appraisal of tidal energy resources was provided, including a list of 'high current speed areas' which are presented in Figure 8.3:

- Inishtrahull Sound
- Carlingford Lough
- Codling and Arklow Banks
- Tuskar Rock and Carnsore Point
- Locally off the Heads on the south west coast
- The Shannon Estuary
- Entrance channels to Estuaries, e.g. Castlemaine Harbour, Achill Island, Ballysadare Bay, Lough Foyle

8.6.2.3 UK Marine Resource Atlas

The UK MRA revised edition, published in 2008, provides both mean spring and neap current flow for the entire UK continental shelf. The tidal parameters are based on prediction from the High Resolution Continental Shelf Model built and maintained by Proudman Oceanographic Laboratory (POL). This widely used hydrodynamic model has a grid cell resolution of 1.8 km. Although, MRA does not cover the Irish study area, it is a useful regional data set that allows for a visual comparison with the SEAI 2004 tidal model outputs.

8.6.3 Theoretical Tidal Energy Resource

Theoretical tidal energy resource is presented in Figure 8.3, which shows the regional model output of peak spring current speed from the SEAI 2004 study along with the highlighted areas of high current speed from the SEAI 2009 report.

Generally, the offshore area of Co. Wexford and Co. Wicklow, on the Irish Sea coast through the St Georges Channel, experiences high potential tidal energy resource, as does the northern offshore area of Co. Donegal in the Inishtrahull Sound. Several sea loughs including Lough Foyle and Carlingford Lough are areas of increased tidal current speed, as well as a number of tidal inlets and estuaries on the Atlantic western coast from Bulls Mouth in Co. Mayo down to Gascanane Sound offshore of Co. Cork.

8.6.4 Technical Tidal Energy Resource

The technical constraints considered in developing tidal power are presented in Table 8.6. Tidal energy converters typically require a minimum water depth of 20 m. An upper operating depth of 80 m has been set, to account for future technology developments that will allow converters to be sited in deeper areas, either in terms of fixed foundation or future floating structures.

Table 8.6: Technical Constraints for Tidal Energy Resource

Parameter	Constraining Threshold
Water depth m to chart datum (CD) approximately equivalent to Lowest Astronomical Tide (LAT)	20 – 80 m
Peak Spring Current Flow	>1.2 m/s

Due to the lack of vector data available for theoretical tidal resource, only a broad technical area has been defined matching the peak spring tide current speed contour of 1.2 m/s. Further digitisation of other current speed contours is problematic due to the image quality.

The bathymetry data used in the SEA provides good coverage at a regional scale across the study area. Detailed 'estuary-level' coverage of the 20m water depth minimum threshold contour is not well resolved in narrow and complex tidal inlets around the coast.

From the available datasets, two significant areas of technical tidal resource have been identified:

- Southern Irish Sea coast through the St Georges Channel, including Codling & Arklow Banks and Tuskar Rock & Carnsore Point
- Inishtrahull Sound

A number of other smaller areas where identified, as having sufficient current speed and water depth available. These sites are generally narrow complex tidal straits and estuaries:

- Lough Foyle
- Gascanane Sound
- Dursey Sound
- Shannon Estuary
- Bulls Mouth & Achill Island

The literature highlighted another two sites, based on high current speed only. These two additional sites are located at Ballysadare Bay, and Carlingford Lough and are illustrated on Figure 8.3. However, it should be noted that no analysis of sufficient water depth has been undertaken as this is below the resolution of the bathymetry data available.

8.7 Assessment Areas

The Assessment Areas are areas within the study area that have been identified as having greatest potential for future development. The identification of these areas is based on the following factors:

- The extent of the available resource (theoretical and technical) for offshore wind, wave and tidal based on the information presented in Chapter 8.
- Feedback from individual developers on current and possible future areas of interest for developments.
- Review of current development patterns taking into account technical feasibility of where development is likely to occur
- Operational parameters (offshore wind, wave and tidal) discussed in Chapter 7: Technologies and summarised below.

8.7.1 Consultation with Offshore Wind and Marine Renewable Energy Developers

Meetings were held with representatives of the National Offshore Wind Association of Ireland (NOW Ireland) and the Marine Renewables Industry Association (MRIA). The main focus for the meetings was to consult on the proposed division of the study area into 6 assessment areas and the allocation of resource development potential within each of these areas. Comments received on the initial resource areas that were presented were taken into account in the preparation of the final assessment areas used as the basis for the main assessment. This included agreement on the 100 km seaward limit for potential development within the timeframe of the SEA, consideration of commercial scale tidal projects only and the exclusion of wave from Assessment Area 3. The rationale for the selection of resource assessment areas is discussed in more detail below.

8.7.2 Identification of the Assessment Areas

The study area (defined in Chapter 1: Introduction) and illustrated in Figure 1.1 was divided into a total of six separate assessment areas (Table 8.7), the main purpose being to divide the study area into a number of smaller more manageable areas within which to undertake the assessment. The key factors used to define the location and extent of each assessment area were the location of offshore wind, wave and tidal resource as discussed in Chapter 8 and presented in Figures 8.1 – 8.3 and the development parameters and constraints associated with each of the technologies as discussed in Chapter 7. The assessment areas identified extend out to 100 km from the shore to reflect the current upper length limit of AC cable technology (i.e. for greater distances DC cables will be required, with converter stations on land to convert to AC).

Table 8.7: Assessment Areas

Assessment Area	Technology	Location
1	Wind	East Coast - North
2	Wind & Tidal	East Coast - South
3	Wind[1]	South Coast
4	Wind & Wave	West Coast - South
5	Wind & Wave	West Coast
5a	Tidal[2]	Shannon Estuary
6	Wind & Wave & Tidal	West Coast - North

Note 1: Wave is not considered in Assessment Area 3, as although there is some offshore technical resource here it was considered to be too far offshore for development within the timeframe of the SEA. It was decided to only consider wave in the more accessible near shore wave resource areas on the southwest, west and northwest coast where developer interest is predicted to be initially focussed (Assessment Areas 4, 5, 6).

Note 2: Only those areas of significant tidal resource suitable for the development of commercial tidal arrays were considered in the assessment. It is recognised that there are a number of smaller discrete areas of tidal resource around the Irish coast. However, due to their scale these areas were only considered to be more suitable for demonstration or test projects rather than full scale commercial developments. The exception to this is the Shannon Estuary where both developers and environmental authorities have indicated that there is interest in the development of a commercial scale tidal array in this area.

8.7.3 Operating Parameters

The operating/development parameters used to assist the identification of the potential resource within the study area are presented in Table 8.8 below.

Table 8.8: Operating Parameters

Development/Operating Parameters		Fixed Wind	Floating Wind	Tidal	Wave
Water Depth		10m to 60m	60m to 200m	20m to 80m	10m to 100m
Constraining Threshold		> 7.0 m/s mean annual wind speed at 100 m height	> 7.0 m/s mean annual wind speed at 100 m height	Peak Spring Current Flow >1.2 m/s	Mean annual wave power (kilowatts) per metre of wave crest (WC) >20 kW/mWC
Approximate MW/km^2		10	10	50	10
Average Turbine/Device Generating Capacity		5 MW	2.3 - 5 MW	1 MW	0.5 MW to 5 MW
Average Scale of Commercial Development	MW	300 MW	300 MW	50 MW	30 MW
	Km^2	30km^2	30km^2	1km^2	3km^2

Section 9: Baseline Environment

9 Baseline Environment

9.1 Introduction

The following chapter provides a description of the marine and coastal environment of Ireland with respect to the specific SEA topics listed in Chapter 1: Introduction. The information presented within this chapter is based purely on current available information and data sources. No additional survey or monitoring work has been undertaken as part of this SEA except for site visits undertaken as part of the seascape assessment.

Information presented within this chapter has been obtained from a range of different sources. These sources are listed below in respect to the relevant SEA topics. In addition to listed main data sources this chapter also provides a description of the current baseline conditions and characteristics (description of the baseline) and identifies key issues and future trends.

The information presented within this chapter has been used to inform the assessment of the individual assessment areas for offshore wind, wave and tidal (Chapter 11) and the assessment of cumulative effects associated with varying levels of development (Chapter 12).

9.2 Water and Soil (Sediment)

9.2.1 Bathymetry and Hydrography

9.2.1.1 Data Sources

- INFOMAR survey*
- Joint Irish Bathymetric Survey (JIBS) data
- UK Hydrographic Office (UKHO) digital data
- Hurrell et al 2003 - An Overview of the North Atlantic Oscillation
- General Bathymetric Chart of the Oceans (GEBCO) digital data set

*The Integrated Mapping for the Sustainable Development of Ireland's Marine Resource (INFOMAR) programme is Ireland's national marine mapping programme, run as a joint venture between the Geological Survey of Ireland and the Marine Institute. The programme is a successor to the Irish National Seabed Survey (INSS) and concentrates on creating a range of integrated mapping products of the physical, chemical and biological features of the seabed in the near-shore area. The survey includes bathymetric mapping of the seafloor, seabed sampling, sub bottom profiling, gravity and magnetic data acquisition, deep refraction seismic and high resolution shallow seismic data acquisition. A programme of research projects has added value by modelling and interpretation of the data. Bathymetric data is acquired and processed and made available to the UKHO for incorporation in Irish Charts. A generalised larger scale version of the data is also incorporated into the GEBCO data set. All outputs from INFOMAR are made available free over the web.

One aim of the INFOMAR project is to deliver a high resolution bathymetry data set, covering the continental shelf around Ireland. Large areas of the shelf remain un-mapped, particularly within the 200 m isobath. As the project proceeds, these data gaps will be filled, with priority being given to key Bays and offshore areas, drawn up from stakeholder consultation. The project is scheduled to complete priority areas by 2016 and map all Irish waters by 2026.

9.2.1.2 Background

Although the continental shelf west of Ireland and the Irish Designated Area extends out more than 1,000km in places, this review of data is limited to the seabed within the Celtic shelf area, out to the 200m contour. The offshore area discussed is bounded by the Irish coast and the 200 m isobath to the west and south of Ireland, and by the limit of the Irish designated area within the Irish Sea, extending north in to the Atlantic and south in to the Celtic Sea.

9.2.1.3 Baseline Description

Ireland is situated near the edge of the European continental shelf, beyond which lie the deep waters of the North Atlantic Ocean. The Celtic sea occurs to the south of Ireland, and the Irish Sea to the east.

Bathymetry is a key factor in the siting of marine devices, which will have optimal water depth ranges within which they can operate.

Generalised Depth contours for the Irish shelf are shown in Figure 9.2.1. The area within the 200 m contour to the west and south of Ireland covers approximately 200,000 km^2, forming a portion of Ireland's even larger seabed territory of approximately 900,000 km^2. Almost two thirds of this area is more than 100 m deep. Off the north-west and south-west coasts of Ireland the coastal shelf edge approaches to within 30 km and 60 km respectively, and extends approximately 170 km west of the Galway Bay coast. The Celtic shelf extends approximately 300 km from the southern tip of Ireland, where the Labadie bank and Great Sole Bank occur. Water depths within the Irish designated waters within the Irish Sea are up to approximately 170 m.

The continental shelf around Ireland forms a area of generally low angle sea floor (approximately 1°) above the 200 m isobath, with local areas of higher relief associated with bedrock outcrop and bedforms in the vicinity of the coast. The continental slope and coastal shelf edge occurs oceanwards of the 200 m depth contour, with sea floor angles of between 3° and 6°.

The region’s oceanography is complex with highly variable water masses with distinct characteristics interacting and mixing. The Gulf Stream forms part of the main circulation cycle of surface water in the North Atlantic Ocean, moving heat from the equator to the Arctic. The North Atlantic Drift (NAD) is the broad, northward flow of surface waters that replaces the sinking waters in the North Atlantic polar seas. Further division of the NAD takes place, moving this water around Ireland and Britain. The impact of the NAD on Ireland's shelf waters and atmosphere is to maintain much warmer conditions that would be expected for its northerly position (i.e. at approximately 51° 30' N-55° 30' N, on a parallel with southern arctic Canada). It increases the biological productivity and biodiversity of Irish marine environments and helps reduce atmospheric temperature extremes over land, with winter-summer temperature differences of only approximately 10°C.

Ireland has a variable climate and experiences some of the harshest metocean conditions in the world. It is exposed to the full force of Atlantic storms with predominant winds from the west and southwest. Present Atlantic wave action produces high-energy conditions on the Irish shelf with maximum significant wave heights (Hmax) of 15-20 m (50 yr return period). Over the middle and high latitudes of the Northern Hemisphere, the most prominent and recurrent pattern of atmospheric variability is the North Atlantic Oscillation (NAO). The NAO is a large scale fluctuation in atmospheric mass between the subtropical high and the polar low. A positive NAO index phase shows a strong subtropical high and a deep Icelandic low. The high differential pressures result in more and stronger winter storms crossing the Atlantic. A negative NAO index phase shows a weak subtropical high and a weak Icelandic low, resulting in fewer and weaker winter storms. Though the NAO index varies from year to year, it also tends to remain in one phase for several years at a time.

The Irish Sea lies to the east of Ireland and is one of the smaller regional seas, about 58,000 km2 in area. It has the form of a fairly shallow basin, with depths ranging from 20-135m. It is connected with the Atlantic Ocean via the North Channel to the north and to the Celtic Sea via the St George's Channel in the south. The water masses of the region have different origins and distinguishable temperature and salinity characteristics. Due to Ireland's protecting effect, wave-energy in the Irish Sea is only approximately 20% of that on the Atlantic coasts.

There is a wide range of tidal current strength around the coast and tidal ranges vary from around 1.75 metres on the south east coast of Ireland and average 4.5 metres on the west coast. Tidal currents are the dominant factor influencing sediment transport, bedrock exposure and sedimentary bedforms and are particularly prevalent in relatively shallow water in the vicinity of headlands, islands and bay environments.

Throughout most of the region tidal mixing is sufficiently intense to ensure that the water column remains well mixed throughout the year, however, during summer months water column stratification occurs off the west coast. Near to estuaries the water column can stratify because fresh water is less dense than saline water. Stratification generally occurs at neap tides, when the weather is calm and when river discharges are large. Once the water column has stratified surface to bed temperature differences can also occur in summer. Compared to estuaries, the study of bay environmental fluxes and dynamics, factors such as tidal and current flushing, fluvial influence, sedimentation, and seasonal thermal and haline stratification events, is often poor. When a seasonal thermal and/or haline stratification event does occur, such as when normal current-driven mixing processes collapse, the bay water column is divided into a warm, brackish surface-water component and a cold, more saline (more dense) bottom-water component. Reduced exchange and mixing across the interface between the two components limits, or prevents, vertical mixing and dilution.

The movement of the water and the amount of mixing prescribe physical effects, such as forces on structures and the movement and dispersion of contaminants, but also significantly influence biogeochemical processes including sediment erosion / deposition and movement, particularly of suspended sediment, benthic exchanges and primary productivity (via stratification, nutrient exchanges and light levels).

9.2.2 Geology, Geomorphology and Sediment Processes

9.2.2.1 Data Sources

- INFOMAR survey (GSI & MI)
- Petroleum Affairs Division (DCENR)
- Joint Irish Bathymetric Survey (JIBS) data
- The Geology of the Malin - Hebrides sea area; The geology of the Irish Sea (BGS UK Offshore Regional Reports)
- British Geological Survey (BGS) chart and digital data
- The Encyclopaedia of Ireland, Coastal and Marine Theme Articles

9.2.2.2 Background

Although the continental shelf west of Ireland extends out more than 1000km in places, this review of data is limited to the seabed within the Celtic shelf area, out to the 200m contour. The offshore area discussed is bounded by the Irish coast and the 200 m isobath to the west and south of Ireland, and by the limit of the Irish designated area within the Irish Sea, extending north in to the Atlantic and south in to the Celtic Sea.

9.2.2.3 Baseline Description

An overview of the seabed sediment characteristics in the study area is given in Figure 9.2.2b.

Seabed sediments, and the marine sedimentary processes of erosion, transport and deposition that control their distribution, character and thickness, are highly relevant to the design and siting of seabed/ near-seabed renewable energy installations. The current seabed landscape is a relict of the underlying bedrock geology and the actions of several glacial periods when large volumes of material were eroded from the shelf and land masses and deposited on the shelf and at the shelf edge and also over the continental slope. The morphology and distribution of surficial sediments in the region has resulted largely from glacial deposition/ scour processes combined with reworking and redeposition as a result of riverine input and tidal processes.

The geological environment can be divided according to main groupings of material, based on age and geological processes:

- Bedrock geology - these are rocks older than 1.8 million years old formed before the last ice ages.
- Drift (Quaternary) geology - these are rocks and semi-consolidated material deposited since the start of the last ice age and are from 1.8 million to 10,000 years old
- Seabed Sediments - these represent the youngest materials and formed from reworking of either the solid or Quaternary material, river inputs of sediments or the creation of new material such as biogenic shells

Excluding offshore islands, the total length of Ireland's coastline is approximately 7,500 kilometres. Its wide diversity of constituent rock types and sediments gives rise to an extensive variety of scenic landscapes. The rock/ sediment types that make up the coast are variably susceptible to erosion. Rock-dominated coasts (total c.3000km) are the least vulnerable. Coastal features associated with rock-erosion include steep cliffs (e.g. Cliffs of Moher, Co. Clare, the sea cliffs at Slieve League, Co. Donegal), headlands and Bays (e.g., Galley Head, Co. Cork), sea-stacks, arches and caves (e.g., Co. Waterford). Coasts most vulnerable to erosion are those composed of unconsolidated (soft) sediments (total c.3500km), comprising glacial sediments, sandy beaches (c.1000km), sand and gravel barriers, dunes and machair. These coastal sediments are most common on Ireland's eastern and southern coasts, but occur as more isolated areas on western and northern coasts (e.g., Inch and Clew Bay). The coast of Ireland is exposed to different degrees of wave energy and Ireland's Atlantic seaboard is subject to high wave energy with breaking swell waves on Atlantic coasts reaching heights of up to 3m and storm waves of over 10m. This gives rise to spectacular cliffs, islands, rocky shores and storm beaches. On the south and east coasts the wave energy is lower and the coastal landscapes are generally softer, with many stretches of sand dunes, shingle and estuarine mud. All around the coast are geological sections and landforms of scientific importance and natural aesthetic value.

The onshore geology of Ireland is very diverse in both age and rocktype and many of the rock units found onshore are also present offshore. Onshore the upland areas are generally dominated by older, more indurated sedimentary or igneous and metamorphic rocks that are relatively resistant to erosion. Onshore rock units may extend several kilometres offshore from the coastal areas. Offshore geology is shown in Figure 9.2.1c.

The present day overall morphology of the eastern Atlantic margin largely results from rifting activities during the Mesozoic which resulted in the formation of the North Atlantic Ocean. Ireland's continental shelf is part of the seismically quiet (passive) Northwest European shelf. The shelf formation began c.100 million years ago, with the development of the North Atlantic under the action of continental drift. Over time the igneous crustal rocks underlying the shelf have been overlain by thick sequences of sedimentary rocks, many accumulating in rifted basins. These structural troughs linked to the ocean spreading underlie the shelf to the south and west of Ireland and in some cases have been proven to contain oil and gas. The sediment accumulations were largely eroded to their current level by subsequent sea level fluctuations and still stand, forming the broad “bench” that is the inner continental shelf. Later palaeovalley systems formed at times of low sea level (sea levels periodically falling by >100m), particularly during the Ice Age (the Pleistocene), cut deep canyons across the shelf. Many of these palaeovalleys are co-incident with earlier deep geological structures.

The modern sedimentary regime is dominated by sediment reworking and redistribution by wave action and strong tidal currents. Locally, the degree to which these processes impinge upon the seabed is reflected in the seabed substrates and bedforms present. Bathymetric and shallow surveys show that river channels (e.g., from Dingle Bay, Lee, Blackwater, Barrow and Suir rivers in Ireland) probably connect into the palaeovalleys. The Shamrock and Whittard major canyons lie to the south of Ireland, with smaller canyons, channels and notches found northwards along the Irish shelf margin (e.g., the Gollum Channel,). Sediment fans (>1-2km thick) accumulate at the ocean ends of some of these canyons, as well as independently along the shelf edge (e.g., the Donegal and Barra Fans).

Rocks of the Carboniferous - Devonian Periods form a basement within the Irish Sea. Six main depositional basins within the Irish Sea contain variable thicknesses of sedimentary rocks (3-6km thick) dating from the Upper Palaeozoic to the present. Igneous rocks of a wide age range also occur extensively. Seafloor sediments comprise a relatively thin (3-60m) and very varied cover of glacial and marine sands, gravels and muds. The Sea has a variable patchy 'rim' of exposed bedrock, fine-muddy sediments and sands, with sands and gravel areas developed in deeper water. Concentrations of sands and gravels are also seen closer inshore (e.g., the Codling Bank). Sediment reworking and redistribution by often strong near bottom currents and gravity-driven processes characterise the modern sedimentary regime.

Estuaries in Ireland include the Liffey (Dublin Bay), Lee (Cork Harbour), Slaney (Wexford Harbour), Nore/Barrow/Suir (Waterford Harbour), Shannon (incl. Fergus/Maigue/Deel Estuaries), Corrib (Galway Bay) and Moy (Killala Bay). Within an estuarine environment tidal influence may extend several kilometres inland. Estuaries generally include a main waterway and conjoined river mouth, plus a number of creeks and other small inlets, rivers and streams that lead into the main waterway. Where high-energy environments occur at the mouths of estuaries, due to wave and weather influences, or internally due to restrictions on flow, the seabed and intertidal areas consist predominantly of bedrock, coarse boulder or pebble deposits, with some finer sediment (sand) beaches. Where lower energy environments prevail, high sediment inputs give rise to extensive intertidal sedimentary mud flats and saltmarshes in near-shore regions adjacent to estuaries and subtidal mud and silt deposits further offshore. Lower energy environments upstream are associated with extensive fringing areas of subtidal mud and intertidal mud banks, particularly in very sheltered environments.

Ireland’s numerous bays include Dundalk, Dublin, Wexford, Youghal, Roaringwater, Dunmanus, Bantry, Kenmare River, Dingle, Tralee, Galway, Kilkieran, Killary Harbour, Clew, Blacksod, Killala, Sligo, Donegal and Gweebarra. The general characteristics of bay environments are a relatively wide sea area with a shallow near-shore area (which may extend up to several kilometres offshore), and maybe also a shallow offshore area. Rivers, estuaries, streams and other watercourses drain into the bay. There are seasonal fluvial inputs of freshwater, with accompanying loads of terrigenous sediments as well as natural and anthropogenic nutrients. Some of the bays off the south and west coast, represent former river valleys, and are relatively deep and show an elongate form.

Surface sediments form a thin layer (average 1m-30m) of mainly fine materials (sand sizes) over the shelf. The BGS seabed sediment data set extends throughout the Irish Sea and out onto the Celtic Shelf, based on wide spaced sampling. UKHO charts also identify sediment type from manual depth soundings and widespaced sampling. Seabed sediments have also been characterised as part of the INFOMAR survey, although this data is limited to priority bays and from the INSS for an area off the south west coast of Ireland, extending out to the 200 m depth contour. The INFOMAR/INSS seabed sediment maps are based on supervised classification of multibeam mapping coverage, validated with groundtruth sampling. In a very general sense, sediments within the central Irish Sea area are generally muddy and sandy becoming more gravelly towards the south. The northern part of the Irish Sea contains an extensive area of very fine sediments, the Dundalk Mud Belt, where fine material comes out of suspension due to very low currents. Sand, shelly sand and gravel substrate predominate within the Celtic Sea. Large areas of bedrock also occur, generally in the vicinity of headlands where the seafloor is swept clear by wind-wave and tidal current action. Bedrock has been mapped during the INFOMAR project, up to 30 km off the Kerry coast and along the SE coast, and extensively off Malin head as part of the JIBS project. Finer sandy and muddy sediments with intermittent bedrock and glacial till has been mapped in the bay areas, including Donegal Bay. Sand and gravel predominate further offshore. Coarse sediment is mapped north of Donegal with patches of mixed sediment, sand and mud.

9.2.3 *Water and Sediment Quality*

9.2.3.1 Data Sources

Available water and associated environmental quality data include:

- Ireland's Marine and Coastal Areas and Adjacent Seas: An Environmental Assessment (MI 1999)
- Reports on contaminant concentrations in shellfish and fish from Irish waters (MI 2002, 2003, 2004, 2005, 2006)
- A Review of the Contaminant Status of the Irish Sea (CEFAS 2005).
- Quality Status Report 2000 Region III Celtic Seas, Chapter 4, Chemistry (OSPAR 2000)
- Irelands Environment 2008, Chapter 9, Estuarine and Coastal Waters (EPA 2008)
- Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters (MI 2006)

9.2.3.2 Background

The sediment and water quality around the Irish coastline are generally good. The chemistry of both reflects a combination of the oceanography of the waters around Ireland, the patterns of settlement and land use within Ireland and inputs from the UK.

9.2.3.3 Baseline Description

Water Quality

In general the water quality around the Irish coastline is good, reflecting a lack of contaminant sources. As is the case elsewhere in the world ocean, the shelf break (approximately the 200m depth contour) marks a discontinuity between oceanic and coastal waters, largely due to trapping of lower salinity water but also as a result of sediment water exchanges in the more shallow environment. Thus many dissolved constituents show a marked increase between oceanic and shelf waters.

There is little evidence for elevated nutrient levels or anthropogenic perturbations in nutrient ratios in Irish coastal or offshore waters (EPA 2008), where the nutrient regime is dominated by the influence of Atlantic sourced water. However, based on the most recent water quality report (EPA 2008), eutrophication (over supply of nutrients, leading to low oxygen levels) is a potential problem in the inner waters of some estuaries, particularly those of the southern and eastern coasts. . Inshore waters with restricted exchange with seawater are sensitive to any removal of oxygen from the water. Further restriction of such waters may result in increases of nutrients (leading to increased blooms with subsequent crashes, which remove oxygen) and warming of restricted shallow waters (decreasing oxygen solubility), both of which contribute to oxygen depletion or, at worst, anoxic conditions.

The quality of the immediate coastal waters (Figure 9.2.3), as indicated by bathing water quality (EPA 2010), reflects local inputs, failure to reach "good" status being largely due to excedence of microbiological standards. Between 102 and 119 bathing beaches, out of a total of 131, were rated as good during the period 2003 to 2009. The highest failure rate during this period was for beaches in the vicinity of Dublin. As a further demonstration of the high quality of Irish coastal waters analyses of indicator species such as fish and shellfish confirm that contamination from metals and halogenated hydrocarbons (which are concentrated by many species) is not a significant issue (EPA 2008)

Concentrations of heavy metals are generally within the expected ranges for essentially natural coastal waters. Concentrations of some metals are elevated in waters receiving the outflow from the Avoca mines, on the south-eastern coast of Ireland, and it is believed that this may represent the largest input of copper and zinc to Irish coastal waters (MI 1999). Freshwater (river-end member) concentrations of copper and zinc in the Avoca River can be as high as 50µgl-1 and 500µgl-1 respectively. However, these concentrations are not unusual in rivers draining mining areas.

There is also some evidence for elevated, probably natural, inputs of copper to the waters of Galway Bay (Knight et. al., 2005). In fully marine Atlantic surface waters to the west of Ireland (salinity >35.5) dissolved copper concentrations are about 0.06µgl 1, increasing to around 1µgl 1 in the lower salinity (around 32) waters of the Irish Sea. Dissolved zinc concentrations range from less than 0.1 to around 2.2µgl 1 over the same salinity range. Dissolved cadmium and lead show similar behaviour, with concentrations up to 0.08µgl 1 and 0.18µgl 1 respectively in the Irish Sea.

There is some evidence for elevated concentrations of mercury in the waters of the more industrialised regions (Dublin Bay, Waterford and Cork Harbours, the Shannon and Boyle estuaries) (MI 1999). However, the concentrations at the time of the report were not sufficiently high to give rise to concern.

Dissolved organic contaminants in the waters of Ireland are not considered to be present at concentrations sufficient to cause concern. The highest concentrations are expected to be in the Irish Sea, reflecting industrial inputs.

Dissolved artificial radionuclides are monitored routinely in the Irish sector of the Irish Sea, in order to establish whether there are any public health issues for Ireland arising from discharges from Sellafield. While the presence of dissolved anthropogenic radionuclides is detectable, concentrations are considerably below the natural background radiation of seawater (13.7Bql-1, mainly due to the presence of potassium 40). In 2007 caesium 137 concentrations ranged from 0.009-0.024Bql¬ 1 and technicium 99 concentrations ranged from 0.003-0.016Bql 1 (RPII 2008).

Sediment Quality and Contamination

Many substances present in the marine environment have a strong association with particulate material, either through the formation of insoluble compounds or by adsorption onto existing particles. These substances will be found at relatively high concentrations in marine sediments relative to the overlying water. This enrichment is increased in sediments with a high proportion of clay minerals and organic material. Much of the available data for Irish sediment quality has been obtained from harbours prior to dredging operations. These are likely to receive waste from both vessels and shore facilities, including industrial sites; hence contaminant concentrations would be expected to be greater than elsewhere.

Only harbour waste (rock and dredged sediments) can currently be legally disposed of at sea in Irish waters (Dumping at Sea Acts 1996 and 2004). Disposal sites around the coast of Ireland are shown in Figure 9.6.2. There was also a sewage sludge disposal site off Dublin (Figure 9.6.2); however, this was closed in 1996. In view of the active nature of the seabed in this area any material is likely to have been dispersed since. Similarly marine disposal of fish waste was discontinued in 2004.

Heavy Metals

Data for metals in sediments from the Porcupine Sea Bight (DCENR 2007) and from the Corrib Gas Field (DCENR 2008), mainly from cores obtained from water depths greater than 200m, indicate that sediments to the west of Ireland are unlikely to have been subject to significant anthropogenic influences outside the immediate coastal area. Data for the metals in sediments from the central Irish Sea (MI 1999) indicates that concentrations are close to natural levels although there is some evidence of anthropogenic influences. Sediments within harbours and ports (Appendix B Sediment and Water Quality and Contamination) generally have higher than background metal concentrations, but are rarely at levels high enough to cause concern.

Organo-tin (TBT, DBT), used in anti-fouling paints, is a persistent sediment contaminant, with imposex in prosobranch molluscs (indicative of organ-tin contamination) observed in a number of harbours (e.g. Cork, Bantry, Killybegs). Organo-tin compounds were banned for use in Ireland initially, from 1987, on boats under 25m in length (Minchin 2003) but subsequently, from 2008, for all vessels (IMO 2001).

Radionuclides

Radionuclide contamination in the sediments of the Irish Sea and adjacent waters have been studied extensively in order to establish whether there is a potential for harm to humans resulting from discharges from nuclear installations, particularly Sellafield, to the Irish Sea (CEFAS 2005, RPII 2008). The RPII studies state that there is no environmental or human risk resulting from these discharges of radioactive materials.

Discharges from Sellafield enter the eastern Irish Sea, and are transported northwards, through the North Channel, either in dissolved (e.g.Caesium-137) or particulate form (e.g. Plutonium and Americium isotopes). In both cases there is a sedimentary reservoir, but Caesium is readily released, while Plutonium and Americium are strongly associated with solid particles.

Elevated levels of artificial radionuclides are largely restricted to the eastern sector of the Irish Sea, in the immediate vicinity of Sellafield. However, there are also relatively high concentrations in sediments from the deeper waters between Ireland and the Isle of Man. This is a result of the depositional environment in the basin between the Isle of Man and the Irish coastline which results in a relatively high proportion of fine material in the sediment.

Munitions

Military waste may be present on the sea bed as a result of:

- Intentional disposal (official and unofficial).
- Live firing ranges and naval exercise areas.
- Wrecks of military vessels and some merchant ships.
- Minefields.
- Migration from the original deposition site.

The distribution and density of exploded and unexploded munitions ('explosive ordnance') on the sea bed varies depending on the history of the area – for example whether it has been used for warfare, naval training, disposal or weapons testing (Crown Estate 2006).

There is one known munitions dump site within Irish waters (55.5˚N 11˚W, in the Rockall Trough, OSPAR 2005). The munitions were contained in a scuttled ship and are unlikely to be of significance to the current study area. The deep water trough between Northern Ireland and south-west Scotland (Beaufort's Dyke) was used as a dumping ground for military munitions between World War II and the 1970's. During this period approximately 1,000,000 tonnes all types of munitions, including 14,500 tonnes of phosgene artillery shells and possibly fuses and detonators, were deposited. While the dumping site itself is outside the study area there is a potential (albeit small) risk of material migrating from the site. In a survey undertaken by the British Geological Survey (BGS) in the Beaufort's Dyke area between 1992 and 2004, seven underwater explosions were detected by the BGS seismograph network within 100 km of the Beaufort's Dyke munitions dumpsite. Over the period 2004 – 2005 there were five explosions detected by the BGS (Nixon 2009).

It should also be noted that under the munitions encounter reporting to OSPAR, the number found in Irish waters is low in comparison to the rest of the North Sea area (Nixon 2009).

Throughout the study area there is a possibility of encountering munitions associated with wartime wrecks, both of military and merchant vessels and of military aircraft (irishwrecksonline 2010). The greatest risk is from direct disturbance of intact wrecks; however, munitions may have been thrown clear of the vessel as it sank, or may become exposed as the wrecks gradually break up. While munitions during transport (including storage in ships' magazines) are inherently safer than those which have been armed but failed to detonate (e.g. unexploded bombs in aircraft or shells retained in guns when a vessel sank), they may still constitute a hazard (Qinetic 2007).

9.2.3.4 <u>Key Issues and Future Trends</u>

As a result of relatively small population and limited industrial pressure around a large proportion of the coast of Ireland, water and sediment quality in certain areas close to the shoreline and beyond the immediate coastline of Ireland is good, remaining close to natural background levels in most areas. However, longer term industrial inputs the Irish Sea have resulted in heavy contamination of the offshore area. However, inputs to the Irish Sea have been decreasing over the past few decades.

Provision of sewage treatment has increased over recent years bringing consequent improvements in inshore water quality. Marine fish farming has expanded in extent and economic value, but has been managed and controlled to minimise its impact. However; the combination of these inputs with coastal engineering works is likely to lead to an increased tendency to eutrophication. The Environmental Protection Agency (EPA) is currently managing estuarine and coastal waters through River Basin Management Plans to achieve good ecological status by 2015, as required under the Water Framework Directive (WFD), and to ensure no deterioration in water quality.

9.3 Biodiversity, Flora and Fauna

9.3.1 Protected Sites

9.3.1.1 Data Sources

In assessing protected sites within the study area, the following data sources have been used:

- UNESCO - World Heritage Sites & Biosphere Reserves
- National Parks & Wildlife Service (NPWS) - Existing and proposed protected sites
- Department of the Environment, Heritage and Local Government
- What is the Future for Marine Protected Areas in Irish Waters? (Johnson et al 2008)
- Report to the Irish Shelf Petroleum Studies Group (Hartley Anderson Ltd. 2005)

9.3.1.2 Background

The coasts and seas around Ireland support a great diversity of marine wildlife and habitats. In recognition of this fact, a large part of the coastline is protected under a range of national, European and International legislation. The existing coastal and marine protected sites in the study area are show in Figure 9.3.1.

9.3.1.3 Baseline Description

International Sites

The following sites, designated under worldwide International legislation are to be found in Ireland:

- World Network of Biosphere Reserves
- Ramsar sites
- OSPAR Marine Protected Areas (MPAs)
- Natura 2000 sites

There are currently two Biosphere Reserves in Ireland:

- North Bull Island (Dublin Bay)
- Killarney (SW Ireland)

Bull Island is home at various times to 8,000 wild fowl and 26,000 waders with up to 180 different bird species having been recorded. The site is of particular conservation interest due to its well developed salt marshes and dune system and is also designated as a Ramsar site.

The Killarney Biosphere reserve (and National Park) comprises the mountains and woodlands surrounding Lough Leane Lake and adjacent smaller lakes, moorlands, parks and gardens. The site is important as it represents one of the most extensive areas of natural woodland in the country.

Ramsar Sites

Ramsar sites were originally intended to protect sites of importance for wildfowl habitat, but now this designation can be applied to a site which qualifies under any aspect of wetland conservation. The Convention on Wetlands (Ramsar, Iran, 1971) recognises that wetlands are extremely important for biodiversity conservation in general and for the well-being of human communities. There are a total of 45 Ramsar sites within Ireland, and 22 sites with a coastal component located in the study area.

OSPAR Marine Protected Areas

The OSPAR Commission in 2003 adopted recommendation 2003/3 which has the purpose to establish the OSPAR Network of Marine Protected Areas (MPAs) and to ensure that by 2010 it is an ecologically coherent network of well-managed marine protected areas.

Ireland's coastal and marine waters have an abundance of sensitive and important species, and to date there are 19 formally designated OSPAR MPAs.

Table 9.3.1a Marine Protected Areas in Ireland

Name of MPA	OSPAR Qualifying Feature
Ballyness Bay MPA	Intertidal mudflats
Belgica Mound Province MPA	*Lophelia pertusa* reefs
Blasket Islands MPA	*Phoecena phoecena*
Cummeen Strand/Drumcliff Bay (Sligo Bay) MPA	Intertidal mudflats
Dundalk Bay MPA	Intertidal mudflats
Galway Bay Complex MPA	Intertidal mudflats Maerl beds
Hovland Mound Province MPA	*Lophelia pertusa* reefs
Kenmare River MPA	Maerl beds Zostera beds
Kilkieran Bay and Islands MPA	Maerl beds Zostera beds
Kingstown Bay MPA	Maerl beds Zostera beds
Malahide Estuary MPA	Zostera beds
Mullet/Blacksod Bay Complex MPA	Intertidal mudflats Maerl beds Zostera beds
Mulroy Bay MPA	Maerl beds Zostera beds
North Dublin Bay MPA	Intertidal mudflats
North West Porcupine Bank MPA	*Lophelia pertusa* reefs
Roaringwater Bay and Islands MPA	Maerl beds Zostera beds *Phoecena phoecena*
South West Porcupine Bank MPA	*Lophelia pertusa* reefs
Tralee Bay & Magharees Peninsula, West to Cloghane MPA	Intertidal mudflats Zostera beds
Tramore Dunes and Backstrand MPA	Intertidal mudflats Zostera beds

There are many additional coastal SACs as well as four designated offshore marine SACs which in due course could also be declared as OSPAR MPAs. The offshore SACs (Belgica Mound, Hovland Mound, NW Porcupine Bank and SW Porcupine Bank) fall outside of the study area (beyond 200m) but have been included for completeness and are also shown in Figure 9.3.1.

Natura 2000 Sites

The following Natura 2000 sites, designated under European legislation are to be found in Ireland:

- Special Areas of Conservation (SAC)
- Special Protection Areas (SPA)

Natura 2000 is a European network of protected sites which represent areas of the highest value for natural habitats and species of plants and animals which are rare, endangered or vulnerable in the European Community. As part of the designation, Member States are required to ensure that appropriate steps are taken to avoid the deterioration of habitats, and habitats of species, as well as significant disturbance of the species. The Conservation Objectives safeguard the habitats of the site, the range, numbers and supporting habitats of the qualifying species.

There are currently 136 SACs and 93 SPAs with coastal and marine aspects in Ireland. The majority of these are to be found along the west coast, which can be seen in Figure 9.3.1.

National Sites

The following sites, designated under National legislation are to be found in Ireland:

- Marine Nature Reserve (MNR)
- National Nature Reserves (NNR)
- Natural Heritage Areas (NHAs)
- Potential Natural Heritage Areas (pNHAs)
- National Parks

Marine Nature Reserves (MNRs) are designated to conserve marine flora and fauna and geological features of special interest. Lough Hyne MNR was set up under the Nature Reserve (Lough Hyne) Establishment Order, 1981 (Figure 9.3.1). This site is extremely important for marine and coastal habitats and species.

National Nature Reserves (NNRs) are selected on the basis of best examples of wildlife, habitats and geology and are protected under Ministerial order. Most are owned by the State, however some are owned by organisations or private landowners.

Natural Heritage Areas (NHAs) this is the basic designation for wildlife under the Wildlife Amendment Act (2000) and covers areas that are considered to be important for the habitats present or which holds species of plants and animals whose habitat needs protection and there are currently 16 sites with coastal and marine aspects designated in Ireland

Potential Natural Heritage Areas (pNHAs) these sites are of significance for wildlife and habitats and have the potential to become designates sites under the Wildlife Amendment Act (2000). They were published on a non-statutory basis in 1995, but have not yet been statutorily proposed or designated. Designation will proceed on a phased basis over the coming years and there are currently 247 sites with coastal and marine aspects proposed for designation in Ireland

National Parks In 1969, the International Union for the Conservation of Nature (IUCN) recommended that all governments agree to reserve the term 'National Park' for areas that have not been materially altered by human exploitation and occupation and where species, geomorphological sites and habitats are of special scientific, educational and recreational interest or which contain a natural landscape of great beauty. There are six National Parks in Ireland, all with coastal elements; Wicklow Mountains National Park (Co. Wicklow), Killarney National Park (Co. Kerry), The Burren National Park (Co. Clare), Connemara National Park (Co. Galway), Ballycroy National Park (Co. Mayo) and Glenveagh National Park (Co. Donegal).

An overview of all the protected sites to be found in the study area is shown in Figure 9.3.1 with the exception of the NNRs and National Parks, as there is currently no data available for mapping. However most of these sites will be covered by the locations of the SACs and SPAs.

A table showing all designated sites can be found in Appendix C Summary of Protected Sites in the Study Area.

9.3.1.4 Future Trends

The possibility of extending existing coastal SACs and SPAs into offshore areas and designating them as OSPAR MPAs, would need to be considered as Ireland works towards its part in creating the effective global MPA network that is required by 2012 under both the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro and the 2002 UN World Summit on Sustainable Development in Johannesburg (Johnson et al 2008).

The SAC and SPA designation process in Ireland is ongoing and further sites are expected in both the coastal and offshore areas. It is also envisaged that Natural Heritage Areas in the marine environment will be considered in the future (pers coms, NPWS Feb 2010).

9.3.2 Benthic Ecology

9.3.2.1 Data Sources

In assessing benthic ecology within the study area, the following data sources have been reviewed:

- Mapping European Seabed Habitats (MESH) Project. GIS maps
- NPWS Conservation Status Assessments of Habitats and Species listed under the Habitats Directive (Submitted in 2007)
- The Status of EU Protected Habitats and Species in Ireland (2008). NPWS publication.
- Boelens et al. (1999). Marine Institute Quality Status Report - Ireland's Marine and Coastal Areas and Adjacent Seas: An Environmental Assessment, March 1999
- Irish Offshore Strategic Environmental Assessments (IOSEA1-3) for Slyne, Erris and Donegal Basins, Porcupine Basin and Rockhall Basin. DCENR 2006-2008
- Hartley Anderson Ltd. 2005. Report to the Irish Shelf Petroleum Studies Group (Project IS03/21) Deep Water Environment to the West of Ireland.
- European Union Life-Environment BioMar Project & BioMar Viewer 2.0.
- Wilson et al (2001).Benthic Biodiversity in the Southern Irish Sea 2: The South-West Irish Sea Survey.
- Roche et al (2007). Irish Wildlife Manual No. 29. Benthic surveys of sandbanks in the Irish Sea. NPWS Publication.
- Aqua-fact International Services Ltd. (2007) Marine Surveys of Two Irish Sandbank cSACs. Report to NPWS.
- Merc Consultants (2005; 2006; 2007), Surveys of sensitive subtidal benthic communities. Unpublished Reports to NPWS.

9.3.2.2 Baseline Description

Overview

The term benthos is used to collectively describe the biota living in, on or closely associated with the seabed.

The European Habitats Directive describes in Annex I those habitats that require designation as SACs for their protection and conservation. Table 9.3.2a lists the marine Annex I habitats which are known to be present in Ireland's waters along with potential constituent habitats or communities.

The current listing for Natura 2000 sites with qualifying interest features for marine Annex I or II (habitats or species) is 80 (with four of those offshore and therefore outside the study area).

It should be noted that the possibility that currently unrecorded benthic habitats and species may also exist in areas outside of those already designated or under consideration for designation cannot be ruled out.

Table 9.3.2a Annex I Habitats found in Ireland's Marine SACs

For the purposes of this SEA Annex I habitats are considered to be marine if they are covered either continuously or intermittently by the sea (* denotes Priority Habitat).

SAC Annex I Habitat	Potential Constituent Habitats or Communities
Sublittoral Habitats	
Sandbanks which are slightly covered by seawater at all times	Sublittoral sands and gravels
Large shallow inlets and bays	Maerl beds Tidal rapids Mudflats Sheltered muddy gravel Seagrass beds Reefs (see below)
Estuaries	Maerl beds Tidal rapids Mudflats and sandflats (see below)
Reefs	Geogenic reef *Sabellaria spinulosa* reef *Sabellaria alveolata* reef *Mytilus edulus* reef *Ostrea edulis* reef
Intertidal and Coastal Habitats	
Mudflats and sandflats not covered by seawater at low tide	Mudflats Seagrass beds
Coastal lagoons* [except where landwards of Highest Astronomical Tide]	Saline lagoons
Reefs	Geogenic reef *Sabellaria alveolata* reef *Serpula vermicularis* reef *Mytilus edulus* reef
Submerged or partially submerged sea caves	-
Annual vegetation of drift lines	-
Salicornia and other annuals colonising mud and sand	-
Spartina swards (*Spartinion maritimae*)	-
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [except where landwards of Highest Astronomical Tide]	-
Mediterranean and thermo-Atlantic halophilious scrubs (*Sarcocornetea fruticosi*) [except where landwards of Highest Astronomical Tide]	-

A predictive map of the marine habitat types present within the study area is presented in Figure 9.3.2 based upon the MESH EUNIS marine habitat classification.

The benthic environment of Ireland's coastal and offshore waters is rich and varied. The composition of the benthos has similarities all around the Irish coast. However, the species comprising particular communities may differ e.g. between easterly and southerly/westerly facing coasts. These differences, which result primarily from different temperature regimes, reflect the meeting of two major biogeographical provinces. Certain species with known southern (Lusitanian) distributions are near their northernmost limits, while some with more northern (boreal) distributions approach their southernmost limits (Boelens *et al*, 1999)

Coastal waters off the west coast of Ireland have been categorised as part of the Boreal-Lusitanian Province, reflecting the influence of more southern species that inhabit the area due to the warm northeast Atlantic Drift. Areas further offshore are part of the deep-sea province encompassing the deep-water area to the west of continental Europe. The most typical substrate type in the deep ocean is mud or, on the upper Continental Slope, muddy sand. Sediments within channels and canyons are variable and include coarse material, rippled sands and soft oozes (Huvenne, 2003). Muddy sand habitats are typically dominated by burrowing bivalves, polychaetes and brittlestars, while coarser material will also include a range of epifaunal species.

Baseline descriptions of the benthos of the continental shelf (50 – 200 m water depth) and the continental slope (below 200m water depth) are provided in the Irish Offshore Strategic Environmental Assessments (IOSEA1-3) for Slyne, Erris and Donegal Basins, Porcupine Basin and Rockhall Basin. The IOSEA1 study area was situated on the continental shelf in sublittoral waters of approximately 50 to 200 m and extended into the bathyal area. The IOSEA2 and 3 study areas were located below the 200 m water depth and predominantly within the bathyal area (depths of 1,000 – 4,000m).

The epibenthic populations of the continental shelf (50m – 200m) are generally thought to show a strong similarity to those of the northern North Sea, although it is believed that they can be distinguished from the North Sea populations (Gage, 1992). Characteristic species include tube dwelling polychaetes, molluscs and sea urchins. Estimates of population densities of the most common epifauna indicate particularly high densities of a few species including the tube dwelling bristleworm *Ditrupa arietina* and the sea urchin *Cidaris cidaris* and *Echinus acutus*.

From the shelf break at approximately 200 m down to 700 m, the composition of the benthic fauna depends on whether coral banks are developed (Gage, 1986). Coral banks are composed mainly of cold water reef building corals *Lophelia pertusa* and *Madrepora oculata*. On the sparse sandy deposits where coral is not developed, the epibenthic fauna is rather sparse but prominent among it are the echinoderm species *Cidaris cidaris*, *Spatangus raschi* and *Stichopus tremulus*.

A number of studies have been undertaken to map the benthos of Ireland's marine coastal region. These have included studies which evaluated the benthic environment under Irish participation in the European Union Life-Environment BioMar project and work under the SensMap project. Benthic biodiversity in the Irish Sea was also described as part of the South-West Irish Sea Survey BIOMÔR Reports.

An overview description of the benthic environment of the seas around Ireland is provided by Boelans *et al* in the Marine Institute Quality Status Report - Ireland's Marine and Coastal Areas and Adjacent Seas: An Environmental Assessment, March 1999. The MI Report provides a good general description of the benthic environment and is based on published descriptions of communities and unpublished survey work arising from the BioMar Project (1992 – 1997).

As a requirement under Article 17 of the Habitats Directive Conservation Assessments have been carried out by NPWS and are reported in The Status of EU Protected Habitats and Species in Ireland (NPWS Report, 2008). Maps are presented within the NPWS Report for each marine and coastal habitat or species which give the known or best estimate of distribution in Ireland and are reproduced for selected marine and coastal habitats in Appendix C.

In 2008, NPWS commenced a national programme to investigate the principal benthic communities of mudflats and sandflats in Natura 2000 sites, and in 2009, a national programme also commenced to investigate the principal benthic communities of inlets, bays, and estuaries including the extent of reef habitat.

The distribution of habitats on the OSPAR List of Threatened and/or Declining Species and Habitats is presented in Figure 9.3.3.

Detailed localised descriptions of the benthic environment are also presented within the NPWS site synopses for individual SACs and within NPWS survey reports of sensitive subtidal benthic communities for selected SACs on the South-West and West Coasts.

A description of the fully marine and intertidal habitats known to occur around the coast of Ireland and their associated benthic environment is provided below, and is largely based upon information provided in the NPWS Conservation Assessments:

Sandbanks which are slightly covered by seawater at all times

A total of 21 sandbanks have been identified around Ireland with the majority located in the Irish Sea. These banks are (from north to south): Bennet, Burford, Kish, Frazer, Bray, Codling, India, Arklow, Seven Fathom Bank, Glassgorman, Rusk, Blackwater/Moneyweights, Lucifer, Long and Holdens Banks. To the west of Ireland only two sandbanks, the Ballybunion and Turbot/Kilstiffin Banks, have been identified at the mouth of the Lower River Shannon cSAC between Counties Kerry and Clare. A small bank also occurs on the north coast of Donegal called Hempton's Turbot Bank. No sandbanks are found on the southern coast of Ireland.

Sandbanks in Irish waters comprise distinct banks (i.e. elongated, rounded or irregular 'mound' shapes) that may arise from horizontal or sloping plains of sediment that ranges from gravel to fine sand. They are primarily composed of sandy sediments permanently covered by water, at depths of less than 20 m below chart datum (though the banks may extend to water depths greater than 20 m). The diversity and types of community associated with this habitat are determined primarily by sediment type together with a variety of other physical, chemical and hydrographical factors. These include geographical location (influencing water temperature), the relative exposure of the coast, topographical structure of the habitat, and differences in the depth, turbidity and salinity of the surrounding water.

Shallow sandy sediments are typically colonised by a burrowing fauna of worms (*Glycera lapidum*, *Nephtys* sp., *Spiophanes bombyx*, etc.), crustaceans (*Pontocrates arenarius*, *Bathyporeia elegans*, etc.), bivalve molluscs (*Abra alba*, *Fabulina fibula*, etc.) and echinoderms. Mobile epifauna at the surface of the sandbank may include mysid shrimps, gastropod molluscs, crabs and fish. Sand-eels *Ammodytes* spp.), an important food for birds, also live in sandy sediments. Where coarse stable material, such as shells or stones is present on the sediment surface, hydroids, bryozoans (seamats) and ascidians (seasquirts) are present.

A benthic faunal study of the Blackwater and north Kish Bank in the Irish Sea during 2005 (Roche et al. 2007) identified the following marine habitat biotopes: *Glycera lapidum* in impoverished infralittoral mobile gravel and sand; infralittoral mobile clean sand with sparse fauna; *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand; *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand biotope and *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment although in some cases the species composition varied (Roche *et al*. 2007). Roche *et al* (2007) compared all the data for Irish sand banks with data for UK sandbanks in the Irish Sea and found the overall diversity to be similar.

The sediment of the Arklow Bank was found to consist predominantly of sand, cobbles, shells and pebbles on the northern end tending towards fine sand at the southern end. Benthic surveys, conducted using a benthic dredge, showed that epibenthic species diversity and abundance were highest in the areas of "sandy shells" and "gravel with cobbles". The species richness was highest at the north-west of the bank where reef building polychaetes (*Sabellaria alvelota*) were recorded (Fehily & Timoney & Co. 2001).

Estuaries

Estuaries are located on all parts of the coastline around Ireland. The largest is located in the mid-west (Shannon Estuary) and constitutes approximately 50% of the national resource. Typically, estuaries are long narrow seaward parts of river valleys, e.g., the River Barrow and River Nore (Waterford/Wexford) and the Blackwater (Cork/Waterford). At low water, there can be extensive areas of mudflats, sandflats and saltmarshes.

Estuarine sediments are typically soft muds but where stones or shells occur, the green algae *Enteromorpha* sp. and *Ulva* sp., and, the brown algae *Fucus ceranoides* and other fucoids are generally present. Invertebrate communities present include bivalves (*Mytilus edulis*), Polychaeta (*Capitella* spp., *Malacoceros* spp., *Hediste diversicolor*, *Nereis* spp, Spio spp., *Magelona* spp), Oligochaetes (*Tubificoides benedii*), Crustacea (*Corophium* spp.). Infaunal species numbers are generally low with oligochaetes dominating. Algal communities comprise *Ulva* spp., *Enteromorpha* spp., the brown algae *Pelvetia canaliculata*, *Fucus cerinoides*, other fucoids, and *Ascophyllum nodosum*.

Large shallow inlets and bays

Shallow bays and inlets are indentations of the coastline that have low level or zero freshwater input. The levels of exposure to wave action vary from sheltered through semi-exposed to exposed. This is reflected in the sediment type with mud or sandy mud occurring in the sheltered sites to mixed sediments on semi-exposed sites to coarser sediments in exposed sites. The variation in sediment types is reflected in the organic carbon content and numbers of species with maximum biological diversity in softer sediments and lowest diversity occurring in coarse material. Large shallow inlets and bays are physiographic units that host a great variety of habitats including, the Annex I habitats, reefs and mudflats and sandflats not covered by seawater at all times. The sediment habitats and their communities within large shallow inlets are very varied reflecting the broad sediment types. Large shallow inlets and bays are located on all parts of Ireland's coastline. The two largest sites are located in the mid-west (Shannon Estuary) and south-west (Dingle Bay).

Typical species, will vary depending on the depth, substrate and degree of exposure to wave and tidal currents. In general these will include coelenterates such as slender sea pen (*Virgularia mirabilis*), and the anemone (*Cerianthus llodyii*); polychaetes including lugworms (*Arenicola* spp.) and the ragworm (*Hediste diversicolor*); crustaceans including various crabs and shrimp; bivalves such as banded venus (*Clausinella fasciata*), and scallop (*Pecten maximus*); echinoderms such as common starfish (*Asterias rubens*); calcareous algae (*Phymatolithum calcareum, Lithothamnion corallioides*), and eelgrass (*Zostera* spp.).

Prior to the designation of SACs, point source information was collected by the BioMar project from 1993 to 1996 for many shallow inlets and bays. Since then subtidal broadscale habitat mapping has occurred in 5 SACs: Kilkieran Bay & Islands and Valentia Island/Portmagee Channel in 2001; Clew Bay Complex, Kenmare River and Roaringwater Bay in 2002. The latter concentrated on reefs and generated detailed habitat descriptions and species lists for a number of communities in each SAC.

In 2005, NPWS commenced a national programme to survey benthic habitats in Large Shallow inlets & Bays in Ireland. Kilkieran Bay & Islands cSAC and Kingstown bay cSAC were mapped in 2005 and Galway Bay Complex cSAC, Clew Bay Complex cSAC and Slyne Head Peninsula cSAC were mapped in 2006. Roaringwater Bay & Islands SAC, Lough Hyne Nature Reserve & Environs SAC, Valentia Harbour & Portmagee Channel SAC and Broadhaven Bay SAC were mapped in 2007.

Within the scope of the project, the following were considered as sensitive subtidal communities:

- beds of seagrass Zostera marina
- beds of maerl forming calcareous algae including Lithothamnion corallioides, Phymatolithon calcareum
- communities of the polychaetes Lanice conchilega (Sand Mason) , Sabella pavonina (Peacock Worm) and the reef forming Serpula vermicularis (Tube Worm)
- reefs of the Native Oyster Ostrea edulis
- reefs of the bivalve mollusc Limaria hians (Gaping File Shell)
- communities of Scolanthus callimorphus (Burrowing Worm Anemone)
- beds of the tubicolous anemone Pachycerianthus multiplicatus (Fireworks Anemone)
- communities of Virgularia mirabilis and other Sea Pen species
- beds of Neopentadactyla mixta and other burrowing sea cucumbers
- communities of the anemone Edwardsia delapiae

In 2006, the Irish National Seabed Survey also commenced a programme including detailed bathymetric mapping which will survey 26 inlets and bays in the Irish inshore sector (the INFOMAR Project).

Mudflats and sandflats not covered by seawater at low tide

Intertidal mudflats and sandflats are widespread around the coast of Ireland, and form part of a mosaic of habitats that occur in estuaries and shallow inlets and bays. The two largest sites are located in the mid-west (Shannon Estuary) and north-east (Dundalk Bay).

The physical structure of these intertidal flats ranges from mobile, coarse-sand beaches on wave exposed coasts to stable, fine-sediment mudflats in estuaries and other marine inlets. They support diverse communities of invertebrates, algae and eel grass (*Zostera* sp). Mudflats are usually located in the most sheltered areas of the coast where large quantities of silt from rivers are deposited in estuaries. In sheltered areas communities are typically dominated by polychaete worms, e.g., *Arenicola* and bivalve molluscs and may support very high densities of the mud-snail *Hybrobia ulvae*. Sand flats occur on open coast beaches and bays where wave action or strong tidal currents prevent the deposition of finer silt. On more exposed coasts the biodiversity may be lower and the communities dominated by crustaceans such as Bathyporeia. The strand line on most shores is characterised by Talitrid amphipods. Where *Zostera* occurs, faunal diversity is higher.

A selected number of intertidal mudflats and sand flats were surveyed by the BioMar project between 1993 and 1996 which generated point source data for the strand line, high and mid and low shore stations. NPWS also commissioned surveys of intertidal sandflats and mudflats of SACs in tidal embayments around Ireland in 2006. In addition, an all-Ireland survey of the distribution, extent and condition of intertidal Zostera communities on sand flats was undertaken in 2005.

Typical species include invertebrate communities such as Polychaetes: *Tubificoides*, *Capitella, Malacoceros*; *Arenicola marina*, *Hediste diversicolor*, *Lanice conchilega*; Bivalvia Molluscs: *Abra alba*, *Mytilus edulis*, *Cerastomderm edule*, *Scrobicularia plana*, *Macoma balthica*, *Mya arenaria*; Crustaceans: *Talitrd* spp., *Bathyporeia* spp., *Corophium* spp. Echinodermata: *Echinocardium cordatum.* Algal species: *Ulva* sp., *Enteromorpha* spp and Angiosperms: *Zostera* spp.

Reefs

Reefs may have a rocky substrate (geogenic reefs) or be constructed by animals (biogenic reefs).

<u>Geogenic Reefs</u>

In Ireland, geogenic reefs are found both intertidally and subtidally, from sheltered waters through areas moderately exposed to swell and wave action, to waters exposed to the full forces of Atlantic waves. Across this range reefs may be subjected to strong tidal currents. The structure of reefs varies from bedrock to boulders or cobbles while topography ranges from horizontal to vertical and the reefs may have numerous ledges and crevices. The geology includes limestone, shale, granite, schists and gneiss. All of these factors affect both the species present and their abundance. Their depth range is unknown but is likely to extend below 1200m. Typical species change with increasing depth. Brown fucoid algae generally dominate the intertidal down to shallow subtidal areas. The latter are characterised by kelp species, frequently with an understory of red foliose algae. Below the kelp and down to about 30 m, red algae characterise the substratum with very few brown algae. Below this, the habitat is characterised by faunal species; very few foliose or filamentous red algae occur although encrusting red algae may be common.

<u>Biogenic Reefs</u>

Biogenic reefs in Ireland include: -

Serpula Reefs

The polychaete worm *Serpula vermicularis* secretes a calcareous tube and is common as a solitary worm. However, under sheltered conditions with a very gentle tidal stream the worms aggregate and form structures which may be up to 1 m in height and about 2 m in diameter. The spaces between the worm tubes are inhabited by a wide variety of species such as brittlestars and crabs. In Ireland such reefs have a very limited distribution and are only known from three localities and occur from depths of 2 – 19 m.

Sabellaria Reefs

In the subtidal reefs are usually formed by *S, spinulosa* which has been recorded at 6 sites around Ireland. The reef structures found in Wicklow Reef SAC are recorded as *S. alveolata* but this has not been confirmed. It is likely that *Sabellaria* reefs are more widespread than currently known. The reefs which can be up to a metre in thickness are constructed of sand grains by the worm and form a substrate for many other species that would not normally be present in the area in the absence of the reefs.

Intertidal *Sabellaria alveolata* reefs are recorded from a number of localities around the coast and are dependant on the presence of sand. To date they have been recorded from the South coast to Lough Swilly in Donegal. It is highly likely that they are also present on the East coast.

Bivalve Reefs

Mussels occur intertidally on rocky shores, particularly on exposed coastlines where they occur in large patches and can be a characterising species but generally remain small. Mussels also form reefs on sediment where there is some hard substratum for attachment. They may also occur in sheltered, tide-swept areas where they reach a much larger size. The distribution of mussel reefs does not appear to be well documented. Native Oyster Ostrea edulis beds, when undisturbed, also form reef-like structures, however, many oyster beds were fished out in the late 1800s and early 1900s with remaining beds now confined to the SW and W coasts (NPWS Conservation Assessment of Reefs). Seven areas support or have recently supported commercial fisheries. These areas are Tralee Bay, Clew Bay, Blacksod Bay, Achill, Lough Swilly, Inner Galway Bay and Kilkieran Bay (OSPAR 2009a).

The only known Modiolus modiolus bed located completely in Irish waters was a small bed discovered off Arklow in 1997 (Wilson et al, 2001), however, subsequent surveys in the same area have failed to find any more. A bed was also known to be present on the boundary with Northern Ireland at the mouth of Carlingford Lough (Erwin et al, 1990). It is now acknowledged that grab survey information from central parts of the southern Irish Sea has been misinterpreted as indicating M.modiolus beds, with grabs here collecting only small or spat-sized individuals. The south and west coasts of Ireland are in the Boreal-Lusitanian biogeographic region and although the species has been recorded sparsely no beds are known to occur here or off the north coast to the west of the border with Northern Ireland (OSPAR 2009b).

Cold Water Coral Reefs

In Ireland coldwater coral reefs are present from 200 – 1600 m and are generally associated with carbonate mound features that rise up to 300 - 500 m above the sea floor in locations found close to the continental shelf slope and on the Rockall and Hatton Banks. The typical reef forming species are *Lophelia pertusa* and *Madrepora oculata* which create a complex 3-dimensional structure that provides a habitat for many other species which live on both live and dead coral or in the spaces between the coral branches.

Sublittoral Sand and Gravel

Sublittoral sand and gravel sediments occur in a wide variety of environments and are one of the most common habitats found below low water around the coast of Ireland.

Littoral and sublittoral sites around the Ireland have been surveyed as part of the BioMar project, which identified habitats and associated communities (BioMar–LIFE, 1996) and as part of the BIOMÔR 2 South-West Irish Sea Survey.

In addition, a more comprehensive sublittoral survey has been conducted, principally around the south–east of Ireland, where sublittoral biotopes have been mapped (EcoServe, 2001).

The EcoServe survey (2001) recorded infralittoral and circalittoral gravel and sand along the open coast from Dalkey to Kilcoole, in an area subject to a high level of wave exposure. Very little fauna was recorded during these surveys at sites to the east of the Muglins and Bray Harbour. However, to the east of Bray Head, surveys identified Sertularia cupressina and Hydrallmania falcata. This community was also recorded at Arklow and east of Kilmichael Point and from east of Ballynamona Hill to south of Rosslare Harbour. The surveys also recorded that infralittoral sand and gravel is present at the outskirts of Wexford Harbour where small pockets of exposed circalittoral rock and infralittoral muddy sand are present.

Generally, the inshore seabed on the east coast is almost entirely sediment, ranging from sand, shell, gravel and cobble to stones and small boulders (Boelens et al, 1999). Epifaunal species are widespread, particularly on gravel, cobble and boulders with infauna more important in areas with sand and mud. The most widespread habitat along the east coast is current swept coarse sediment. This stretches almost continuously from Dundalk Bay to Hook Head on the south coast and consists of compact sand, with gravel, shell and/or cobbles in varying proportions. The fauna is characterised by erect hydroids which attach to cobbles or shell. The bryozoans Flustra folicacea is abundant on bedrock exposed to strong sediments and sand scour. Other habitats in the region described in Boelens et al, 1999, include:

a) Banks of cobbles, gravel or horse mussel (Modiolus modiolus) shells on which the brittlestar Ophiothrix fragilis can be very abundant (e.g. Codling Bank);

b) Duned gravel with few species except for the sea cucumber Neopendactyla mixta;

c) Coarse sands characterised by polychaetes and bivalves

d) Bedrock and boulders with a species rich fauna dominated by sponges, hydroids, and anthozoans in deeper water, and these taxa with algae in shallower water.

The ‘shallow Venus community’ dominates at depths of 5-40 m in nearshore sands and is often associated with areas subject to strong currents where the sand formations consist of sand banks or sand wave systems. The Tellina sub-community occurs in fine stable sands with typical species including the bivalve Tellina fabula and the polychaete Magelona mirabilis. The Spisula sub-community occurs in medium to coarse sands subject to disturbance and typical species include the bivalve Spisula ellipitica and polychaete Nephtys cirrosa. The shallow Venus community is widely distributed around the Irish Sea coastline.

The ‘deep Venus community’ is strongly associated with coarse sand/gravel/shell sediments at moderate depths (40-100m). Typical species include the urchin Spatangus purpureus, and bivalves Glycymeris, Astarte sulcata and Venus spp. This community is the most widespread in the Irish Sea.

The dominant seabed habitats in Cork and Kinsale Harbours are muddy sand with the most commonly recorded biotopes being infralittoral gravel sand with N. cirrosa and Bathyporeia species in areas exposed to tidal currents and wave action and infralittoral muddy sand communities with Scoloplos armiger, Abra alba, Amphiura filiformis and Phoronis muelleri (Connor et al., 1997b). On the open south coast the seabed below about 20m consists of large expanses of sand with localised patches of pebble, gravel and shells in strong currents.

Chamelea bivalve communities, associated with sandy substrates, are found in the outer part of Dingle Bay, in parts of the outer Shannon, in Clew Bay and much of Donegal Bay. West of County Clare and south-west of the Aran Islands, the coarse sand with patches of gravel and cobble in shallow water changes with increasing depth to muddy sand and then sandy mud (O’Connor, 1987). The latter has an epifuana characterised by the brittlestar Amphiura chiajei along with the brachiopod Crania anomola.

Mud habitats in deep water

Mud habitats in deep water typically occur below 20-30m and are found in the Irish Sea and in a number of marine inlets and sea loughs around Ireland, including Lambay Deep, Kinsale Harbour, Inner Kenmare River, Mannin Bay, Lough Hyne, Kilkeiran Bay and Bantry Bay. Some of the largest area of mud deposits lie in the deeper waters off the east coast extending across a wide expanse between the Isle of Man and the Irish coast.

The relatively stable conditions associated with deep mud habitats often lead to the establishment of communities of burrowing megafauna, where deep water (>200m) species may be mixed with coastal species. This habitat can be made up of various different communities each making a contribution to the overall appearance of the habitat and is characterised by seapens and burrowing megafauna communities where burrows and mounds produced by megafauna are prominent features on the surface of plains of fine mud, created by populations of seapens, typically *Virgularia mirabilis* and *Pennatula phosphorea* and other burrowing crustaceans such as *Calocaris macandreae*, *C. subterranea* and *Goneplax rhomboides*. *Virgularia mirabilis* and *Pennatula phosphoreal* are more likely to be found in deeper water habitats as are the communities of brittlestars *Amphiura* spp.

In offshore mud habitats the burrowing urchin *Brissopsis lyrifera* is common along with the brittle star *Amphiura chiajei* and in some areas around Ireland, such as the northern Irish Sea, the community includes *Nephrops. norvegicus*. The *Amphiura* and *Nephrops* communities can also be found in the muddy areas of outer Dingle, Kenmare and Bantry Bays, in outer Galway Bay and in the deep water west of the Aran Islands, Boelens *et al*, 1999. The Celtic deep at the southern limit of the Irish Sea, extending into the Celtic Sea, also has a mud-dwelling, polychaete-dominated infauna similar to that of the *Nephrops* grounds in the north-west Irish Sea but with larger numbers of taxa (Mackie *et al*., 1995).

Submerged or partially submerged sea caves

Sea caves usually occur on cliff faces with entrances extending above the surface of the sea but a number of caves are known to be completely under water and form tunnels or caverns some of which may have both underwater openings and small surface openings. Their distribution in Ireland has not been systematically mapped with the exception of the cave system at Doolin, Co. Clare. A limited amount of information is available from the SCUBA diving community and 23 caves, a number of which are completely under water, have been identified from Hook Head in Co. Wexford to Malin Head, Co. Donegal and all known caves occur within 1 km of the coastline.

The floor of caves varies from being a sediment floor to bedrock and or boulders. Frequently the sides of caves are devoid of fauna close to the floor due to sediment or boulder scour. Where boulder / sediment scour is intense, the cave may have very limited fauna. Two caves were surveyed by the BioMar Project and the species found on the walls and roofs support a community that is typical of steeply sloping rock or overhangs. The walls and roofs are generally densely covered in encrusting sponges including *Leuconia nivea*, *Clathrina coriacea*, *Dysidea fragilis* and *Dercitus bucklandi*, which is characteristic of caves and crevices. Other species recorded included the hydroid, *Tubularia indivisa*, anthozoans *Corynactic virids* and *Phellia gausapata*, bryozoans *Crisia* spp and *Scrupocellaria reptans*, the sea squirt *Dendrodoa grossularia* and encrusting coralline algae. All species recorded to date are not specific to caves and are widely distributed occurring on steeply sloping to vertical bedrock in a high energy areas.

Annual vegetation of drift lines

Annual vegetation of drift lines is found on beaches along the high tide mark, where tidal litter accumulates. It is dominated by a small number of annual species (i.e. plants that complete their life-cycle within a single season). Tidal litter contains the remains of marine algal and faunal material, as well as a quantity of seeds. Decaying detritus in the tidal litter releases nutrients into what would otherwise be a nutrient-poor environment. The habitat is often represented as patchy, fragmented stands of vegetation that are very short-lived and subject to frequent reworking by the tide.

The habitat is mainly associated with a sandy substrate and shows a continuous distribution along the coast of Ireland with a more dispersed pattern along the north of Co. Mayo, as well as counties Cork and Kerry. County Donegal contains the highest concentration of habitat records, followed by Galway. County Wexford has the highest number of habitat records along the east coast.

The vegetation is limited to a small number of highly specialised species that are capable of coping with salinity, wind exposure, an unstable substrate and lack of soilmoisture. Typical species include spear-leaved orache (*Atriplex prostrata*), frosted orache (*Atriplex laciniata*), sea rocket (*Cakile maritima*), sea sandwort (*Honckenyapeploides*) and prickly saltwort (*Salsola kali*).

Saltmarsh habitats

Saltmarshes are stands of vegetation that occur along sheltered coasts, mainly on mud or sand, and are flooded periodically by the sea. The plants and animals are restricted to a small number of specialist species that can survive the salt content of the substrate. Saltmarshes are often dissected by a pattern of muddy channels or “creeks”. In Ireland, there are five separate saltmarsh habitats listed under Annex I of the EU Habitats Directive:

- Salicornia and other annuals colonising mud and sand
- Spartina swards
- Atlantic salt meadows
- Mediterranean salt meadows
- Halophilous scrub

Transitional communities can occur between these habitats and they may also form mosaics with each other.

Coastal lagoons

Coastal lagoons are lakes or ponds fully or partially separated from the sea by sandbanks or shingle, or less frequently by rocks. They are present at a number of locations around the coast of Ireland.

The salt content of the water (salinity) in the lagoon varies depending on rainfall, evaporation and through the addition of seawater from storms, temporary flooding by the sea in winter or tidal exchange. This habitat also includes artificial lagoons such as salt basins and salt ponds providing that they had their origin on a transformed old natural lagoon or on a salt marsh, and are not significantly exploited. Plant species characteristic of coastal lagoons include tasselweed (*Ruppia* spp.) and algae such as *Chaetomorpha linum*, *Cladophora battersii*, *Chara baltica*, *C. canescens*, *C. connivens*, *Lamprothamnion papulosum* and *Tolypella nidifica*. Animal species that are characteristic of this habitat include the hydroid *Cordylophora caspia*, sand shrimp (*Gammarus chevreuxi*), snails including *Rissoa membranacea* and beetles such as *Enochrus bicolor*.

Zostera beds

There are two internationally recognized species of seagrass in Ireland, Zostera marina (Common Eelgrass) and Z. noltii (Dwarf Eelgrass; syn. Z. noltei). Z. marina forms dense beds, with trailing leaves up to 1 m long, in sheltered bays and lagoons from the lower shore to about 4 m depth (however it can occur much deeper), typically on sand and sandy mud (occasionally with a mixture of gravel), (Dale, A. L., et al, 2007)

Seagrass habitat is considered to be under threat in Ireland. Intertidally, Zostera communities have been recorded on all Irish coasts and subtidally, Zostera communities have only been recorded from the south, west and north coasts (see Figure 9.3.3).

Maerl beds

Maerl is a marine calcareous alga which lives in shallow waters ranging from 3 to 20 metres in depth. Living maerl is pink due to a combination of photosynthetic pigments. The distribution of *Lithothamnion corallioides* and *Phymatolithon calcareum* has not been mapped in detail although the primary maerl beds have been mapped. These two species form a thin veneer on the surface up to about 20cm in depth. Beneath this veneer is a deposit of dead maerl gravel with varying degrees of mud. Biodiversity in maerl beds is often very rich, varying according to the three dimensional structure of the living veneer and the composition of the deposit below it.

Dead maerl gravel may also be found away from living beds. It is not known whether these beds are formed by movement of the gravel by wave action, or whether they supported live maerl in the past. Beds of maerl gravel are as ecologically important as those with live material present. Maerl is extremely slow growing (1-2 mm per year) and so is essentially non-renewable. It is not known whether a population of live maerl will recover if removed. As improved knowledge on the distribution and extent becomes available, the known range of the species may increase.

Maerl is widely distributed in the mid-west and the southwest of Ireland. The minimum number of maërl beds in Irish waters is estimated to be 35-40, with the majority (c. 65-70%) located in Galway Bay and along the Connemara coastline (De Grave & Whitaker, 1999), in water depths from 0.5 to 15 m (De Grave, 1999). The majority of the maërl beds are located between 0 and 20 m with the exception of one off Inishman found in depths of 20 to 30 m (Hall-Spencer et al, 2010).

See Figure 9.3.3.

9.3.2.3 Key Issues and Future Trends

Sources of contamination, or seabed disturbing activities such as trawling, dredging and development, can all impact directly or indirectly on benthic communities, removing or destroying habitats.

In order to identify the location of key sensitive benthic habitats which, under the Habitats Directive, may warrant protection more detailed, study area wide monitoring or surveying programmes may be required. However, this is beyond the scope of this SEA.

Ireland is currently considering possible sites for designation as offshore SACs on the basis of their benthic ecology. This will increase the protection afforded to the designated sites, thus reducing potential for marine development to adversely impact benthic ecology in these areas.

9.3.3 Fish and Shellfish

9.3.3.1 Data Sources

The following data sources have been used in describing fish and shellfish within the assessment area:

- Academic Journal papers on a number of species (Arai et al, 2006; Berrow and Heardman, 1994; Fahy and O' Reilly, 1990; Gore et al 2008; Igoe et al, 2004;, Southall et al, 2005)
- Marine Institute Reports and Publications
- Atlas of the Commercial Fisheries around Ireland. 2009.
- Climate Change. Implications for Ireland's Marine Environment and Resources. 2005
- Ireland's Marine and Coastal Areas and Adjacent Seas: an environmental assessment, 1999.
- Framework for an Action Plan on Marine Biodiversity in Ireland. 2000.
- Larval distribution of commercial fish species in waters around Ireland. 2004
- Working Document on the Assessment of the "Irish Box" in the context of the Western Waters Regime. 2009
- The Stock Book 2009
- Oceanographic Data Coverage of the Northeast Atlantic 1970-2000, 2002
- IUCN Red List of Threatened Species for Ireland.
- Heritage Council Report on Basking Shark Tagging and Tracking. 2009. Berrow and Johnston.
- National Parks and Wildlife Service Report. The Economic and Social Aspects of Biodiversity Benefits and Costs of Biodiversity in Ireland. 2008.
- The Status of Irish Salmon Stocks in 2008 and Precautionary Catch Advice for 2009. Draft Report of the Standing Scientific Committee to Department of Communications, Energy and Natural Resources.

9.3.3.2 Background

The assessment area covers from the high water mark down to the 200m depth contour and therefore incorporates a broad range of marine habitats and associated inter-tidal, coastal and deep-water fish and shellfish species. In terms of biodiversity of fish and shellfish species Costello, 2000, reports that there were approximately 1500 known species of marine fish and shellfish species in British and Irish waters. That figure has increased somewhat in the intervening years and the majority of these species are present in the assessment area i.e. in waters of less than 200m depth.

The degree of mobility between species varies greatly, with some of the fish species in particular being highly mobile and undertaking long spawning and feeding migrations while the majority of shellfish species have a more static life cycle. In addition all fish and shellfish species at different stages in their life cycles will vary in the degree to which they are mobile or vulnerable to disturbance and therefore will present different challenges in relation to offshore energy installations.

Throughout the assessment area the fish and shellfish species present are determined primarily by: water depth; water temperature; salinity in inshore areas; seabed type; sediment grain size; hydrographic and oceanographic conditions; wave climate in shallow areas (Boelens *et al*, 1999).

9.3.3.3 Baseline Description

Finfish

Pelagic fish species are shoaling fish mainly found swimming in the water column as opposed to near the seabed. Important pelagic fish species within the study area include mackerel, herring, horse mackerel, bluefin tuna, albacore tuna, boarfish, horse mackerel, blue whiting and basking sharks.

Demersal fish live on or near the sea bed and they tend to occur in diverse mixtures of species. There is a high diversity of demersal species within the assessment area which includes gadoids (cod, whiting, haddock, hake etc), flatfish (plaice, sole, megrim, turbot etc), elasmobranchs (sharks, rays and skates) and others such as Angler fish.

For the purposes of the SEA the long list of fish species present can be made more manageable by focusing on species of commercial importance and those with protected or threatened status.

Distributions of spawning and nursery area maps for a number of the most important commercial species are shown in Figure 9.3.4 (Lordan and Gerritsen, 2009). The distribution maps in this report represent the most comprehensive and up-to date research information and present a more accurate picture of spawning and nursery areas than previous reports which were drawn mainly for British rather than Irish waters. The report compiles findings from a number of relevant fishery surveys and from the findings of Dransfeld, 2004, on distribution of larvae of commercial fish species. The trend for many fish species is for them to be distributed in three distinct areas corresponding to different phases in their life cycle, these being spawning areas, nursery areas and adult feeding grounds.

Further details of the distribution of adult feeding grounds of the main commercial species can be found in Section 9.5.1 Fisheries and Aquaculture.

Diadromous species

Diadromous fish species are those which migrate between fresh and salt water at various stages in their life cycle.

Atlantic salmon (Salmo salar) Atlantic Salmon are an anadromous species. This means that after hatching young fish pass through several riverine phases before maturing over a number of years at sea and making a return migration to their home river to spawn. The migration path for Irish salmon appears to be northward along the west coast and then towards Greenland and the Norwegian Sea (White *et al*, 2002). Salmon are native to rivers right around the Irish coast although recently almost all of the rivers having healthy stocks (57 out of 148 rivers) are to be found in the south-west, west and north-west (Draft Standing Scientific Committee Report, 2008).

In 2006 drift netting for Salmon was banned in Irish waters due to concerns over the interception of fish from depleted river stocks as they migrated around the coast. The Salmon is listed as a protected species under Annex II of the Habitats Directive and the National Parks and Wildlife Service overall assessment of its Conservation Status is listed as Bad.

European eel (*Anguilla anguilla*) – The European eel spawns in the Sargasso Sea, after which the larvae drift back towards Europe on the North Atlantic Current (Arai, 2006). 6-8 months after hatching the eels re-enter their home rivers and migrate upstream. After a number of years in fresh water the eels make a return spawning migration to the Sargasso after which they die. Stocks of European eel have been assessed by the International Council for the Exploration of the Sea (ICES) as being outside safe biological limits, and this assessment is supported by decreasing catches in commercial eel fisheries in recent years. Under Council Regulation 1100/2007 an Eel Management Plan (EMP) must be prepared by all Member States. Under Irish law (Bye-law No C.S. 303, 2009) fishing for eel is now prohibited. These fisheries will remain closed until at least 2012.

Twaite shad (*Alosa fallax*). Twaite Shad is a diadromous species moving between coastal and estuarine waters and the lower reaches of rivers. It is listed in Annex II of the Habitats Directive and its overall conservation status was described in 2007 by the National Parks and Wildlife Service as **unfavourable**.

Allis shad (*Alosa alosa)* is a diadromous species found in coastal, estuarine and lower river waters. It is listed in Annex II of the Habitats Directive and its overall conservation status was described in 2007 by the National Parks and Wildlife Service as **Unknown**.

Sea lamprey (*Petromyzon marinus*) and **River Lamprey (*Lampetra fluviatilis*)**. Both species are Annex II listed diadromous species which spawn in freshwater and spend part of their adult lifecycle in the marine environment feeding on fish (Igoe, 2004). The sea lamprey's overall conservation status was described in 2007 by the National Parks and Wildlife Service as **Unfavourable**. The River Lamprey's overall conservation status was described in 2007 by the National Parks and Wildlife Service as **Favourable**.

Smelt (*Osmerus eperlanus*) is an anadromous pelagic fish which is found in estuarine and coastal waters. It is classified by IUCN as **least concern**.

Elasmobranchs

Basking Shark (*Cetorhinus maximus*) The Basking Shark is the largest fish in Irish waters and distributed widely throughout. Recent research suggests that they may spend the winter months in deep water (Gore, 2008) while they are most commonly sighted in coastal locations feeding on zooplankton in summer months particularly June and May (Berrow and Johnston, 2009). They move gradually northwards during this period as sea temperatures increase and plankton populations increase (Berrow and Heardman, 1994).

The vulnerability of the Basking Shark to over-exploitation is due to the following factors:

- Its large size, rendering it vulnerable to entanglement,
- Its feeding ecology which maintains it at or near the surface, and
- Its long gestation period and the late development of sexual maturity (between 12 and 20 years).

Although the Basking Shark is not protected under Irish law it is classified on the IUCN Red list as endangered in the N.E. Atlantic, it is listed in CITES Appendix II, and also in OSPAR's list of threatened species. Target fisheries, which were in the past conducted in Irish waters, are now prohibited by EU regulation 41/2007. Its population status is unknown although IUCN classifies its population trend in the N.E. Atlantic as downwards. However within Irish and UK waters sightings have risen in recent years (IWDG sightings database) and the cessation of drift netting for Atlantic Salmon in 2006 may have resulted in fewer fisheries related fatalities for the species.

Figure 9.3.5 shows the locations of Basking Shark sightings from the IWDG database. These sightings data are to an extent clustered around watch sites so they reflect observation effort. Basking Shark are known to occur in Irish waters outside of the areas mapped here (Southall, 2005; Berrow and Heardman, 1994).

Porbeagle (*Lamna nasus*), classified by IUCN as vulnerable. Its population status is uncertain.

Common Skate (Dipturus batis) - The Common Skate was once widely distributed in Irish waters but due to its large size it has suffered from commercial fishing and may be extirpated from the Irish Sea although it is still present around the rest of the Irish coast. It is listed on the IUCN Red List as critically endangered.

Small Eyed Ray (Raja microocellata), classified by IUCN as near threatened. May be significant as waters off South east Ireland are one of the few areas where it is relatively abundant (Fahy and O Reilly 1990). Its population status is unknown but is assessed by IUCN as decreasing.

Common Smoothhound (*Mustelus mustelus*), classified by IUCN as vulnerable. Its population status is uncertain.

Nursehound, (*Scyliorhinus stellaris*), classified by IUCN as near threatened. Its population status is unknown.

Bird-beaked dogfish, (*Deania calcea*), classified by IUCN as least concern. Although mainly found at depths greater than 400m its range starts from 70m. Its population status is unknown.

There are a number of other shark and ray species listed in the IUCN Red List for the NE Atlantic and Ireland but they are mainly found in water deeper than 200m. The population of the majority of these species is uncertain.

Shellfish

The habitat diversity within the assessment area includes a wide variety of shellfish species and semi-discrete communities. The category of shellfish includes a wide variety of taxonomic classes including bivalve molluscs (oysters, mussels, clams etc), gastropod molluscs (whelks, periwinkles, sea slugs), crustaceans (lobsters, crabs, prawns etc) and echinoderms such as sea urchins.

The shellfish fauna of the Irish Sea is largely determined by sediment type. Inshore western Irish Sea areas are dominated by current swept coarse sediment habitats which support shellfish such as horse mussel (Modiolus modiolus) (historical records only) and other bivalves such as Spisula elliptica. Large deeper areas of the Irish Sea with fine mud sediments are dominated by Nephrops norvegicus (Boelens, 1999).

The Celtic Sea area is more heterogeneous, and significant shellfish dominated communities include Venus fasciata-type communities on coarse sands and gravels, large areas of sandy muds characterized by Nephrops norvegicus and interspersed with fine-sand communities of Abra prismatica, and deep sand communities of Similipecten similis (Boelens et al, 1999).

On the west coast the two general shellfish and sediment-type community associations are Chamelea striatula communities on sandy substrates and Nephrops norvegicus communities on mud (Boelens, 1999).

9.3.3.4 Key Issues and Future Trends

- **Climate change** - Loss of species can be expected due to shifts in temperature ranges. Potential knock on effects include invasive alien species moving into these niche openings, that may further destabilise the environment (Heritage Council and Fáilte Ireland, 2009). Climate change may damage current fish and shellfish spawning and nursery areas, provide more suitable conditions for invasive species and alter the overall distribution range of fish and shellfish species in Irish waters (Heritage Council and Fáilte Ireland, 2009; Boelens et al., 2005).
- **Reform of the Common Fisheries Policy** – the focus of the reformed CFP will be an increased application of the Ecosystem Approach. The ecosystem approach is designed to account for all species and elements within the relevant environment, rather than being focused solely on fisheries target species and therefore addresses issues of biodiversity.
- **The EU Plan of Action for the Conservation of Sharks**, which also covers skates and rays, has already resulted in the prevention of targeted fisheries for species such as spurdog (Squalus acanthias) in Irish waters and the curtailment of the Spanish operated deep water shark gill net fishery should limit further deterioration in the stock status of elasmobranch species.
- **Biodiversity** in the Irish coastal and marine environment is under numerous pressures such as pollution, nutrient enrichment, overfishing and general overdevelopment (Bullock et al., 2008).

9.3.4 Birds

9.3.4.1 Data Sources

In assessing birds within the study area, the following data sources have been used:

- The status of birds in Ireland: an analysis of conservation concern 2008-2013 (Lynas et al 2007)
- Seabird populations of Britain and Ireland (Mitchell et al 2004)
- The distribution of seabirds and cetaceans in the waters around Ireland (Pollock et al 1997)
- Cetaceans and Seabirds of Ireland's Atlantic Margin. Volume 1 – Seabird distribution, density and abundance (Mackey et al 2004).
- A Gap Analysis of Irish Waters using the European Seabirds at Sea (ESAS) database (Pollock & Barton in press)
- Ireland's Wetlands and their Waterbirds: Status and Distribution (Crowe 2005)
- Special Protection Areas Site Synopses (NPWS 2010)

9.3.4.2 Background

The coastal sea cliffs, estuaries and offshore islands of Ireland are host to a number of nationally and internationally important bird species, with many areas designated as Special Protection Areas (SPAs). Coastal habitats provide important breeding sites for many species of seabirds, a number of which are protected under national and European legislation. This section summarises the populations and distribution of coastal and marine birds found from the high tide line out to 200 m water depth, around Ireland.

9.3.4.3 Baseline Description

At least 45 species of seabird have been recorded during at-sea surveys in Irish waters, of which 23 species regularly breed around Ireland (Pollock *et al* 2007, Mackey *et al* 2004).

In addition, a further 59 species of waterbird regularly occur at coastal sites such as estuaries around Ireland, including 5 grebe species, 2 heron species, 26 species of wildfowl and 26 wader species (Crowe 2005). Some of these species are migratory, and are present only during migration periods in spring and autumn; others come to Ireland to breed or to spend the winter, while some are resident all year round.

Coastal or Marine Species of Conservation Concern

BirdWatch Ireland (BWI) have categorised species of high, medium and low conservation priority in Ireland. Coastal or marine species of high and medium conservation status are outlined below.

There are currently 19 breeding species on the Red List, (which signifies species of high conservation concern) including Common Scoter, four species of upland breeding wader (Golden Plover, Lapwing, Curlew, Redshank), Black-headed Gull and Herring Gull. Golden Plover is also listed on Annex I of the EU Birds Directive (79/409/EEC).

Six wintering or passage species are also Red-listed, including Sooty Shearwater and Balearic Shearwater, which is also an Annex I species. Both are listed because of their global conservation status (Lynas *et al* 2007).

A further 25 species of seabirds, 6 species of wildfowl and 9 species of waders are Amber-listed, which signifies species of moderate conservation concern. Thirteen of these species are Annex I listed species.

In addition, 15 seabird species, 2 heron species, 5 wildfowl species and 11 species of wader are listed on the Green list (Lynas *et al* 2007). Of these, five species (Black-throated Diver, Great Northern Diver, Little Egret, Ruff and Wood Sandpiper are also Annex I listed.

Breeding seabirds

Of Ireland's 23 regularly breeding seabird species, ten species breed in internationally important numbers (Table 9.3.4a).

Table 9.3.4a: Breeding Populations of Seabirds in Ireland

Species	Breeding population [1]	Species	Breeding population [1]
Manx Shearwater	37,178	**Great Black-backed Gull**	2,319
European Storm-petrel	99,065	Black-legged Kittiwake	49,160
Leach's Storm-petrel	310	**Sandwich Tern**	3,716
Northern Gannet	36,111	Roseate Tern	738
Great Cormorant	4,736	Common Tern	4,189
European Shag	3,727	Arctic Tern	3,502
Mediterranean Gull	5	Little Tern	206
Black-headed Gull	13,983	**Common Guillemot**	236,654
Common Gull	1,617	**Razorbill**	51,530
Lesser Black-backed Gull	4,849	Black Guillemot	3,367
Herring Gull	6,235	**Atlantic Puffin**	21,251

1 Totals given as pairs, except for Common Guillemot, Razorbill, Black Guillemot and Atlantic Puffin, which are individual birds attending colonies. Species that breed in internationally important numbers are shown in **bold**. Totals include inland populations.
Source: Mitchell *et al* 2004

At least 40 seabird colonies around Ireland regularly hold nationally important breeding numbers for at least one species. Further details of these are given in Appendix D: Birds Technical Report. All of these sites have been designated as SPAs on the basis of the suite of breeding species present. See Figure 9.3.6.

International importance of Ireland's breeding seabirds

For fifteen species, more than 1% of the bio-geographical population breeds in Ireland. For two species, European Storm-petrel and Roseate Tern, more than 10% of the biogeographical populations are found breeding in Ireland, while significant numbers of Great Cormorant and Manx Shearwater also breed.

On the global level, more than 1% (the threshold that indicates international importance) of the global breeding populations of nine species of seabird breeds in Ireland, with European Storm-petrel and Northern Gannet the most important species.

Seabirds at sea

At least 45 species of seabird have been recorded during at-sea surveys (Pollock *et al* 2007, Mackey *et al* 2004). The following accounts summarise the at-sea distribution of the most regularly occurring species. More detail is given in Appendix D: Birds Technical Report.

Divers and grebes: Three species of divers occur regularly off the Irish coast; Red-throated Diver, Black-throated Diver and Great Northern Diver. All three prefer inshore waters, with sandy or rocky bottoms.

Petrels: Northern Fulmar and European Storm-petrel are regularly recorded in Irish waters, while Leach's Storm-petrel and Wilson's Storm-petrel are seen less often. Northern Fulmar is the only resident petrel species, and is widely distributed in low to moderate density over shelf waters (out to 200m). European Storm-petrels winter off southern Africa, returning to Irish waters to breed, and so are most abundant in summer months.

Leach's Storm-petrels are predominantly found over deeper water, only returning to breeding colonies at night. Wilson's Storm-petrel is a rare but regular visitor to Irish waters, with the majority of sightings occurring over the shelf edge between June and August.

Shearwaters: Five species are regularly recorded in Irish waters in the summer months, but only Manx Shearwater actually breeds, with several internationally important colonies. Highest density of Manx Shearwaters on ESAS surveys was recorded between July and August in the Irish Sea, where birds associate with the Irish Sea front, as well as off the Welsh colonies of Skomer and Skokholm (Pollock *et al* 2007). Manx Shearwaters were also found in moderate to high densities off the south west coast, and in offshore areas such as the Rockall Bank (Mackey *et al* 2004).

Sooty Shearwater, Cory's Shearwater and Great Shearwater are all non-breeding visitors to Irish waters, mostly in late summer and early autumn. Small numbers of Balearic Shearwater are also recorded in late summer and autumn, particularly off the south-west coast. The species is listed as Critically Endangered on the 2007 IUCN (World Conservation Union) Red List (Birdlife International 2007), and is also Annex I listed, and Red Listed by BWI (Lynas *et al* 2007).

Northern Gannet: ESAS surveys show that Northern Gannets are generally found in low to moderate density over Irish shelf waters throughout the year, with high densities in inshore areas recorded close to the main breeding colonies in the south-west in summer months.

Great Cormorant and Shag: Highest densities of Great Cormorants were recorded on surveys in Galway Bay, Dingle Bay and Tralee Bay, while moderate to high densities of European Shags were recorded along the north-west and south-west coasts (Pollock *et al* 1997).

Seaduck: Five species of seaduck have been recorded in low numbers on ESAS surveys in Irish waters; Common Eider, Common Scoter, Velvet Scoter, Common Goldeneye and Red-breasted Merganser (Pollock et al 1997).

Grey Phalarope: Sightings of Grey Phalaropes on ESAS surveys occurred mainly off the west coast over shelf waters, between July and October (Pollock *et al* 1997).

Skuas: Four species of skua are regularly recorded in Irish waters. Great Skua and Arctic Skua are the most commonly seen, while Pomarine Skua and Long-tailed Skua occur in smaller numbers.

Gulls: Seven species of gull are regularly recorded on ESAS surveys in Irish waters. Little Gulls are present in varying numbers off the Irish east coast in winter months. Surveys over the Arklow Bank have recorded large numbers in winter e.g. 4,032 birds in January 2005, which greatly exceeds the internationally important threshold for this species (840 birds - Crowe 2005) (Barton et al 2008). Inshore species such as Black-headed Gull and Common Gull were generally under-recorded on ESAS surveys.

ESAS surveys recorded the majority of Lesser Black-backed Gulls to the south of Ireland in winter months, with coastal waters more important during the breeding season. Herring Gull at-sea distribution showed a north-easterly distribution, with highest concentrations in the eastern Irish Sea and North Channel throughout the year. Great Black-backed Gull distribution was patchy in coastal waters, with low to moderate densities recorded off the west coast in winter, and around the north coast in summer (Pollock *et al* 1997, Mackey *et al* 2000).

In summer, ESAS surveys recorded Black-legged Kittiwakes in moderate to high concentrations all round the Irish coast. In winter, highest densities were recorded in south-west coastal waters and over the shelf edge (Pollock *et al* 1997). In addition, counts of over 10,000 Black-legged Kittiwakes have also been recorded in winter over the Arklow Bank (Barton *et al* 2008).

Terns: Four species of terns are regularly recorded in Irish waters in summer; Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern. Highest recorded densities were concentrated mainly around the breeding colonies (Pollock *et al* 1997).

Auks: Common Guillemot and Razorbill were the commonest two auk species recorded on ESAS surveys in Irish waters, and Common Guillemot was the most numerous species recorded in the Irish Sea. Highest densities of both species were recorded around the main breeding colonies in summer, but large concentrations were also recorded in the western Irish Sea over the east coast sand banks and over the Irish Sea front. Inshore waters were important for moulting auks in August, with highest densities recorded in the bays of south-west Ireland (Pollock *et al* 1997). Both species were widely distributed at low densities in winter, with moderate to high concentrations of Common Guillemots off the south coast at this time.

ESAS surveys recorded Black Guillemots as being patchily distributed in inshore waters throughout the year. Atlantic Puffins were recorded at low to moderate density in the Irish Sea in summer, but showed a more pelagic distribution in winter (Pollock et al 1997).

Wildfowl and waders

There are a total of 28 coastal sites in Ireland listed as being of international importance for at least one species, based on Irish Wetland Bird Survey (I-WeBS) data (Table 9.3.4b)(Crowe 2005). A breakdown of key species at these sites is shown in Appendix D: Birds Technical Report.

Table 9.3.4b: Coastal wetland sites of international importance between 1996/97 and 2000/01

Site	County	Number of species of international/national importance		Mean of summed annual peak 1996 - 2000
		International	National	
Dundalk Bay	Louth	5	14	53,722
Shannon & Fergus Estuary	Clare	3	19	52,654
Wexford Harbour & Slobs	Wexford	5	24	40,843
Cork Harbour	Cork	2	18	35,836
Dublin Bay	Dublin	4	15	29,448
Tralee Bay, Lough Gill & Akeragh Lough	Kerry	1	23	28,652
Tacumshin Lake	Wexford	3	11	20,913
Dungarvan Harbour	Waterford	2	13	19,483
Boyne Estuary	Louth	1	8	17,434
The Cull & Killag	Wexford	2	8	17,346
Castlemaine Harbour & Rossbehy	Kerry	1	15	16,687
Inner Galway Bay	Galway	2	15	15,968
Rogerstown Estuary	Dublin	1	16	15,234
Bannow Bay	Wexford	2	11	13,809
Courtmacsherry, Broadstrand & Dunworley	Cork	1	9	13,510
Blackwater Estuary	Waterford	1	7	11,581
Broadmeadow Estuary	Dublin	2	12	10,918
Tramore Backstrand & Bay	Waterford	1	8	10,578
The Mullet, Broadhaven & Blacksod Bays	Mayo	2	9	8,437
Clonakilty Bay	Cork	1	3	7,645

Site	County	Number of species of international/national importance		Mean of summed annual peak 1996 - 2000
		International	National	
Baldoyle Bay	Dublin	1	5	6,699
North Wicklow Coastal Marshes	Wicklow	1	4	6,537
Ballysadare Bay	Sligo	1	4	6,295
Sligo Harbour	Sligo	1	3	4,417
Donegal Bay	Donegal	2	2	4,131
Drumcliff Bay Estuary	Sligo	1	2	2,779
Skerries Islands	Dublin	1	3	2,660
Trawbega Bay	Donegal	2	**0**	2,554

Source: Crowe 2005

9.3.4.4 Quality of Baseline Data

Breeding seabirds

Overall, the quality of survey coverage for seabird 2000 was very good, however, some of the more remote island colonies for hard to census species were not covered. Thus for Manx Shearwater, while the major colonies were covered, some smaller colonies or potential sites were not visited, however. For European Storm-petrel, one of the largest colonies in Ireland, Illaunmaster, was not surveyed, and was highlighted as a priority for future work by Mitchell et al (2004).

Seabirds at sea

In both summer and winter seasons, ESAS survey coverage was generally below the desired level of coverage, with some inshore areas of the south-west and north-west coasts unsurveyed in winter months. In addition, temporal gaps in coverage are an important issue as many species are migratory and risk being under-recorded if there is no coverage at appropriate times of year.

Wildfowl and waders

Land-based counts such as I-WeBS tend to underestimate numbers of divers, grebes and seaduck as counts are conducted on preset dates, which may not coincide with the good weather conditions required to obtain accurate counts of these species (Evans 2000).

There may also be problems covering larger sites, resulting in incomplete counts, incomplete geographical coverage in remote areas and reduced coverage of non-estuarine habitat types e.g. rocky shores. In addition, some species are included as ‘optional’ species to count, and so are not always recorded e.g. gulls and terns.

9.3.4.5 Data Gaps

A review of ESAS survey data in Irish waters, highlighting areas which have not yet been covered or are in need of further surveys has recently been completed (Pollock & Barton in press). A brief summary of seasonal data less than 20 years old is presented here.

Data were summarised into two seasons - summer (April to September) and winter (October to March) to look at seasonal differences in coverage. Seasonal survey coverage was considered adequate if surveys had been conducted in a minimum of 4 months per season. This was defined as coverage of 120 km2 per ¼ ICES rectangle (offshore areas) and 40 km2 per 15'N x 10' W rectangles (inshore areas) (See Figure 1 and 2 in Appendix D)

Although there was coverage over the majority of inshore waters out to 200m in summer, much of this was below the desired target, apart from small areas off Cork Harbour, Galway Bay, off the north-west coast and west of Ireland out to the shelf edge. Further offshore, there were major gaps in coverage in oceanic waters north-west of Ireland, as well as along the shelf break south-west of Ireland.

In winter months, survey coverage was almost entirely restricted to shelf waters (within 200 m depth). Again, coverage was generally below the desired target, and was totally lacking in some inshore areas of the south-west such as Kenmare River, Dingle Bay and Tralee Bay. In the north-west, the Clifden coast, Aran Islands, Clew Bay, the north coast of Mayo and Sligo, inner Donegal Bay, Gweebarra Bay and Sheep Haven also had no coverage. These gaps were mainly because of lower vessel availability and harsher weather conditions.

9.3.4.6 Key Issues and Future Trends

Vulnerability to surface pollution and disturbance: Many shallow inshore areas contain important aggregations of diving waterbirds such as divers, ducks and grebes. These areas provide key feeding grounds for large numbers of birds during winter, and also during summer for coastal breeding species. As such, these inshore areas are particularly vulnerable to surface pollution and disturbance.

Legislation: Currently there are no entirely marine SPAs protecting offshore aggregations of seabirds or important feeding locations for particular species in Irish waters. The SPA designation process is ongoing and seaward extensions of existing designated coastal seabird colonies are expected to give protection to feeding or resting birds in the vicinity of coastal colonies. It is also envisaged that Natural Heritage Areas in the marine environment will be considered in the future.

Climate change: An increase in sea temperatures caused by global warming could have many effects on marine and coastal birds. A rise in sea temperatures may lead to changes in prey availability, affecting the distribution, abundance, and breeding cycles of whole populations of many different species. Rising sea levels may also decrease available feeding areas for migratory wading birds.

9.3.5 Marine Mammals

Due to the large amount of information on marine mammals in Irish waters, a summary of baseline data is presented below. A more detailed baseline description incorporating additional reference material is provided in Appendix E.

9.3.5.1 Data Sources

In assessing baseline data for marine mammals in Irish waters, the following sources have been used:

- Primary data for distribution/abundance maps come from:
  - Irish Whale and Dolphin Group (IWDG) cetacean sighting database
  - Joint Nature Conservation Committee (JNCC) European Seabirds at Sea (ESAS) database.
  - National Parks & Wildlife Service seal census data

- Additional information on distribution and abundance come from programs such as:
  - Small cetaceans in the European Atlantic and North Sea (SCANS I &II)
  - Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA)
  - Reid et. al. (2003) Atlas of Cetacean distribution in north-west European waters
  - Berrow et. al. (2002) Irish Whale and Dolphin Group Cetacean Sighting Review (1991-2001)

- Species–specific information on distribution, abundance, diet, and general ecology are referenced in the text below and Appendix E and are sourced from:
  - Scientific journal articles
  - Reports to funding bodies, and other unpublished literature which may not necessarily have been peer-reviewed, but do provide useful general baseline information.

9.3.5.2 Background

Below is a summary of the known distribution and abundance of marine mammals off the coast of Ireland. 28 species of marine mammal are known to occur in these waters (24 cetacean, 2 seal, walrus, and otter).

Ireland is obliged to implement the EC Habitats Directive on the Conservation of Natural Habitats and of Fauna and Flora. The Habitats Directive states that species listed in Annex IV require strict protection; prohibiting deliberate capture, killing, disturbance (particularly during breeding, rearing, and migration), and deterioration or destruction of breeding sites or resting places. All cetacean species occurring in European waters are listed as Annex IV species. Five species are further listed as Annex II species of community importance (bottlenose dolphin, harbour porpoise, grey seal, harbour seal, otter) and require the designation of Special Areas of Conservation (SACs) for their protection.

The Wildlife Act 1976 and Wildlife (Amendment) Act 2000 are Ireland’s primary national legislation for the protection of wildlife. It provides strict protection from injury and disturbance/damage to breeding or resting places, and covers all dolphin, porpoise, seal and whale species.

Table 9.3.5: List of marine mammal species occurring in Irish waters and current conservation status

Species	Conservation Status	Special Areas of Conservation (SAC)
Minke whale	Good	N/A
Sei whale	Unknown	N/A
Blue whale	Unknown	N/A
Fin whale	Good	N/A
Beluga/White whale	Unknown	N/A
Common dolphin	Good	N/A
Northern right whale	Unknown	N/A
Long-finned pilot whale	Unknown	N/A
Pygmy sperm whale	Unknown	N/A
Risso’s dolphin	Unknown	N/A
Northern bottlenose whale	Unknown	N/A
Atlantic white-sided dolphin	Good	N/A
White-beaked dolphin	Unknown	N/A

Species	Conservation Status	Special Areas of Conservation (SAC)
Humpback whale	Unknown	N/A
Sowerby's beaked whale	Unknown	N/A
Gervais' beaked whale	Unknown	N/A
True's beaked whale	Unknown	N/A
Killer whale	Unknown	N/A
Harbour porpoise*	Good	Roaringwater Bay, Blasket Islands
Sperm whale	Unknown	N/A
False killer whale	Unknown	N/A
Striped dolphin	Unknown	N/A
Common bottlenose dolphin*	Good	Lower River Shannon
Cuvier's beaked whale	Unknown	N/A
Harbour seal/Common seal*	Good	Glengarriff Harbour and Woodland, Donegal Bay (Murvagh), West of Ardara/Maas Road, Galway Bay Complex, Killala Bay/Moy Estuary, Ballysadare Bay, Cummeen Strand/Drumcliff Bay (Sligo Bay), Clew Bay Complex, Kilkieran Bay and Islands, Kenmare River, Rutland Island and Sound
Grey seal*	Good	Roaringwater Bay and Islands, Horn Head and Rinclevan, Slieve Tooey/Tormore Island/ Loughros Beg Bay, Lambay Island, Inishbofin and Inishshark, Slyne Head Islands, Duvillaun Islands, Inishkea Islands, Saltee Islands, Blasket Islands
Walrus	Unknown	N/A
Otter*	Poor	Blackwater River, Castlemaine Harbour, Clew Bay Complex, Connemara Bog Complex, Galway Bay Complex, Glengarriff Harbour and Woodland, Gweedore Bay and Islands, Kenmare River, Kilkieran Bay and Islands, Lough Melvin, Lough Swilly, Lower River Shannon, Mullet/Blacksod Bay Complex, Mulroy Bay, Mweelrea/Sheeffry/Erriff Complex, North Inishowen coast, River Barrow/River Nore, Roaringwater Bay and Islands, Slaney River Valley, Slieve Tooey/Tormore Island/Loughros Beg Bay, The Twelve Bens/Garraun Complex, Tralee Bay and Magharees Peninsula, West of Ardara/Maas Road

*Included on Annex II of the EU Habitats Directive and requiring designation of Special Areas of Conservation (SAC)
Source: NPWS, 2008

9.3.5.3 Baseline Description

Cetaceans

24 species of cetacean are recorded in Irish waters, of which 10 are considered to be resident (Atlantic white-sided dolphin, harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, white-beaked dolphin, killer whale, bottlenose whale, pilot whale and sperm whale). Seven species are considered migratory (blue whale, fin whale, sei whale, minke whale, northern right whale, humpback whale and striped dolphin), and the remaining 5 species are vagrants (Gervais' beaked whale, True's beaked whale, pygmy sperm whale, white whale, and false killer whale). Marine mammal distribution in Ireland is shown in Figure 9.3.7a. SAC designation for marine mammals is shown in Figure 9.3.7b

Minke whales (*Balaenoptera acutorostrata*) are the most widespread and frequently recorded baleen whale in Ireland. They are considered migratory and occur along all coasts and in the Irish Sea, with most records occurring on the south and southwest coasts (Reid *et al*. 2003). SCANS II abundance estimates were 2,222 individuals in Atlantic coastal Ireland with a further 1,073 in the Irish Sea.

Blue whales (*Balaenoptera musculus*) sightings are a relatively rare occurrence in Irish waters. They generally travel alone or in small groups, with numbers peaking in October to December (Clark & Charif 1998, Charif *et al*. 2001). Peak detection using acoustic monitoring methods occurs in November and December (Charif & Clark 2009).

Fin whales (*Balaenoptera physalus*) are seasonally abundant off the south coast of Ireland, with peak numbers from September to March (Clark & Charif 1998, Charif *et al*. 2001) and highest acoustic detection in December and January (Charif & Clark 2009). High site fidelity and inter-annual occurrence of individuals along the south coast suggest that these inshore waters are an important habitat (Whooley *et al*. 2005).

Sei whales (*Balaenoptera borealis*) tend to occur in deep water beyond the continental shelf (NPWS 2008).

Humpback whales (*Megaptera novaeangliae*) have been recorded in small numbers inshore off all coasts including the Irish Sea, with the majority of sightings occurring along the Cork coast (Berrow *et al*. 2002). Singing individuals have been recorded October-March moving south-westerly, suggesting that the offshore waters west of Ireland are a migration corridor (Charif *et al*. 2001, Charif & Clark 2009). Repeat sightings of individuals shows high site fidelity along the south coast (Whooley *et al*. 2005).

Sperm whales (*Physeter macrocephalus*) tend to occur in deep-water off the western seaboard and over deep gullies and canyons (de Soto *et al*. 2004, Reid *et al*. 2003). Sighting records show them to be most abundant during summer and autumn.

Pygmy sperm whales (*Kogia breviceps*) are rarely sighted in Ireland, and only a handful of records of stranded individuals have been made (Berrow & Rogan 1997).

Beluga or White whales (*Delphinapterus leucas*) are considered vagrants in Irish waters with very few reported sightings (Reid *et al*. 2003).

Long-finned pilot whales (*Globicephala melas*) tend to occur along the shelf edge, and have been observed in surveys off the northwest coast (Gordon *et al*. 1999). They are rarely seen inshore except during strandings, and are most often recorded June-August.

Harbour porpoise (*Phocoena phocoena*) is the most widespread and abundant species in Ireland occurring over the continental shelf and all around the coast. Harbour porpoises rarely occur over deep water as they predominately feed on demersal fish species. Harbour porpoise abundance in Atlantic coastal Ireland was estimated at 10,716 individuals, with a further 15,230 in the Irish sea (SCANS-II 2008). The density of harbour porpoises in the Celtic Sea had doubled between the SCANS-I and SCANS-II surveys, but may reflect a change in the overall distribution of harbour porpoises rather than an actual population increase. High densities of harbour porpoise have also been recorded in Galway Bay, Roaringwater Bay, Dublin Bay and the Blasket Islands (Berrow et al 2008a,b). SACs have been designated for harbour porpoise conservation at the Blasket Islands and Roaringwater Bay. Within the Blasket Islands SAC, recent surveys give a robust estimate of 303 individuals in 2007 (Berrow *et al*. 2009).

Common dolphins (*Delphinus delphis*) are the second most frequently sighted species in Ireland are most abundant off the southwest and northwest coasts and in the Celtic Sea (Reid *et al*. 2003). They are also observed over deep water, especially along the edge of the continental shelf. Common dolphin abundance estimates from the SCANS-II surveys were 15,327 in Atlantic coastal Ireland, and 366 in the Irish Sea. Between SE Ireland and west Wales, abundance of common dolphins was estimated to be 186 in 2004, 1644 in 2005, and 2166 in 2006 (Evans *et al*. 2007).

Bottlenose dolphins (*Tursiops truncatus*) have a coastal distribution with most sighting records off the western seaboard and in the Celtic Sea (Reid et al. 2003). They are also commonly sighted in the Irish Sea and the continental shelf. Recent studies recorded large-scale movements of bottlenose dolphins, with re-sightings of individuals at distances of up to 650km from each other (O'Brien et al. 2008). Bottlenose dolphins using the waters of Connemara also appear to belong to a single, wide-ranging coastal community (Ingram et al 2009), The SCANS-II surveys estimated abundance at 313 in coastal Ireland, 235 in the Irish Sea, and 5,370 in the Celtic Sea, representing nearly 50% of the estimated 12,645 bottlenose dolphins in the entire SCANS-II northeast Atlantic survey area. The coastal waters off Mayo may represent a population of considerable significance in Irish waters, and the presence of calves showing birthmarks/neonatal folds, suggests that the region may function as a nursery area (Oudejans et al 2008). The Lower River Shannon has been designated a SAC for bottlenose dolphin conservation, where mark-recapture estimates give an increasing population of 113 in 1997 (Ingram 2000), 121 in 2003 (Ingram & Rogan 2003), 140 in 2006 (Englund et al. 2007), and 114 in 2008 (Englund et al. 2008).

Atlantic white-sided dolphins (*Lagenorhynchus acutus*) tend to occur offshore, mainly along the western seaboard and offshore banks (Ó Cadhla *et al*. 2004, Wall *et al*. 2006, Reid *et al*. 2003). They are rarely seen close to land.

Striped dolphins (*Stenella coeruleoalba*) tend to occur well beyond the continental shelf in depths of 1000m or deeper and are rarely seen in Irish waters.

Risso's dolphins (*Grampus griseus*) have been recorded throughout the year in Irish waters with a wide distribution. They are regularly observed both inshore and offshore along the south and west coasts (NPWS 2008) and inshore off the northwest and southeast coasts (Reid *et al*. 2003).

Killer whales (*Orcinus orca*) have been observed off all coasts and in the Irish Sea but mainly on the continental shelf (Reid *et al*. 2003). Inshore sightings tend to increase during late summer and autumn, with occasional incidences of killer whales entering harbours and estuaries.

White-beaked dolphins (*Lagenorhynchus albirostris*) tend to occur in shallow waters over the continental shelf. They are particularly abundant in the northwest (Ó Cadhla *et al*. 2004, Wall *et al*. 2006, Reid *et al*. 2003). SCANS II surveys estimated abundance of white-beaked dolphins at 267 in Irish coastal waters, and 75 in the Irish Sea.

Beaked whales (northern bottlenose whale, Cuvier's beaked whale, True's beaked whale, Sowerby's beaked whale and Gervais' beaked whale) have been sighted in Irish waters, typically in deeper offshore waters (Reid *et al*. 2003). Beaked whales prefer deep water canyon habitat occurs (MacLeod & Mitchell 2006), which occur to the southwest, the northwest, and the Porcupine Seabight.

Pinnipeds

Grey seals (*Halichoerus grypus*) are widespread in Ireland, but occur in greatest haulout concentrations along exposed southwestern, western and northern coasts (Ó Cadhla & Strong 2007). However, Lambay Island (Co. Dublin) and the Great Saltee (Co. Wexford) are the most important pupping sites in the eastern Irish Sea (Kiely et al 2000). The largest populations are found on the Blasket Islands and the Inishkea Island group. Grey seals give birth from September to late November, and haul out in large numbers during the moult from January to April, although some individuals may start the moult as early as November (Ó Cadhla & Strong 2007). Studies on the foraging distribution of grey seals in southwest Ireland are currently being undertaken by the CMRC, suggesting movements between SW Ireland and NW Scotland. However, sampling effort is limited to the southwest of Ireland, and at this stage, it is not known whether similar foraging ranges are utilized by grey seals along the rest of the Irish coast. Minimum estimates of grey seal abundance in Ireland are 5,509-7,083 grey seals of all ages in 2005 (Ó Cadhla et al. 2005), and 5,343 moulting individuals in 2007 (Ó Cadhla & Strong 2007). Increases in annual pup production have been recorded at several key regional breeding sites (Ó Cadhla et al. 2005). Ten SACs have been designated for grey seals (Table 9.2.5a).

Harbour seals (*Phoca vitulina*) are widespread around Ireland, with the largest populations occurring along the west coast. Haul-out groups tend to be found on tidally exposed areas of rock, sandbanks or mud in inshore bays and islands, coves and estuaries (Lockley 1966, Summers *et al*. 1980). Harbour seals pup in June and July. The annual moult is thought to occur from late July through August, representing peak abundance at haulout locations, which is used to give a minimum population estimate. The most recent national survey in 2003 calculated a minimum population of 2905 harbour seals (Cronin *et al*. 2007). Limited studies on the at-sea distribution of harbour seals in southwest Ireland suggests foraging generally no further than 20km from the haul-out sites, however numbers of individuals tagged is small (n=17) so it is uncertain if the behaviour of this sample is representative of the population. Longer distance trips of up to 200km and 850km from haul-out sites have been recorded in the UK and US respectively (Rehberg & Small 2001, Sharples *et al*. 2005). Eleven SACs have been designated for harbour seal conservation (Table 9.3.5a).

Otters

Otters (*Lutra lutra*) occupy both freshwater and coastal habitats, and Ireland is considered to hold one of the most important otter populations remaining in Western Europe (Whilde 1993). Surveys carried out in the early 1980s, early 1990s and early 2000s confirmed the species to be widespread throughout the country (Bailey & Rochford 2006). The Irish population is estimated to be between 10,000 and 20,000 adults (NPWS 2008). 44 SACS have been designated for otter conservation, 23 of which are in offshore coastal areas (Table 9.3.5a).

Key Issues and Future Trends

By catch: The incidental capture and entanglement in fishing nets is one of the main threats to marine mammals (Lewison *et al*. 2004), with many cetacean and seal species recorded as by-caught in Irish waters. Although difficult to quantify, illegal killing of individual seals at fishing gear also occurs (Duggan 2003). Ireland is subject to the EU's Bycatch Regulation 812/2004, which requires monitoring of cetacean bycatch in pelagic trawl fisheries and use of acoustic deterrents (pingers) on vessels using bottom-set or entangling gillnets off the south and southwest coasts.

Phocine distemper virus: (PDV) outbreaks in 1988 and 2002 caused widespread mortality in the European harbour seal population (Hall *et al*. 2006). During the 2002 outbreak, positive pathology was recorded from an individual found on the Aran Islands (NPWS, unpublished data). However, it is unclear to what extent the disease affected Irish populations. While harbour seals are highly susceptible to infection, sympatric grey seals appear resistant, but could be important asymptomatic carriers of the disease (Härkönen *et al*. 2006).

Climate change: changes in prey availability and distribution, abundance and migration patterns, community structure, susceptibility to disease and contaminants are all potential consequences of climate change (Learmonth *et al.* 2006). Cetacean strandings and sightings off the west coast of Scotland have also shown a trend towards increasing warmer water species and decreasing colder waters species (MacLeod *et al*. 2005). Changes to the shoreline as a result of rising sea levels may also decrease available haul out sites for seals.

Habitat disturbance or loss: Fishing activity may degrade the seafloor and its resident benthic fauna (Piet *et al*. 2000). Coastal development including harbour developments e.g. pier construction, channel dredging etc can cause significant disturbance to marine mammals, and seals in particular can be affected at their terrestrial haul-out sites, resulting in change in habitat use.

Resource Competition: As top predators marine mammals and humans share a common resource of fish. Overfishing will potentially impact negatively on marine mammals directly through reducing the biomass of fish available, and indirectly by causing changes in the marine ecosystem.

Pollution: High concentrations of PCBs have been associated with an increase in disease in cetaceans in UK waters (Jepson *et al*. 2005), and toxic algal blooms have also been linked to deaths and neurological dysfunction of marine mammals (Scholin *et al*. 2000). Plastics represent an additional threat to marine mammals, with a large number of species known to be harmed and/or killed by plastic debris through entanglement or ingestion (Derraik 2002).

Noise: Noise is considered an acoustic pollutant, and the expansion of renewable energy devices into the marine environment may create additional sources of underwater noise causing disruption of behaviour during construction and, to a lesser degree, during operation (Madsen *et al*. 2006). Detailed studies of the impact of wind farm construction on cetaceans, mainly harbour porpoises, were carried out in association with the Horns Reef and Nysted windfarms in Denmark. Displacement of harbour porpoises has been shown to occur during construction (Carstensen *et al*. 2006), and simulated underwater noise from a 2MW wind-turbine resulted in avoidance behaviour by both harbour seals and harbour porpoises (Koschinski *et al*. 2003). The impact on baleen whales is likely to be greater as they are more sensitive to low frequency sounds. The impact of wave and tidal devices on marine mammals is also not well researched and understood. Shipping is an important source of such ambient noise, which may also mask the low frequency sounds produced by baleen whales for communication and navigation.

9.3.6 Marine Reptiles

9.3.6.1 Data Sources

In assessing protected sites within the study area, the following data sources have been used:

- 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 (Doyle, 2007)
- Jellyfish aggregations and leatherback turtle foraging patterns in a temperate coastal environment. Ecology 87: 1967-1972. (Houghton et al., 2006)
- Prey landscapes help identify potential foraging habitats for leatherback turtles in the NE Atlantic. Marine Ecology-Progress Series 337: 231-243. (Witt et al., 2007)
- High-use oceanic areas for Atlantic leatherback sea turtles (Dermochelys coriacea) as identified using satellite telemetered location and dive information. Marine Biology, 149, 1257-1267 (Eckert, 2006)
- Flexible foraging movements of leatherback turtles across the North Atlantic Ocean. Ecology, 87, 2647-2656 (Hays et al., 2006)
- Endangered species - Pan-Atlantic leatherback turtle movements. Nature, 429, 522-522 (Hays et al., 2004)
- Provisional list of the occurrence of the leathery turtle, Dermochelys coriacea (L) for the British Isles since 1971. Unpublished manuscript (King, 1983)
- Marine turtles in Irish waters. Irish Naturalist's Journal (King & Berrow, 2009)
- Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate. Global Change Biology, 12, 1330-1338 (McMahon & Hays 2006)
- TURTLE: A Database of marine turtle records for the United Kingdom & Eire (Pierpoint & Penrose 1999)
- The status of EU protected habitats and species in Ireland. Conservation status in Ireland of habitats and species listed in the European Council Directive on the Conservation of Habitats, Flora and Fauna 92/43/EEC. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government (NPWS 2008)
- Review of marine turtle records in Northern Ireland. Environment and Heritage Service, Research and Development Series. No 07/02 (King, 2006)
- Leatherback turtles: The menace of plastic. Marine Pollution Bulletin, 58, 287-289 (Mrosovsky et al. 2009).
- Diversification trials with alternative tuna fishing techniques including the use of remote sensing technology. Final report of EU Contract 98/010, Bord Iascaigh Mhara, Dun Laoghaire. (2000)
- Strategic Environmental Assessment (SEA) of Offshore Wind and Marine Renewable Energy in Northern Ireland, Environmental Report, Department of Enterprise, Trade and Investment (DETI) (2009)

9.3.6.2 Baseline Description

Leatherback sea turtles (*Dermochelys coriacea*) are a migratory species that can occur anywhere in Irish coastal waters between June and October (see Figure 9.3.8). They are more likely to occur in higher numbers off the south and west coasts of Ireland because of their facing aspects. There is a greater probability of leatherback occurrence in areas where jellyfish (turtle food) regularly occur in high concentrations. Irish oceanic waters may also support appreciable densities of foraging leatherbacks because of the high abundance of gelatinous zooplankton located there. Aerial survey estimates of leatherback numbers suggests that the density of leatherbacks in Irish waters is low when compared to similar high latitude foraging areas (e.g. Nova Scotia, Canada). The number of leatherbacks in Irish territorial waters during a summer day is probably in the order of 25. If you include Ireland's marine territory, the number of leatherbacks during a summer day may be as many as 400.

Loggerhead sea turtles (*Caretta caretta*) are also a migratory species that are occasionally sighted during the summer months in Irish waters. It is uncertain whether these individuals are healthy, as summer sea surface temperatures in Irish waters may be too cold. However, loggerheads (and other sea turtles) are often found stranded on Irish beaches during the winter and spring months. These animals are either dead, moribund, or require rehabilitation in an aquarium.

Leatherback turtles are listed in Appendix I of the Convention on the International Trade in Endangered Species of Flora and Fauna (CITES) 1975, Appendix II of the Bern Convention 1979, Appendices I and II of the Bonn Convention 1979, and Annex IV of the Habitats Directive. All marine turtles were added to the 5th Schedule of the Wildlife Act (1976) under the SI 112/1990. Therefore, all marine turtles are protected under the Wildlife Act (1976) where it is an offence to harm, deliberately disturb, possess or trade in them, whether alive or dead (Wildlife Act, 1976 & 2000) (King & Berrow 2009).

9.3.6.3 Key Issues and Future Trends

Issues affecting marine turtles include, but are not limited to:

Entanglement in buoy ropes

A small but significant threat to leatherbacks in Irish coastal waters is from fixed fisheries (i.e. fishing gear that is anchored to the bottom, or rests on the bottom). Examples of fixed gear include the pot fisheries for lobster (*Homarus gammarus*) and crawfish / spiny lobster (*Palinurus elephas*). Another type of fixed gear is the gill net fishery for hake (*Merluccius merluccius*), Angler fish (*Squatina squatina*) and turbot (*Psetta maxima*), although in reality many of these fisheries are mixed (i.e. they target several species). However, in terms of their potential threat to leatherbacks, it is not the actual pots or nets that pose a risk, but the ropes used to secure and mark their positions (i.e. buoy ropes and their loose ends (slack). Leatherbacks that become entangled in fixed gear have a high risk of mortality, because turtles entangled at depth or at the surface during low tide will almost certainly drown. However, considering the amount of fixed fisheries in our coastal waters the number of leatherbacks caught per unit effort is very small. Notably, many of these entangled turtles are released alive.

Fisheries by-catch

Salmon drift net fisheries – The recently banned salmon drift net fishing industry probably had one of the highest encounter rates of leatherback turtles in Irish waters. King & Berrow (2009) stated that of 868 records of leatherbacks turtles recorded in Irish waters, the 'real number of actual captures, especially in surface drift nets was much higher', 'as in many cases, turtles caught in nets and released alive were recorded as sightings'. Importantly, there was a very low mortality (if any) of by-caught individuals as most turtles were very loosely entangled and could come to the surface to breathe. **Other fisheries** – It is uncertain what impact other fisheries in Irish waters may have on leatherbacks. A trial to make pelagic pair trawls for albacore tuna a viable option to replace the banned tuna drift-net fisheries, recorded two leatherback turtles as by-catch with both specimens returned to the sea alive (BIM 2000). However, as the tuna catches are very sporadic and the diesel costs (to run the boats) very high, there are only 2 – 3 pairs of vessels fishing each year, and only for ~1 month during the summer. As such this fishery may have relatively minor impact leatherback mortality.

Global perspective – Globally, one of the biggest threats to leatherbacks are the interactions with pelagic longline fisheries for tunas (*Thunnus* spp), swordfish (*Xiphias gladius*) and blue shark (*Prionace glauca*). These fisheries generally use a monofilament polyamide longline, that can be up to 80 kilometres long, with ~ 1300 hooks baited with squid or/and mackerel per set, at a depth of 40-80 m. There are no Irish or European vessels fishing this way and as such no longlining within Ireland's Exclusive Fisheries Area (i.e. 200 nautical miles from shore). However, outside of this area Japanese long-liners fish for blue-fin tuna from August to November. Their fishing effort is sporadic (largely depending on where the fish are) and at times they concentrate their effort as far south as the Azores.

Marine litter

Marine pollution in the form of plastic bags and debris offers a real threat to leatherback turtles in Irish waters as turtles seemingly cannot discriminate between indigestible plastic debris and their jellyfish food. A recent study by Mrosovsky *et al.* (2009) found that about one third of adult leatherbacks have ingested plastic. It is difficult to ascertain whether such plastic causes mortality or not.

Ship strikes

Leatherback sea turtles spend time at the surface to breathe and are therefore vulnerable to boat strike and propeller injuries. There are no figures on how frequently this happens or not.

Climate change

Considering recent trends of warming seas, leatherback sea turtles and loggerheads are likely to increase in abundance and occupancy in Irish waters. Changes in the distribution and abundance of their food are also likely.

9.4 Cultural Heritage including Archaeological Heritage

9.4.1 Marine and Coastal Archaeology and Wrecks

9.4.1.1 Data Sources

- Strategic Environmental Assessment SEA 6: The scope of Strategic Environmental Assessment of Irish Sea Area SEA 6 in regard to prehistoric archaeological remains (Flemming 2005)
- Deep Water Environment to the West of Ireland, Report to the Irish Shelf Petroleum Studies Group (Hartley Anderson 2005)
- Irish Wrecks Database (irishwrecksonline 2010)
- Seaarea Wrecks Database

9.4.1.2 Background

Submarine archaeology in Ireland can be divided into two distinct fields of interest:

- The potential for discovery of the preserved remains of pre-historic settlement sites submerged as a result of sea level changes.
- Investigation of wrecks and associated objects

The existence of submerged pre-historic sites off Ireland is largely a matter of conjecture. However, the existence of extensive inundated land areas off the coast of Ireland, that were both ice free and accessible, through land bridges from mainland Europe, allows the possibility of remains predating the earliest known (Mesolithic, about 10,000 years BP) Irish land sites. During later pre-historic and early historic periods there is a wealth of evidence of settlement and land use throughout Ireland, with numerous sites which are either maritime (e.g. medieval harbour facilities), reflect maritime interests (e.g. coastal fortifications) or are situated on the coastline. Accordingly the focus of marine archaeology shifts to the search for evidence of maritime trade and warfare.

Legislation acting to protect submarine archaeological remains in Ireland is based on provisions of the United Nations Convention on Law of the Sea (UNCLOS) 1982 and of the European Convention on the Protection of the Archaeological Heritage (Revised) 1992 (the Valletta convention), both of which oblige signatories to protect submerged archaeological remains. Wrecks greater than 100 years old and underwater archaeological objects in Irish territorial and continental shelf waters are protected under the provisions of The National Monuments Acts 1930 to 1994. The act also allows the imposition of an Underwater Heritage Order, in order to protect sites of historical, archaeological or artistic importance. These can include wrecks less than 100 years old (e.g. RMS Lusitania, sunk May 1915, was placed under such an order in 1995). Current proposals (National Monuments Service 2009) are likely to extend protection to later wrecks (e.g. World War II) if required. They will also allow Ireland to ratify the United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the Protection of Underwater Heritage 2001.

The National Monuments (Amendment) Act 1994 provides for State ownership of archaeological objects found in the State which have no known owner at the time of finding. The Director of the National Museum of Ireland (NMI) has statutory responsibility in respect of decisions on the retention in the NMI or other disposal of such material. Under the Merchant Shipping (Salvage and Wreck) Act 1993 the Director of the NMI has a statutory role regarding dealing with notifications from receivers of wreck of unclaimed wreck and the retention on behalf of the State of unclaimed wreck if it is of archaeological interest.

9.4.1.3 Baseline Description

Submerged Pre-historic Sites

The pre-historic submarine archaeology of the study area is largely a matter of conjecture, as no remains have been found. Early settlement of Ireland is likely to have been initially dominated by the extent of ice cover and access routes from the mainland of Europe. However, ice free land areas are likely to have existed off the current south and south-western coastlines of Ireland as long ago as 22,000BP. These would have become increasingly accessible during the following 4000 years with land bridges between Ireland and mainland Europe up until between 12,000 and 20,000BP (Flemming 2004).

Early occupation of Ireland was probably by nomadic hunter/gatherer groups, without permanent settlements, but temporary habitation sites may remain below the present sea level. With the advent of settled communities (based on agriculture) there is a wealth of archaeological and historic sites throughout the land mass of Ireland and the focus of marine archaeology tends to shift to the search for evidence of trade routes and shipping rather than evidence of human habitation.

Preservation of submerged remains requires low energy conditions and is most favoured by rapid burial of remains. Alternatively shelter from prevailing conditions may be provided by coastal features such as islands or bays. Rediscovery of sites depends on low sedimentation rates and is favoured by gentle erosion, leading to exposure of the site.

It should be noted that the best conditions for preservation of archaeological remains are unlikely to be found in areas where tidal and wave energy resources are potentially exploitable. Wind energy sites may provide better conditions for preservation. In all cases, however, seabed surveys and infrastructure installations may reveal such sites adventitiously. The archaeological importance of submarine sites of any age is such that all efforts should be made to recognise and/or preserve them.

The following types of remains may be present in the study area:

Paleolithic (up to about 9,000BP): While it is possible that early hominid and human settlements existed in Ireland, as yet no evidence for them has been found. While remains have been found in England dating from up to 700,000BP, it is probable that any terrestrial sites in Ireland dating from before 22,000BP (the period of greatest ice cover in the most recent glaciation) have been destroyed. However, an ice free land bridge connected Ireland with adjacent land masses (both Britain and France) during a period from around 20,000 to 13,000BP. In addition there were extensive coastal areas which have since been submerged (Flemming 2004). Thus it is possible that remains exist within the continental shelf area dating from the period between 22,000 and 9000BP. It is clear that any finds dating from this period would be of the highest importance.

Mesolithic period (9,000 to 5000BP): There is limited evidence for human activity in Ireland during the Mesolithic period; however, the earliest known Irish sites (in Northern Ireland) date from around 9000BP. These settlements were probably temporary in nature reflecting a predominantly nomadic culture. As sea levels have risen through much of the study area, it is likely that some archaeological sites from this period are now underwater (Bell et. al. 2006). As there was no direct connection between Ireland and other European lands during the Mesolithic, human settlement of Ireland implies the use of vessels of some type. In this context the oldest known remains of logboats (from the Netherlands) date as far back as 9000BP while remains found in (Northern) Ireland date back to 7300BP.

Neolithic and late pre-historic (5000BP to 1600BP): By contrast to the Mesolithic period, there are many Neolithic (i.e. from 5000BP to 3500BP in Ireland), Bronze Age (up to 2500 yrs BP) and early Iron Age (up to about 1600 yrs BP) sites throughout Ireland, reflecting a similarity in settlement patterns, based on agriculture, throughout this period. Shorelines were essentially those of modern Ireland, thus extensive inundated settlement sites are unlikely. Known submerged sites include fish traps and weirs. There is also the possibility of finding evidence for transport routes, either through complete or partial remains of trading vessels or their cargoes. There is also abundant evidence for offshore fishing and overseas trade during the Neolithic period.

Within the study area, areas that have been identified as possessing a potential for future archaeological discoveries are:

Irish Sea: The Irish Sea is unique among the North European shelf seas in that no submarine pre-historic sites have been identified. It appears highly probable that the Irish Sea floor and in particular the edges of the Irish Sea Deep, which was likely to have been an ice dammed lake for 4000 years, were occupied during the late Paleolithic and Mesolithic periods.

Continental Shelf South of Ireland: The land bridge, linking Ireland to Wales, Cornwall and France extended along the entire south coast of Ireland. It is likely that the seaward boundary of this area was inhabited by fishing communities. Submerged, infilled river valleys and estuaries may contain evidence of settlement sites

Western Ireland Inlets: The floors of bays and inlets on the western coast of Ireland, particularly where protected by islands, may have provided sheltered settlement sites with the potential for subsequent preservation. However settlements may have existed further offshore and thus there are potentials discoveries throughout the area although preservation in exposed areas of this coastline is unlikely.

Shipwrecks and Associated Remains

The submarine archaeology of the later pre-historic to modern periods is predominantly concerned with the search for, and preservation of, evidence of commerce and war. The Underwater Archaeology Unit of the National Monuments Service is currently preparing an inventory of recorded shipwrecks in Irish waters; however, this is not yet available online. Charted wrecks (279) in or adjacent to Irish waters are shown in Figure 9.4.1. A web database designed for divers (irishwrecksonline 2010) lists a total of 8008 recorded wrecks around the Irish coastline (Table 9.4.1), of which 6015 are more than 100 years old with the oldest wreck listed dating to about 500 AD. For all wrecks over 100 years old protection is automatic and the requirement to report recovered artefacts extends to all objects originating from them. In addition there are 874 records dating from the period 1914-18 and 498 from 1939-45 (including a number of aircraft wrecks). One of them, the R.M.S Lusitania, sunk 20km off Kinsale Head (Cork) in 1915, is protected under an Underwater Heritage Order. While not all of these wartime wrecks are the result of military action the majority are likely to have been so and may be considered as war graves.

Table 9.4.1: Recorded Wreck Sites on the Irish Coast

129	Pre- 1910	14-18	39-45	Total
Donegal	464	125	244	923
Sligo (inc Leitrim)	77	1	2	89
Mayo	215	22	16	279
Galway	198	15	35	310
Clare	166	17	12	211
Limerick	62	NR	NR	64
Kerry	343	56	30	467
Cork	1071	379	99	1652
Waterford	556	39	9	652
Wexford	1279	140	37	1602
Wicklow	420	29	4	478
Dublin	882	45	8	979
Louth (inc Meath)	282	6	2	302
Totals	6015	874	498	8008

Source: Irishshipwrecksonline.com , 2010 [NR – None Recorded]

While the majority of vessels wrecked, particularly those constructed of wood, are likely to have been broken up both as a result of impact with coastal features and due to subsequent salvage efforts, some items may have been preserved even under the most adverse conditions. In particular metal and ceramic objects are resistant to destruction or relocation and can be found in extremely high energy environments. Where vessels have sunk in harbours or enclosed waters a considerable degree of preservation can result through burial, although such wrecks are likely to have been subject to some degree of looting. Further, throughout the period, and particularly during the 20th century a proportion of vessels (including aircraft) will have been lost through incidents not involving grounding (e.g. adverse weather, icebergs, human error, fire, enemy action). The locations of wreckage from such incidents are likely to be unknown or unsure, particularly in deep water or where smaller vessels were concerned. However, if found such wrecks are often near intact. While the majority of preserved wrecks are likely to be younger than the current general protection it is probable that wrecks of any age considered important will be protected in the near future.

Coastal Sites

In addition to the submerged marine sites there are a wide variety of near coastal archaeological and cultural heritage sites. These range from sites which were essentially maritime in purpose (e.g. harbours, seawalls, navigation aids) to sites which were functionally dependant on a coastal site (e.g. tide mills, coastal fortifications) to the many sites which merely occur on the coast, with similar sites remote from the coast (e.g. stone circles, religious houses). Many of these are important tourist resources which partly depend for their attraction on the quality of their local environment. Information on sites is available from the website of the National Monuments Service (2007). Legal protection to these sites is provided under the terms of the National Monuments Act and Amendments (1930 to 2004).

Protected Archaeological Sites

There are currently two World Heritage Sites in Ireland, which are protected for archaeological interest features:

- The Archaeological Ensemble of the Bend of the Boyne
- Skellig Michael

The Archaeological Ensemble of the Bend of the Boyne (Brú na Bóinne) was designated as a World Heritage Site by UNESCO in 1993 in recognition of the site being Europe's largest and most important concentration of prehistoric megalithic art. The three main prehistoric sites of the Brú na Bóinne Complex, Newgrange, Knowth and Dowth that make up the Ensemble are situated on the north bank of the River Boyne 50 km north of Dublin.

The monastic complex of Skellig Michael was designated in 1996 as it is considered to be of outstanding universal value as an exceptional and unique example of an early religious settlement. The complex is situated on the rocky island of Skellig Michael, some 12 km off the coast of south-west Ireland.

Ireland ratified the World Heritage Convention in 1991 and although World Heritage Sites are not statutory designations, by signing the Convention, Ireland has pledged to conserve not only the World Heritage sites situated on its territory, but also to protect its national heritage.

9.4.1.4 Future Trends and Key Issues

It is not possible to predict the finding of submerged pre-historic sites. However, if found such discoveries will be of inestimable importance to our understanding of the early settlement of North West Europe. An increasing number of wrecks will come under the protection of the National Monuments Act, both as a natural result of the passage of time and also as protection is extended to significant recent wrecks. Correct recording and preservation of any artefacts or remains found is both a legal obligation and would be likely to have a high positive publicity value.

9.5 Population and Human Health

9.5.1 Commercial Fisheries, Shell Fisheries and Aquaculture

9.5.1.1 Data Sources

The following data sources have been used in describing fisheries and aqauculture within the assessment area.

- The Rising Tide: A Review of the Bottom Grown (BG) Mussel Sector on the Island of Ireland. Bottom Grown Mussel Review Group. 2008.
- Atlas of the Commercial Fisheries around Ireland. 2009. Marine Institute.
- The Stock Book 2009. Marine Institute Fisheries Science Services.
- The Status of Irish Aquaculture 2007. Report compiled by MERC Consultants.
- Department of Agriculture, Fisheries and Food Annual Review & Outlook for 2008.
- Fishing Activity, Biological Features and Suggested Management Measures for the Biologically Sensitive Area off the Irish Coast. Paula Harrison MSC thesis, UCC, 2007
- MIDA (2010). Marine Irish Digital Atlas (MIDA). http://mida.ucc.ie
- The Shrimp Fishery: Analysis of the Resource 2003-2007. BIM 2008.

9.5.1.2 Background

According to the Department of Agriculture, Fisheries and Food (DAFF), the Irish seafood industry (covering fisheries, aquaculture and processing) provided 11,000 jobs and €780m in revenue in 2008. In 2008 there were approximately 2,000 fishing vessels on the fleet register and although overall fleet tonnage has declined by 25%, the number of vessels has risen. This is mainly due to the replacement of larger vessels with new inshore vessels.

There is significant fishing activity in Irish waters from the following foreign fleets:

- UK - operating in all Irish waters particularly on Nephrops grounds and in deeper water off the west coast with gillnets,
- France - mainly in the Celtic Sea and west coast targeting Nephrops, whitefish and deep water species,
- Spain - mainly in the western Celtic Sea and along the shelf edge targeting Hake, Angler fish, megrim and Nephrops with trawls, gillnets and longlines.
- Belgium - using beam trawls targeting flatfish and concentrated in the Irish Sea and off the southeast coast,
- Netherlands - targeting pelagic species off the west coast
- Norway - targeting Blue Whiting in deep water off the west coast.

Due to the intensity of fishing effort in Irish coastal waters it is a reasonable assumption that any location within the study area will be subject to commercial fishing of some sort. Available recent maps of fishing effort in Irish waters are drawn from Vessel Monitoring System (VMS) data and do not include smaller vessels (under 15m). Hence areas that may appear to have less fishing activity may well have significant numbers of smaller vessels operating there, particularly in summer using static gear for shellfish. The study area covers all current Irish aquaculture operations and their distribution tends to be much more localized and is mainly concentrated in sheltered or semi-sheltered bays.

9.5.1.3 Baseline Description

Commercial Fisheries

See Figure 9.5.1a.for the location of some restricted fishing and conservation areas in Irish waters. Figures 9.5.1b and 9.5.1c map the distribution of fishing effort for a number of pelagic, whitefish and shellfish species. Table 9.5.1a highlights the most economically valuable species landed by Irish vessels. Further information is presented in Appendix F.

Table 9.5.1a: Top 20 most economically valuable species landed by Irish vessels in 2008

Species	Live weight (Tonnes)	Landed weight (Tonnes)	Value (€)
Mackerel	44,767	44,767	€39,959,734
Nephrops	9,179	5,685	€31,610,454
Horse mackerel	36,631	36,631	€11,521,366
Angler fish	2,837	2,269	€9,658,905
Edible crab	6,979	6,945	€8,324,799
Lobster	497	497	€6,918,843
Haddock	3,715	3,397	€6,208,644
Herring	27,975	27,975	€6,154,596
Megrim	1,745	1,662	€6,118,324
Albacore tuna	1,522	1,522	€5,321,422
Cod	1,524	1,292	€3,582,421
Hake	1,392	1,244	€3,509,386
Whiting	2,564	2,451	€3,453,799
Blue whiting	22,852	22,852	€3,141,641
Scallop	1,071	1,071	€2,744,116
Black sole	212	202	€2,214,319

Species	Live weight (Tonnes)	Landed weight (Tonnes)	Value (€)
Whelk	1,816	1,816	€2,027,405
Shrimp	156	156	€1,950,000
Ray	1,237	1,083	€1,851,590
Pollack	702	617	€1,530,590

Source: Atlas of Commercial Irish Fisheries, 2009

Pelagic Fisheries

Pelagic fisheries target shoaling fish mainly found swimming in the water column and are mainly operated by large, modern vessels known as refrigerated rea water or RSW vessels. However lower volumes of pelagic species are also caught by other fleet sectors such as the polyvalent and inshore fleets.

Mackerel was the most valuable Irish fishery in 2008 at almost €40 million, and also the largest by volume at 44,000 tonnes. The winter-spring fishery by the larger pelagic and polyvalent RSW vessels tends to follow the shelf break at around 200m depth, and as such a substantial proportion of that fishing activity would be outside of the study area. Mackerel fishing in summer and autumn (mainly July – October) tends to be conducted by inshore vessels using gear including handlines, jigging machines and gillnets.

Horse mackerel is almost exclusively targeted by pelagic and polyvalent RSW vessels in winter and spring. The fishery is concentrated around the 200m depth contour although the pattern of landings has a more northerly focus.

Blue whiting is an exclusively RSW fishery which is mainly conducted in deep water north of the Porcupine Bank i.e. the majority of the fishing effort occurs outside of the assessment area.

The Irish **herring** fishery is mainly an inshore shallow water fishery and is targeted by vessels of less than 10m to vessels of over 70m. The fishery has two main focal areas, Donegal and Waterford/Cork. Both fisheries are conducted mainly between October and January.

Albacore Tuna: The Irish Albacore Tuna fishery began as a drift net fishery in the early 1990's fishing in the summer months from the Bay of Biscay up to the Porcupine Seabight. Since drift-netting for this species was banned in 2002, Irish vessels have mainly targeted the fishery using pair-pelagic trawling. Some smaller vessels use the "trolling" method, which involves multiple lines with lures towed behind the vessel.

Demersal Fisheries

Demersal fisheries target species on or near the sea bed, where fish tend to occur in a diverse mixtures of species. Important demersal fisheries in Irish waters include, cod, haddock, whiting, hake, plaice, sole, rays, Angler fish and megrim. These fisheries are usually targeted using trawls, gill-nets and long-lines. The semi-discrete demersal fisheries which exist in Irish waters which may be grouped as in Table 9.5.1b.

Table 9.5.1b: Main Demersal Fisheries in Irish Waters

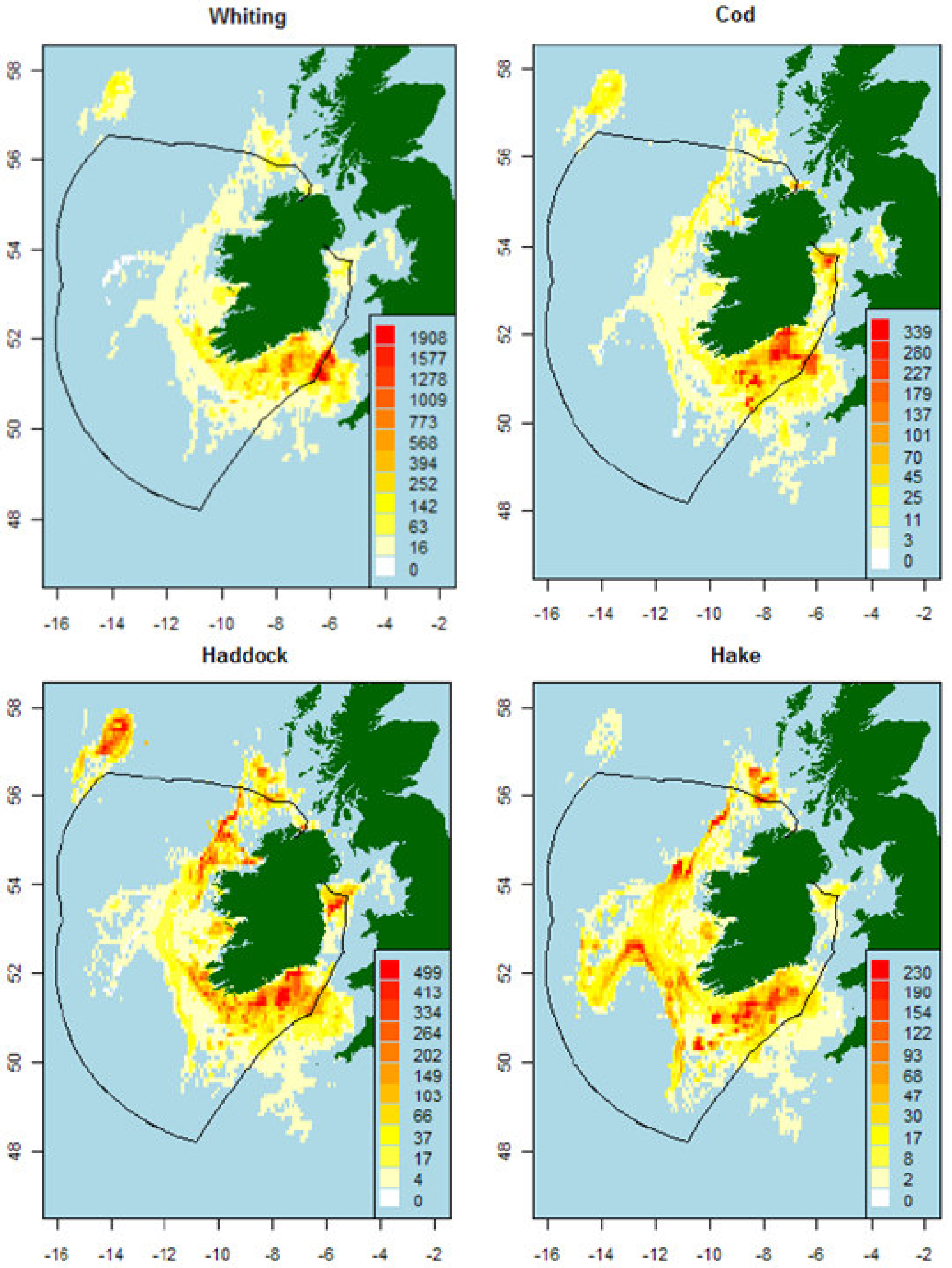
Gear	Area	Species	Country
Beam trawl	Irish Sea, Celtic Sea	black sole, plaice, lemon sole, rays, mixed whitefish	Ireland, UK, Belgium
Gill Nets	Eastern Celtic Sea and inshore areas around coast	cod, pollock	Ireland, UK
	Celtic Sea	turbot, Angler fish	Ireland, UK
	South-west, West & North-west	hake, Angler fish	Spain, France, UK, Ireland
	South-west, West & North-west in deep water	deep water fish and sharks	France, Spain

Gear	Area	Species	Country
Trawl	Irish Sea	cod, whiting, haddock	Ireland
	Celtic Sea	cod, whiting, haddock,	Ireland, France, UK
	Western Celtic Sea	Angler fish, megrim	Spain, France, Ireland
	Western Shelf Break	Angler fish, megrim, other whitefish and deepwater sp.	Ireland, Spain, France
	Rockall	haddock, megrim and other whitefish	Ireland, France, Spain
Seine nets	Celtic Sea, Irish Sea	hake, whiting, cod, haddock	Ireland
Longlines	Shelf areas and shelf break on South-west, West & North-west	hake, deepwater species	Spain, Ireland

Source: from Harrison, 2008

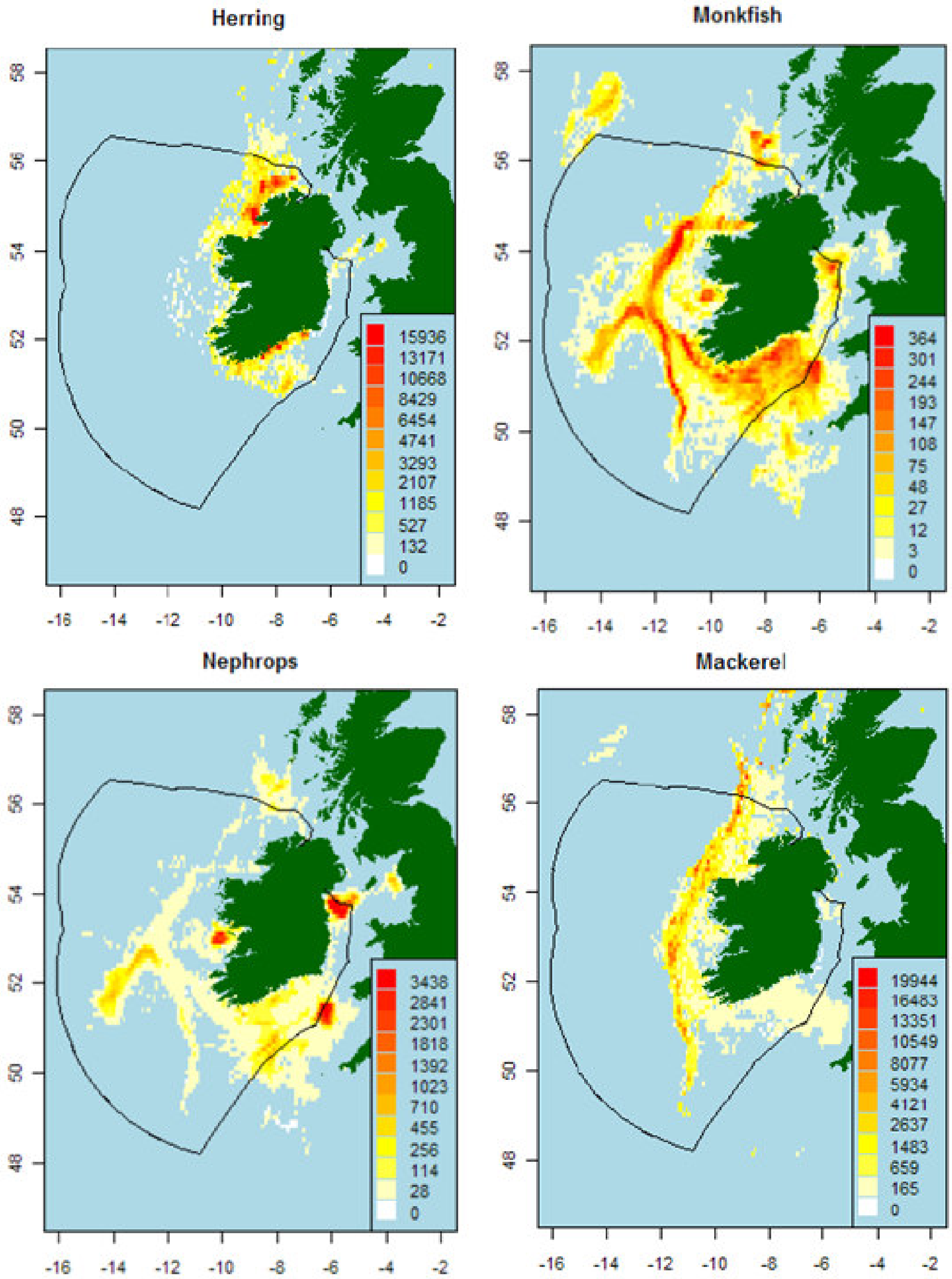
Figures 9.5.1b and 9.5.1c show the distribution of averaged annual landings from Irish vessels over 15 m for the period 2006 – 2008.

Figure 9.5.1b: Average annual landings (whiting, cod, haddock and hake) of Irish vessels >15m (2006-2008)



Source: Marine Institute (from VMS database and Irish Logbooks database). [Note: Data is expressed as liveweight (kg) per square nautical mile.]

Figure 9.5.1c: Average annual landings (herring, Angler fish, Nephrops, mackerel) of Irish vessels >15m (2006-2008)



Source: Marine Institute (from VMS database and Irish Logbooks database). [Note: Data is expressed as liveweight (kg) per square nautical mile.]

Shellfisheries - Trawling

***Nephrops* (or Dublin Bay Prawn)** is the second most valuable fishery for Irish vessels. In recent years, the fishery has increased in importance to the Irish fishing fleet as stocks of other fisheries have declined. The main *Nephrops* fishing grounds within the assessment areas are clearly visible in Figure 9.5.1c in the Irish Sea, straddling the boundary line with UK waters in the Celtic Sea (the Smalls ground) and west of the Aran Islands. All of these fisheries include the involvement of smaller vessels (<15m) up to vessels of 30m in length.

Shellfisheries - Potting

Edible Crab: The fishery for edible crab is conducted by an inshore fleet and offshore vivier fleet (which hold crab live in sea water tanks) using pots. The fishing effort for the vivier fleet is mainly focused in offshore waters off the northwest coast. Fishing effort for the inshore fleet (March-October) is widely distributed in inshore waters (inside the 12 mile limit) from Wexford to Donegal and, to a lesser extent in the Irish Sea.

Lobster: The fishery for lobster remains an extensive one right around Irish coastal area and is mainly concentrated inside the 6 mile limit. As with other inshore pot fisheries, numbers of pots have been increasing. This is due partly to displaced effort from the closure of the Salmon drift-net fishery. Due to heavy fishing pressure lobster stocks in some areas have become depleted. Some recovery has been achieved in areas where v-notching schemes have been implemented.

Shrimp: Shrimp live in shallow water areas and are mainly caught in depths less than 40m. Shrimp fishing occurs from Wexford to Kerry, from Galway to Mayo and in Donegal. The main management measure for Shrimp is a closed season from May 1st to August 1st.

Whelk: The whelk fishery is confined mainly to the Irish Sea with some activity in the adjoining part of the Celtic Sea and off Malin Head in Co. Donegal.

Aquaculture

Although volumes and value of aquaculture production have declined somewhat in recent years, it remains a significant industry around the Irish coast. In 2007 the industry provided 1,981 full and part-time jobs (BIM, 2008). There were 573 active aquaculture licenses of which 494 were for shellfish (268 for oysters and 167 for mussels), 75 were for finfish and 4 were for algae. Figure 9.5.1d shows the distribution and locations of aquaculture licences in the study area.

Shellfish Aquaculture

Table 9.5.1c highlights the contribution of various species to the total aquaculture production in Irish waters in 2007.

Table 9.5.1c: Total shellfish Aquaculture Production in Irish Waters 2007

Species	Volume (Tonnes)	Value (€000's)
Bottom mussel	18,270	20,906
Rope mussel	11,200	7,784
Gigas oyster	7,032	15,390
Native oyster	382	1,630
Clam	170	1,038
Scallop	58	339
Other shellfish*	N/A	204
Total	37,112	47,291

*Other shellfish is expressed as individuals, and a value for tonnage is therefore not available.

Bottom grown mussels comprise 50% of shellfish aquaculture volume and 45% of its value. The sector depends on the dredging of seed mussel mainly in the South Irish Sea, Lough Swilly, Lough Foyle, Carlingford Lough and Cromane Co. Kerry. Seed mussel is subsequently relaid in ongrowing areas for later harvest. The areas licenced for ongrowing are: Carlingford Lough, Wexford and Waterford Harbours, Cromane, Co Kerry, Lough Swilly and Lough Foyle.

Rope mussels make up 30% of shellfish production by volume and 16% by value. Mussels are suspended from ropes connected to barrels on the surface. This method is mainly concentrated in sheltered bays in Cork, Kerry, Galway, Mayo and Donegal.

Pacific or Gigas oysters make up 19% by volume and 33% by value of shellfish aquaculture production. The cultivation method in this sector mainly used is that of laying down seed oyster in mesh bags on intertidal trestles. Gigas oyster production sites are distributed around the coast but with particular concentrations in Waterford, West Cork, Kerry, Galway Mayo and Donegal.

Finfish Aquaculture

This sector is dominated by salmon production which makes up 88% by volume and value. Freshwater trout makes up 7% by volume of finfish production and sea trout makes up 5% (Table 9.5.1d). The balance of production is made up by Salmon smolts, cod and turbot. The main finfish production areas can be seen in Figure 9.5.1d. They are quite tightly focussed in three main production areas where conditions for the growth of finfish (water quality, currents, wave shelter and access to landing sites) are optimal. These areas are West Cork/Kerry, West Galway/South Mayo and Donegal.

Table 9.5.1d: Total Finfish Aquaculture Production in Irish Waters 2007

Species	Volume (Tonnes)	Value (€000's)
Salmon	9,923	51,294
Salmon ova/smolt*	N/A	2,869
Freshwater Trout	760	2,027
Sea reared Trout	507	1,932
Other Finfish	48	317
Total	11,238	58,439

*Salmon ova/smolt is expressed as individuals, and a value for tonnage is therefore not available.

9.5.1.4 Key Issues and Future Trends

Commercial Fisheries

- **Increased focus on inshore fisheries**: As highlighted above, the number of vessels and the fishing effort in inshore areas has increased in the recent past. Notwithstanding the fact that the majority of inshore fisheries are fully exploited it is difficult to see this trend changing unless the issue of limited access to inshore fisheries is resolved. As a counter-balancing trend, however the enforcement of EU legislation on SACs is likely to result in curtailment of fishing development within designated areas.
- Further **decommissioning** schemes aimed at reducing overall European fishing pressure may be introduced within a context of overcapitalisation in fishing vessels relative to available resources.
- **Reform of the Common Fisheries Policy**: the focus of the reformed CFP will be an increased application of the Ecosystem Approach with an inherent focus on integration with other marine sectors and users and the application of marine spatial planning.

- **Future Fisheries Studies**: Information from fisheries studies will continue to provide valuable data to the emerging offshore renewables industry. The Erris Inshore Fishermen's Association are undertaking an assessment of their fishing activities, part of which will include a study incorporating geographical/physical mapping of the inshore fishing activity off the west coast and information on fisheries production and landings. This approach is considered to be an ideal way to plug the information gap for inshore fisheries while simultaneously engaging with local fishermen. This assessment will assist in gathering baseline data of the fisheries which may be used in the future to assess the impact if any of any developments in the areas.

Aquaculture

- **Offshore aquaculture** – as the number of aquaculture operations in inshore waters reaches its maximum capacity there will be an increased focus on development in more offshore areas. A 2006 report by BIM and the Marine Institute entitled "Offshore Aquaculture Development in Ireland: Next Steps" identified 5 offshore sites showing development potential These sites are listed below:
  - North East of Gola Island, Donegal,
  - East of Inishturk Island, Mayo
  - North East of Skerd Rocks, south Connemara, Galway
  - North East of Inisheer Island, Galway
  - Dunmanus Bay, Cork.

9.5.2 Ports, Shipping and Navigation

9.5.2.1 Data Sources

The following sources of data have been used to inform the description and assessment of effects on ports, shipping and navigation:

- Automatic Identification System (AIS) data: The main vessel traffic data used was provided by the Irish Coast Guard (IRCG) AIS Network. All vessels over 300 gross registered tonnes are required to carry AIS equipment which transmits information about the ship and its movements to other suitably equipped vessels and coastal authorities. The IRCG has a series of stations that receive AIS data located throughout the Irish coastline. Data was acquired for the month of July 2008. This data provides a snapshot of information on the movements of shipping vessels in the study area which is considered to give a good indication of the routes being taken and numbers of vessels transiting the area. The data was used to create shipping density datasets for a 2 x 2nm grid and broken down to give an overview of the different types of vessels transiting the study area.
- Irish Maritime Development Office (IMDO) publications.
- Central Statistics Office Ireland (CSO). This data provides statistics for ships entering and leaving main ports in Ireland. It can be used to identify the most heavily used ports for commercial shipping and to describe the general levels of shipping activity in the study area.
- UKHO Hydrographic Office (UKHO) Digital Data: This data has been used to give an overview of traffic management features in the study area.

9.5.2.2 Background

During the scoping phase of the project Ports, Shipping and Navigation was identified as a sea use to be taken forward to assessment of impact by offshore renewable development. In order to aid the assessment and identify areas where shipping could conflict with offshore renewable development, shipping density data, derived from AIS data provided by the Irish Coast Guard (IRCG), has been used to plot vessel traffic in the study area.

The baseline environment is described in terms of the types of vessels transiting the study area including any patterns identified in the types of routes taken, the variation in the intensity of shipping across the SEA study area, and navigational features and considerations.

9.5.2.3 Baseline Description

As an island, shipping and the movement of goods by sea is essential to the Irish Economy, 95% of Ireland's trade is carried by sea.

Ports

There are many ports located along the coastline of Ireland ranging from commercial port facilities to numerous smaller ports which are essential for ferry traffic and local trade and supplies (Figure 9.5.2a).

Commercial Ports

Irish ports handled 51.08 million tonnes of goods in 2008, 3.06 million tonnes less than were handled in 2007 (CSO, 2009). The main ports in the study area are shown in Figure 9.5.2a and Table 9.5.2a.

Table 9.5.2a: Total Tonnage of Goods Handled (000 Tonnes) classified by port and category of traffic, 2008

Port	Category of Traffic					Total
	Roll-on / Roll-off	Lift-on / Lift-off	Liquid bulk	Dry bulk	Break Bulk & all Other Goods	
Dublin	9,222	5,214	4,074	2,385	232	21,127
Shannon Foynes			1,482	9,089	248	10,819
Cork	87	1,495	6,002	1,763	286	9,633
Rosslare	2,722					2,722
Waterford		1,180	25	706	170	2,081
Bantry Bay			784	225		1,009
Galway			737	15	86	838
Greenore				528	172	700
New Ross			138	504	52	694
Drogheda		56	70	361	177	664
Dundalk				142	75	217
Kinsale				133		133
Killybegs			2		119	121
Youghal					86	86
Wicklow					85	85
Dun Laoghaire	49					49
Castletownbere				42	6	48
Sligo				14	27	41
Tralee Fenit					14	14

Source: CSO, 2009

In terms of goods handled in 2008, Dublin is the busiest port in the study area, handling over 40% of the country's goods (21,127,000 tonnes). The three busiest goods ports in Ireland, Dublin, Shannon Foynes and Cork, together handled over 80% of the country's goods (CSO, 2009). Use of ports in the study area by merchant vessels can be seen in the shipping density data displayed in Figure 9.5.2b.

There are numerous local ferry ports around the coast of Ireland providing access to the surrounding islands and routes across estuaries and inlets. There are also four large ferry ports located within the study area providing services to the UK and France, passenger activity at these ports is shown in Table 9.5.2b below.

Table 9.5.2b: Passenger Vehicles (Roll On/Roll Off) handled by Irish Ports, 2008

Port	Passenger Cars, Motorcycles and Accompanying Trailers/Caravans Handled	Passenger Buses Handled	Total Passenger Vehicles
Dublin	291,009	52,700	343,709
Rosslare	291,920	3,540	295,460
Dun Laoghaire	152,863	3,248	156,111
Cork	23,347	275	23,622

Source: CSO, 2009

Fishing Ports

The main fishing port in Ireland is the deep water harbour of Killybegs, located on the North West coast of Ireland. Over a third of all the sea fish landed into Ireland are received at Killybegs (SFPA, 2008). Significant landings are also made at Castletownbere, An daingean (Dingle) and Dunmore east. Table 9.5.2c gives the landing statistics for the 20 most used Irish fishing ports. There are numerous smaller fishing ports located all around the coast of Ireland that are regularly used by local fishing vessels, see Figure 9.5.2a.

Table 9.5.2c: 20 Busiest Irish Fishing Ports, 2008

Port	Value (€000's)	Live Weight (tonnes)
Killybegs	48,367	138,151
Castletownbere	29,233	14,454
An Daingean	24,175	11,319
Dunmore East	15,918	6,515
Ros An Mhíl	7,739	4,478
Howth	8,683	2,934
Greencastle	6,161	2,763
Kilmore Quay	11,849	2,217
Union Hall	8,273	2,213
Baltimore	1,524	2,138
Wicklow	1,755	1,415
Clogherhead	5,779	1,365
Downings	1,721	1,091
Skerries	2,304	935
Kinsale	2,536	878

Port	Value (€000's)	Live Weight (tonnes)
Crosshaven	1,425	670
Achill	1,144	650
Rosslare	3,165	639
Ballycotton	1,980	588
Duncannon/St. Helens	4,273	573

Source: SFPA landing statistics

Shipping

Commercial Vessels

There are several large ports in the vicinity of the Irish Sea (Dublin, Liverpool, Milford Haven, Clyde, Belfast and Manchester) which form an important focus for shipping in the study area. As such the majority of shipping activity in the study area is concentrated in the waters to the east of Ireland (Figure 9.5.2b), notably in a north-south direction between the Western Approaches and the Northern Channel. In addition to the north-south flow of traffic there are significant movements in an east-west direction, with vessels from Dublin, Dun Laoghaire and Rosslare accessing ports in the UK and mainland Europe. Although shipping activity is less intense in the remainder of the study area the major ports of Cork and Shannon Foynes attract a significant number of vessels and so there is a coastal flow of traffic all around Ireland.

Tankers tend to adhere to particular routes, predominantly to the south west and east of the study area with vessels visiting Galway, Shannon Foynes, Cork and Dublin. Cargo vessels appear to utilise more of the study area although traffic is concentrated in routes between ports.

Passenger Vessel Routes

Passenger vessels (or ferries) provide transport from Ireland to the UK and France, with major ferry ports located in Dublin, Rosslare, Cork and Dun Laoghaire. In addition to ferries operating out of Irish ports a number of passenger vessels transit the study area. Figure 9.5.2b highlights passenger vessel routes which are primarily through the west and south of the study area.

Ferries are also an essential mode of transport between Ireland and the surrounding islands, of which there are many. Ferries tend to take distinct routes and in certain areas there is no, or limited, scope for adjustment of routes, due to bathymetry and other characteristics

Passenger vessel activity on the west coast is characterised by shorter mainland to island routes, whereas east and south coast activity is predominantly routes to the UK and mainland Europe.

Recreational boating is addressed in Section 9.5.3.

Navigational Infrastructure

The International Maritime Organisation (IMO) is an international body that implements routeing measures for international shipping to aid navigation of certain ships, or ships with certain cargoes. IMO routeing measures include traffic separation schemes, areas to be avoided and deep water routes which are areas surveyed for obstacles. Traffic separation schemes are in place at Tuskar Rock and Fastnet Rock (Figure 9.5.2a). There are also numerous anchorage areas around the coast of Ireland.

As with civil and military aviation radar, wind turbines have the potential to interfere with marine radar, including shore based radar systems. A number of ports in the study area use shore based radar systems.

9.5.2.4 Key Issues and Future Trends

Despite the economic downturn creating difficult operating conditions for Irish shipping companies, port development in Ireland is expected to continue, with many ports looking to add to their existing facilities. A number of organisations will be putting together program applications for the European Commission's Marco Polo and Motorways of the Sea programs, which aim to shift freight transport from Europe's roads.

The increased interest in the development of offshore renewable energy generation in Ireland (see Section 9.7.1) will require additional investment in construction ports. Both the investment in ports and the increase in offshore renewable developments will inevitably result in increased shipping traffic in the study area.

9.5.3 Recreation & Tourism

9.5.3.1 Data Sources

The following sources of data have been used to inform the baseline description of marine and coastal recreation and tourism in Ireland:

- Irish Sailing Association
- Petroleum Affairs Division (PAD) Reports (2006-2008)
- Fáilte Ireland – the National Tourism Development Authority
- Tourism Renewals Group (TRG) Report (Sept 2009)
- Marine Irish Digital Atlas (MIDA)
- Marine tourism data supplied by MI
- Blue Flag

9.5.3.2 Background

This section provides an overview of key tourism and recreation activities within the study area.

The majority of Ireland's coastline is generally unpolluted and pristine, therefore giving much appeal to Ireland as a tourist destination.

Ireland's coastal waters constitute a major part of Ireland's attraction as a holiday destination for both domestic and overseas visitors. A significant part of Ireland's tourism industry comprises water based recreation, and generates significant benefits to the Irish economy (Fáilte Ireland 2009).

Two thirds of Ireland's population lives within 10km of the coast, with over 50% of Irish adults participating in water-based leisure activities. Sailing is the major coastal activity, with the Irish Sailing Association (ISA) having 22,000 members nationwide (PAD 2006/08).

A review of tourism in relation to Ireland's economy recently undertaken by the Tourism Renewal Group, on behalf of Ireland's Department of Art, Sport & Tourism (DAST) identified that in 2008 128,400 jobs in Ireland were directly supported by tourism. Total tourism revenue was €6.3 billion, including €4.8 billion total international earnings (including carrier receipts and Northern Ireland), and €1.5 billion domestic tourism revenue. There were 8.3 million domestic trips within Ireland and over 8 million non-domestic tourist visits to Ireland. Direct tourism spending amounted to 4% of GNP (3.4% of GDP) (TRG 2009).

9.5.3.3 Baseline Description

Tourist Attractions and Sightseeing

Ireland's environment, heritage and culture has a strong national and international appeal and tourism is therefore an important activity in the study area. The entire coast of Ireland has a developed tourist infrastructure and numerous coastal attractions. Ireland's landscape, seascape and visual amenities are discussed in detail in Section 9.5.6. The landscape, seascape and views around the Irish coastline are intrinsic to the area's ability to attract tourists and visitors.

Access to the coast is relatively easy, with a good infrastructure in place, although car parking facilities are in short supply in some areas whilst long distance footpaths allow exploration of less accessible sites.

Table 9.5.3a below shows the number of visitors recorded by area for Ireland in 2008 and as would be expected, shows that the Dublin area received by far the majority of visitors (4,310,000).

In addition, the South West, West and Shannon areas also received high numbers of visitors after the capital city, due to their high appeal as a tourist destination. Designation as amenity areas and the inclusion of a number of major tourist resorts helps to draw people to these areas.

Table 9.5.3a: Number of Visitors per Area

Rank	Area	Number of Visitors
1	Dublin	4,310,000
2	South West	1,836,000
3	West	1,405,000
4	Shannon	1,088,000
5	South East	902,000
6	Midlands East	839,000
7	North West	502,000

Source: Tourism Ireland, 2008

There are numerous sites of natural interest in Ireland along the coastlines, with the majority of Ireland's protected sites falling in coastal areas. Also with up to twenty three species of cetacean and two species of seal, either inhabiting or visiting the coastal waters of the study area, wildlife watching tours are popular with visitors.

There is a great range of marine and coastal tourist activities that can be undertaken in Ireland, such as golf (links courses) sailing and boating, scuba diving, sea angling, walking, canoeing, surfing, bird watching, and visiting coastal attractions such as castles and archaeological features.

Coastal Walks

There are 46 walks around the coast of Ireland that traverse areas of distinctive coastline, often coinciding with National Parks. These are major attractions for an increasing number of outdoor enthusiasts who are intent on walking part or the entirety of a trail, often camping along the way. Table 9.5.3b indicates the locations of these coastal walks.

Table 9.5.3b: Walks along Ireland's Coastline

Name	County	Length
Ardmore Head	Waterford	5 km
Arranmore Island	Donegal	21 km
Belderrig to Portacloy	Mayo	24 km
Benwee Head	Mayo	20 km
Bere Island Long Walk	Cork	28 km
Bere Island Short Walk	Cork	13 km
Bloody Foreland	Donegal	14 km
Bray Head	Wicklow	10 km
Cape Clear Island	Cork	19 km
Carnsore Point	Wexford	30 km
Clare Island	Mayo	18 km
Cliffs of Moher	Clare	10 km
Clonmany and Binnion	Donegal	10 km
Croaghaun and Achill Head	Mayo	26 km
Derrtnane Bay	Kerry	5 km
Donabate and Portrane	Dublin	13 km
Downpatrick Head	Mayo	1 km
Dursey Island	Cork	14 km
Glencolumbcille	Donegal	26 km
Great Blasket Island	Kerry	14 km
Great Island	Cork	25 km
Horn Head	Donegal	20 km
Howth Head	Dublin	13 km
Inis Meain	Galway	14 km
Inis Mor	Galway	24 km
Inis Oirr	Galway	10 km
Inishbofin	Galway	23 km
Inishowen Head	Donegal	10 km
Inishturk	Mayo	10 km
Kerry Head	Kerry	10 km
Killary Harbour	Galway	8 km
Loop Head	Clare	15 km
Malin Head	Donegal	13 km
Melmore Head	Donegal	13 km

Name	County	Length
Minaun Cliffs Achill Island	Mayo	18 km
Mizen Head	Cork	1 km
Omey Island	Galway	8 km
Raven Point	Wexford	10 km
Sheeps Head	Cork	20 km
Sherkin Island	Cork	8 km
Slea Head	Kerry	16 km
Slieve League	Donegal	15 km
The Magharees	Kerry	22 km
The Three Sisters	Kerry	13 km
Tory Island	Donegal	13 km
Valentia Island	Kerry	14 km

Source: Marine Institute, 2009

Water Sports

Yachting is popular in the more sheltered coastal waters, bays and sea lochs, and in addition particular routes are used to traverse the coast, and between islands. The Irish Sailing Association has 99 clubs registered in Ireland, 77 of which are based on the coast, with the highest concentration to be found around the Dublin area (Figure 9.5.3). Sailing occurs around the entire coastline. The Ireland Sailing Directions publications cover the East and North Coast (from Tuskar Rock northwards to Bloody Foreland) and the South and West Coasts (from Tuskar Rock westwards to Bloody Foreland by way of the Fastnet Rock, Cape Clear, Valentia, Shannon and Galway). Racing sailing takes place all around Ireland's coastline, with Lough Foyle is also identified as a semi-inland racing sailing area.

The study area is known for its clear waters and diverse marine life and diving attractions within the study area include both wrecks and marine wildlife. There is diving around the entire coastline and dive boat charters to more remote areas. Particular areas of interest include the wrecks of the RMS *Lusitania* and UB 260, as well as the Maharees Islands, The Saltee Islands and the Blasket Islands (Figure 9.5.3).

The majority of coastal surf shops are to be found on the north-west coast in the county of Sligo whilst outdoor activity operators within the study area are primarily located on the east coast in the vicinity of Dublin, or along the south coast of Co. Kerry. These centres offer a range of marine related activities including surfing, wind surfing, kayaking and angling. The coast of Ireland receives swell waves from the Atlantic Ocean. Surfing areas can be found all along the Irish coastline, however the more popular surfing locations can be found along the Sligo coastline (Figure 9.5.3), with Achill Island in Co. Sligo being particularly popular for kite surfing as well as other forms of Watersports.

Sea Angling

Recreational sea angling is an important contributor to coastal tourism. The Marine Institute holds records on 113 charter boats in Ireland, located around the coast and used for various activities such as diving, dolphin & whale watching and general sightseeing tours. The locations of these can be seen in Figure 9.5.3.

Recreational Beach Use

There are currently 74 beaches classified as “Blue Flag Beaches” in Ireland (Table 9.5.3c).

Table 9.5.3c: Ireland's Blue Flag Beaches

Region	Municipality	Number of Beaches
Dublin	Dublin	1
Mid-East	Wicklow	3
South-East	Waterford	2
South-East	Wexford	4
South-West	Kerry	12
South-West	Cork	8
Mid-West	Clare	7
West	Galway	8
West	Mayo	13
Border	Donegal	12
Border	Louth	3
Border	Sligo	1

Source: Blue Flag, 2010

There are also a 122 coastal beaches designated under the EC Bathing Waters Directive which are used for recreation predominantly during the tourist season. Designated bathing waters in the study area are shown in Figure 9.5.3.

Wildlife Watching

The generally unspoilt and undeveloped nature of much of Ireland's coastline makes it ideal for wildlife related tourism. Notable sites include Bull Island, Dublin which is a UNESCO biosphere reserve and a bird sanctuary and is home at various times to 8,000 wild fowl and 26,000 waders with up to 180 different bird species having been recorded.

Whale watching and angling vessels can also be chartered from 40 locations around the coast of Ireland (Figure 9.5.3). Sightings off the coast of Ireland have increased over recent years as whale-watching becomes more popular. The best places for whale-watching are headlands, islands and bays when the sea is calm.

9.5.3.4 Key Issues and Future Trends

As a result of the current recession there are plans in place to promote Ireland as a tourist destination, for both the local population and also to potential overseas visitors.

According to Tourism Ireland's Marketing Plan for 2010 these plans include offering low cost flights for overseas visitors, being more visible in the promotion of offers, dramatically increase the level of PR and marketing for Ireland as a holiday destination throughout Europe as well as providing more industry engagement with co-operative marketing opportunities within key markets.

Fáilte Ireland's Tourism Product Development Strategy 2007-2013 proposes to increase Ireland's tourism industry by protecting and managing the physical environment, enhancing access to and around the country and improving access to cultural heritage. It also recommends that the State invests €280 million in product development over the period of the National Development Plan (NDP) 2007- 2013.

9.5.4 Aviation

9.5.4.1 Data Sources

The following sources of data have been used to inform the baseline description of aviation in Ireland:

- Irish Aviation Authority website
- Irish Aviation Authority (IAA) Operations Advisory Memorandum (2002)
- Irish Aviation Authority (IAA) Policy on Consultation Report (2008)
- Fehily Timoney & Co. - Arklow Bank Wind Park EIA Report (2001)

9.5.4.2 Background

The safety of aviation operations is more of a concern for offshore wind developments in the study area, rather than offshore wave and tidal developments which do not project as far from the sea surface.

There are two ways in which aviation operations may be affected by windfarm development; the physical obstruction caused by a tall structure and the effects that the supporting structure and rotating turbine blades can have on communications, navigation and surveillance (CNS) systems (including radar).

The Department of Defence (DoD) and the Irish Aviation Authority (IAA) have a statutory duty to safeguard certain sites and airspace from radar interference in the interests of national security and for the safe operation of passenger and military aviation.

The Irish Aviation Authority (IAA) is a commercial state-sponsored company which was established on 1 January 1994 to provide air navigation services in Irish-controlled airspace, and to regulate safety standards within the Irish civil aviation industry.

Consultation with the IAA is always required when the construction of wind turbine generators is proposed, even when outside the areas defined as being a Building Restricted Area (BRA) (IAA 2008).

Offshore wind farms are also subject to ‘conspicuity’ requirements which include lighting, marking and radar enhancements (IAA 2002).

9.5.4.3 Baseline Description

Ireland has numerous civil aerodromes, military aerodromes and radar installations as can be seen in Table 9.5.4a below and also in Figure 9.5.4. Of these, Cork, Dublin and Shannon Airports are State owned and also have onsite radar facilities.

Ireland also has fifteen privately licensed aerodromes and one heliport (Knocksedan Heliport, Dublin) which have not been mapped due to data availability.

Table 9.5.4a: Ireland’s Aerodromes and Radar Installations

Name	Facility	Location
Inishmore (Aran Islands)	Civil Aerodrome	Co. Galway
Inishmaan (Aran Islands)	Civil Aerodrome	Co. Galway
Inishsheer (Aran Islands)	Civil Aerodrome	Co. Galway
Carnmore	Civil Aerodrome	Co. Galway
Casement	Military Aerodrome	Co. South Dublin

Name	Facility	Location
Cork	Civil Aerodrome & Radar	Co. Cork
Donegal Carrickfin	Civil Aerodrome	Co. Donegal
Dooncarton	Radar	Co. Mayo
Dublin	Civil Aerodrome & Radar	Co. Dublin
Kerry County	Civil Aerodrome	Co. Kerry
Knock (Connaught)	Civil Aerodrome	Co. Mayo
Malin Head	Radar	Co. Donegal
Mt Gabriel	Radar	Co. Cork
Shannon	Civil Aerodrome & Radar	Co. Clare
Sligo	Civil Aerodrome	Co. Sligo
Spiddal Connemara	Civil Aerodrome	Co. Galway
Waterford	Civil Aerodrome	Co. Waterford
Weston	Civil Aerodrome	Co. South Dublin
Woodcock Hill	Radar	Co. Clare

Source: Irish Aviation Authority, 2010

An area covering the River Shannon has been prohibited for generating station use as it is used as a low level (flying) route by marine rescue helicopters operating out of Shannon Airport. The area extends south from Loop Head (North Coast Shannon Estuary) to 52° 30’ N and then covers the upriver area past Shannon Airport (Figure 9.5.4)

Offshore wind developers would be required to undertake consultation with aerodrome licensees for any potential wind farm site, as consultation with the IAA is always required when the construction of wind turbine generators is proposed (IAA 2008).

Search and Rescue operations are provided by both civil (Irish Coastguard Services) and military authorities (Aircorps at Casement Aerodrome) (Fehily Timoney 2001) and the waters surrounding Ireland are all within the range of Search and Rescue (SAR) helicopters (190 – 250nm). Figure 9.5.4 shows the Marine Search and Rescue Region (IMSRR) for Ireland broken down by Division.

9.5.4.4 Key Issues and Future Trends

The building of new airports or expansion at Ireland’s existing airports may influence the location of future offshore wind developments.

Currently the IAA has plans for a new Control Tower at Dublin Airport which is linked with a probable decision by the Dublin Airport Authority (DAA) to proceed with its plans to develop a new parallel runway at Dublin Airport for which a new Control Tower will be required. The timing of the construction of the Tower will be linked to the decision by the DAA to proceed with the new parallel runway and no further work will be undertaken on this project (other than to facilitate the planning application process) until the DAA commits itself to firm and fixed dates for proceeding with the construction of the runway (IAA 2010).

9.5.5 Military Activity

9.5.5.1 Data Sources

In order to identify and assess the military practise areas in the study area the following data sources have been used:

- UKHO charts
- Liaison with the Department of Defence

9.5.5.2 Background

Military Practice and Exercise Areas (PEXA) can belong to the Army, Navy or Air Force and are used to practice manoeuvres, test armaments and to conduct any other general exercises.

Military practice areas in the study area are shown on Figure 9.5.5.

9.5.5.3 Baseline Description

There is relatively little military activity in the waters around Ireland although there are significant coastal bases at Bere Island, Cork Harbour and Gormanstown. The Irish Naval Service is based on Haulbowline Island within Cork Harbour on the south coast of Ireland. The fleet comprises of a helicopter patrol vessel, five offshore patrol vessels and two coastal patrol vessels. Fishery protection patrols are carried out daily.

Within the study area there are three areas that are used by the Department of Defence (DoD) as gunnery, bombing or firing ranges. These Danger Areas, the only permanently defined danger areas in use (Department of Defence, pers coms), are located off the coast of Gormanstown, Co. Meath (D1), Galley Head, Co. Cork (D13) and west of Bantry (D14), respectively (see Figure 9.5.5). All of the above mentioned Danger Areas are restricted and would not be considered suitable for offshore renewable energy development.

There are two regions within the study area that are extensively used for submarine exercise and transit, located in the south and the north east. These areas are also used for fleet exercises, no ammunition firing is undertaken. Any development in these areas would require consultation with the Department of Defence, Ireland and the Ministry of Defence, UK.

9.5.6 Noise Environment

9.5.6.1 Baseline Description

Ambient (or background) noise can be made up of either natural (e.g. wind noise) or anthropogenic sources (e.g. shipping, fishing etc). These sounds combine to give a continuum of noise against which all acoustic receivers have to detect the signals they are looking for. Both natural and anthropogenic ambient noise can affect bioacoustic receivers. Therefore this section of the report gives an overview of the different contributors to ambient noise in the SEA study area. This information is important in determining the baseline environment against which noise emissions from installation and operation of marine renewable energy devices can be assessed.

The potential sources of ambient noise in the SEA study area are summarised below.

Table 9.5.6: Potential Contributors to Ambient Noise in the Study Area

Source	Indicative Frequency Range	Comments
Wind-sea noise	500Hz – 25kHz	Noise levels are dependant upon local wind speed.
Precipitation noise	1 – 100kHZ	In the winter months precipitation is likely to be a significant contributor to ambient noise
Shore and surf noise	1 Hz – 1000kHz	Shore and surf noise is likely to be a major contributor to ambient noise in coastal areas in the SEA study area - particularly at coastlines that are exposed to large waves
Sediment transport noise	Mostly above 10kHz	Sediment transport mainly occurs in the intertidal area but can also occur away from the coastline.
Commercial Shipping	50 – 300 Hz for large ships	Shipping noise is typically the dominant contributor to ambient noise in shallow water areas and close to shipping lanes in the study area. At higher frequencies than 300 Hz, the sounds of individual ships merge into a background continuum. At higher frequencies the dominant noise source is likely to be wind generated noise. In the shallower waters (e.g. tens of metres) of the SEA study area the water is too shallow to support long-range propagation of the very low frequencies. Different types of ships give different noise contributions from different sources. For a fast ferry the main source of noise is from the displaced water and the machinery. For a small coaster, virtually all of the noise is from the propulsion machinery.
Leisure craft	Various	Largely confined to coastal waters. In tourist areas it can be the dominant source of sound through the summer months.
Industrial noise: Offshore	Various	Includes noise generated from offshore wind farms, construction and oil and gas developments.
Industrial noise: Onshore	<100Hz	Potential sources include traffic noise from roads or railways and quarry blast noise. Coupling through the substrate into the marine environment will generally only occur at low frequencies (i.e. less than 100 Hz).
Military noise	Various	Military activities and exercises occur across the study area and noise sources include firing and bombing practice. Military shipping is generally very quiet and will only make a small contribution to overall shipping noise. Military sonar is covered below.
Sonar	Echosounder: 26 kHz – 300kHz	Used by small leisure craft up to the largest commercial ships. The higher frequencies are attenuated over short distances by absorption but their contribution to ambient noise is significant due to the high numbers of such units.
	Fishing sonar: Lower frequencies than those for general echosounders noted above.	Their contribution is mainly restricted to fishing grounds, which can also be sensitive areas where there is a high density of fish and cetaceans.
	Acoustic modems: 2 – 10 kHz	Used to carry data from seabed installations to the surface.
	Sidescan Sonar/echocounder100 kHz – 700 kHz 100 Hz – 7.5 kHz	Used to collect shallow seabed geological / geophysical survey work Side scan sonar / multibeam echosounder Sub bottom profilers (sparkers, pingers, boomers)
	Airguns 10 Hz – 200 Hz	Airguns used for oil and gas exploration and sub-surface geohazard mapping.
	Military sonar: 1 – 300kHz	High frequencies above 80 kHz are used by mine hunters and the high acoustic absorption coefficient of seawater at such frequencies means that any impact is limited to a very small area around the ship, typically less than 3 km. Lower frequencies (<3 kHz) are used in the deeper waters and can fill a whole ocean basin with sound. In the shelf region to the west of the Hebrides, medium frequencies are most likely to be used (3 to 10 kHz).

Source	Indicative Frequency Range	Comments
Aircraft noise	Various	Noise caused by helicopters servicing lighthouses can be coupled in to the underwater environment. This noise is significant during the event but these events occur so infrequently they are unlikely to be a significant contributor to ambient noise in the study area. Aircraft noise from coastal airports and noise from helicopters servicing oil and gas rigs may be locally significant.
Fishing Activity	Vessel: Less than 1 kHz	Noise can come from vessel, sonar or gear noise (e.g. trawl noise). No published information is available on noise levels/frequency ranges for fishing gear.
Biological Noise	Sperm whale echolocation: 2- 40 kHz Bottle nose dolphin echolocation: 80 – 120 kHz Cetacean tonals: 2 – 25 kHz Harbour porpoise echolocation: 130 kHz	Fish, cetaceans and seals can all produce sound. Cetacean sounds are either tonal whistles in the range 2 to 25 kHz, or wideband echolocation clicks with maximum energy in the 40 to 140 kHz region. Seals are also very common in the waters around the Hebrides and northern islands, and, although not as vocal as the cetaceans, can make a significant contribution to ambient noise at certain times of the year, particularly during the breeding season (July to August) when the male harbour seals emit a broadband roar
Thermal Noise	More than 100kHz	Caused by thermal motion of molecules. This sound source is only relevant in the absence of all other sound sources.

9.6 Material Assets

9.6.1 Oil & Gas Infrastructure

9.6.1.1 Data Sources

The following data sources have been used to inform this section:

- Hartley Anderson Ltd Report to the Irish Shelf Petroleum Studies Group (2005)
- Petroleum Affairs Division (PAD) Reports (2006-2008)
- DCENR (PAD) Website
- DCENR Six Monthly Acreage and Activity Report (2009)

9.6.1.2 Background

There is currently limited offshore oil & gas activity in Irish waters at present. Since the first well was drilled in 1970, approximately 200 wells have been drilled, including those for appraisal and development. The majority of wells drilled have not been taken forward for development and currently Ireland's exploration success rate is considered to be very low (Hartley Anderson 2005).

Within the Department of Communications, Energy and Natural Resources (DCENR), the role of the Petroleum Affairs Division (PAD) is to maximise the benefits to the State from exploration for and production of indigenous oil and gas resources, while ensuring that activities are conducted safely and with due regard to their impact on the environment and other land/sea users. The Marine Institute provides technical advice to PAD, underpinning environmental regulation and supporting sound environmental practices in the offshore oil and gas sector.

Licensing offshore oil and gas activities also falls under the remit of PAD and there are several different types of licence available and these confer differing rights from basic exploration with seismic surveys to the exclusive right to produce hydrocarbons.

There are currently two initiatives running in relation to offshore oil and gas activity in Irish waters, the Petroleum Infrastructure Programme (PIP) and the Irish Offshore Operators Association (IOOA). PIP was set up by PAD in 1997 and is comprised of a consortium of oil and gas exploration companies and government and aims to promote hydrocarbon exploration and development activities. IOOA was formed in 1995 and represents the oil and gas companies that have operating interests in Ireland's offshore hydrocarbon industry (Hartley Anderson 2005).

9.6.1.3 Baseline Description

The following are full descriptions of the different types of licensing available for the Irish offshore oil & gas industry issued by the Minister for Communications, Energy and Natural Resources under the Petroleum and Other Minerals Development Act, 1960:

Petroleum Prospecting Licence (issued under Section 9 (1) of the 1960 Act) This is a non exclusive licence giving the holder the right to search for petroleum in any part of the Irish Offshore which is not subject of a Petroleum Exploration Licence, Reserved Area Licence or Petroleum Lease granted to another party.

Licensing Option (issued under Section 7 (1) of the 1960 Act) This is a non exclusive licence giving the holder the first right, exercisable at any time during the period of the Option, to an Exploration Licence over all or part of the area covered by the Option.

Exploration Licence (issued under Section 8 (1) of the 1960 Act) There are three categories of Exploration: a Standard Exploration Licence for water depths up to 200m; a Deepwater Exploration Licence for water depths exceeding 200m and a Frontier Exploration Licence for areas so specified by the Minister. For Standard and Deepwater Explorations Licences the holder is obliged to carry out a work programme which must include the drilling of a least one exploration well in the first phase. For a Frontier Exploration Licence the holder must commit to at least one exploration well in order to proceed to the second phase. The area of an Exploration Licence shall be expressed in terms of blocks and/or part blocks of the Williams Grid.

Lease undertaking (issued under Section 10 (1) of the 1960 Act) When a discovery is made in a licensed area and the licensee is not in a position to declare the discovery commercial during the period of the licence but expects to be able to do so in the foreseeable future, the licensee may apply for a Lease Undertaking. This is an undertaking by the Minister, subject to certain conditions, to grant a Petroleum Lease at a stated future date. The holder of a Lease Undertaking is required to hold a Petroleum Prospecting Licence which will govern activities under the Lease Undertaking.

Petroleum Lease (issued under Section 13 (1) of the 1960 Act) When a commercial discovery has been established it will be the duty of the authorisation holder to notify the Minister and apply for a Petroleum Lease with a view to its development.

Reserved Area Licence (issued under Section 19 (1) of the 1960 Act) A Petroleum Lease holder may apply for a reserved area licence in respect of an area adjacent to or surrounding the leased area and which is not subject of an authorisation other than a Petroleum Prospecting Licence.

Since 1970, thirty companies have undertaken exploration activities in Irish waters, with the most recent drilling operations (as per DCENR's Offshore Well Listing 2008) occurring in 2008 when four wells were drilled; two exploration wells, one in the Rockall Basin by Shell E&P and the other in the Erris Basin by Statoil Exploration Ireland Ltd and two appraisal wells in the North Celtic Sea Basin by Providence Resources Plc.

Presently there are only three areas that are subject to a petroleum lease (Kinsale, Seven Heads & Corrib Gas Fields) with two offshore gas platforms (Alpha & Bravo) located in the Kinsale Head Gas Field. There are five areas covered by a Licensing Option and thirty areas are subject to Exploration Licenses; eleven Standard Exploration Licenses and nineteen Frontier Exploration Licenses (Figure 9.6.4)

There are currently only two companies operating offshore developments; PSE Kinsale Energy (formally Marathon Ireland Petroleum Inc.) produces natural gas from the Kinsale Head Field (including the Ballycotton and Greensand subsea satellites) and the Southwest Kinsale Field. Star Energy Group Plc now operates the Seven Heads development (in association with Island Oil and Gas Plc. & Sunningdale Oils (Ireland) Ltd.) which also produces natural gas (Figure 9.6.4). This is then processed through the Kinsale Head facilities and exported back via the existing pipeline (see Section 9.6.2 for information pertaining to pipelines) to the Inch Onshore Terminal for distribution (Hartley Anderson 2005 & DCENR 2009).

9.6.1.4 Key Issues and Future Trends

The Corrib Gas Field (Figure 9.6.4) is currently in the process of being developed by Shell E&P Ireland (SEPIL) in association with Statoil Exploration (Ireland) Ltd and Marathon International Petroleum Hibernia Inc. This medium sized gas field will be developed as a subsea 'tie-back' facility and will produce natural gas which will then be flowed back via pipeline to a terminal situated at Bellanaboy Bridge (Co. Mayo). It is estimated that up to 60% of Ireland's gas needs will be supplied by Corrib once it reaches peak production. Even though the field itself falls outside of the study area, the pipeline that will connect the facility to the mainland will still need to be taken into consideration.

The large Rockall Basin area to the North-West of Ireland (Figure 9.6.4) has recently been opened for license applications by the Department for Communications, Marine and Natural Resources. This is an extension of the 2005 North East Rockall Basin and 2006 Slyne/Erris/Donegal frontier license rounds. The region has been classified as Frontier due to the deep water and challenging environment. However this area fall outside of the study area as it is beyond the 200m depth contour.

9.6.2 Cables and Pipelines

9.6.2.1 Data Sources

In order to identify the location of cables and pipelines in the study area the following data sources have been used:

- UK Hydrographic Office (UKHO) digital charted data. This gives the locations of cables shown on Admiralty Charts.
- Kingfisher Cable Awareness Charts (KISCA). These charts give the locations of a number of national and international cable systems. Inclusion of cables on the charts is dependant on cable owners subscribing to KISCA.
- Petroleum Affairs Division

9.6.2.2 Background

The location of submarine cables and pipelines in the study area will be significant in terms of the siting of offshore renewable devices. Arrays will need to be located away from active cables and pipelines, in order to allow cable owners access for any necessary maintenance and repairs.

Submarine telecommunications cables, power cables and pipelines are all located within the study area. Figure 9.6.1 accompanies this chapter and major cables systems located within the study area are detailed in Table 9.6.2a.

9.6.2.3 Baseline Description

There is an extensive network of national and international submarine telecommunications cables located within the study area (see Table 9.6.2a), connecting Ireland, the UK, Europe and the US. Most of these cables are located in the south and east of the study area, with only the Hibernia ‘A’ cable passing through Irish waters in the north.

Table 9.6.2a: Major Cable Systems in the SEA Study Area

Cable	Flow	Operator
Atlantic Crossing 1 (AC1)	Telecoms	Global Crossing
Apollo North	Telecoms	Apollo
Esat 1	Telecoms	Esat
Esat 2	Telecoms	Esat
Flag Atlantic North	Telecoms	Flag LTD
Hibernia 'A'	Telecoms	Hibernia Atlantic
Hibernia 'C'	Telecoms	Hibernia Atlantic
Hibernia 'D'	Telecoms	Hibernia Atlantic
Sirius South	Telecoms	NTL
Solas	Telecoms	C&W
TAT 12	Telecoms	BT
TAT14 (G)	Telecoms	BT
UK-Ireland Crossing 1	Telecoms	Global Crossing
UK- Ireland Crossing 2	Telecoms	Global Crossing
VSNL Atlantic North	Telecoms	VSNL Telecoms
VSNL Atlantic South	Telecoms	VSNL Telecoms
VSNL W Europe UK-Portugal	Telecoms	VSNL Telecoms
Yellow	Telecoms	Level 3 Global Submarine
East-West Interconnector	Proposed Power Cable	EirGrid

Source: Kingfisher Cable Awareness Charts

On the east coast an export cable connects the Arklow Bank wind farm to the Irish grid and there are plans to install a High Voltage Direct Current (HVDC) electricity interconnector between Ireland and the UK.

A number of smaller telecommunications and power cables are also present in the study area, linking island communities to the mainland. There are also subsea pipelines within the study area, supporting the Irish oil and gas industry (see Figure 9.6.1). Two gas pipelines (Interconnector 1 and 2), owned and operated by Bord Gais Eirean (BGÉ), link the gas networks of Ireland and the UK.

There is a small network of pipelines involved in exporting gas from the Seven Heads, Ballycotton and Kinsale Head gas fields on the south coast. In the north west of the study area the offshore section of a pipeline to export gas from the Corrib field has been laid in preparation for connection, via a planned onshore pipeline, to a processing terminal in Co. Mayo.

A number of smaller local outfall pipes are located along the coast.

9.6.2.4 Key Issues and Future Trends

The telecommunications industry is set to grow significantly as existing services are expanded, new services provided and consumer demand for internet access and use increases.

Future marine renewable energy development (wind, wave and tidal) and large wind farm developments in the Irish Sea are expected have a significant impact on the electricity grid systems of Ireland and the UK, which will require export cables, and may also increase the requirement for high voltage interconnectors in the study area.

9.6.3 Aggregates, Dredging & Disposal Areas

9.6.3.1 Data Sources

The following data sources have been used to inform this section:

- Guidelines for the assessment of dredge material for disposal in Irish waters (Cronin et al. 2006)
- Marine Institute data on disposal sites and maerl extraction
- Irish Sea Marine Aggregate Initiative (IMAGIN) Policy Report (O'Mahony et al 2008)
- Marine Working Group Ireland (MWGI)
- Ireland's Marine and Coastal Areas and Adjacent Seas (IMI 1999)

9.6.3.2 Background

At present there is no offshore marine aggregate extraction in Irish waters, however interest has been expressed in developing this industry in Ireland.

Dumping at sea is regulated under the Dumping at Sea Acts, 1996 and 2004. This Act implements the OSPAR Convention adopted in 1992 and entered into force in 1998. The Dumping At Sea Act, 1996 (as amended) prohibits the dumping at sea from vessels, aircraft or offshore installations of a substance or material unless permitted by the Minister for Communications, Marine and Natural Resources.

The deposit of substances or articles in the sea or under the sea-bed within Irish territorial waters or controlled waters is regulated by the Department for Agriculture, Fisheries & Food (DAFF), and all permit applications for the dumping of dredge spoil at sea are processed by the Department of Communications, Marine and Natural Resources (DCENR) Coastal Area Management Division. Before a Dumping at Sea permit can be granted, the assessment of the material must demonstrate that there is no unacceptable ecological risk associated with the disposal operation. In cases where sediments are heavily contaminated, it is unlikely that dumping at sea will be permitted. In such cases, alternative management and disposal options will be considered (Cronin *et al.* 2006).

Typically it can be assumed that there will be minimal interaction between marine renewable energy developments and disposal sites. Active disposal sites will almost certainly be avoided in site selection and it is also likely that out of use disposal sites may also be avoided due to the potential complexities (e.g. variable bathymetry, potential for disturbing contaminants) of installing in areas where materials have been previously been disposed.

9.6.3.3 Baseline Description

Currently all of Ireland's primary aggregates are sourced from land-based quarries, and whilst marine aggregates have been used in the past for specific non-commercial purposes (beach nourishment, reclamation, backfill & coastal defence), there are currently no licenses for commercial extraction in Irish waters. A number of potential sites have been identified, mainly off the east coast of Ireland (Dublin – Rosslare), as areas that could be exploited for marine aggregates (primarily sand and gravel) as a part of the Irish Sea Marine Aggregate Initiative (IMAGIN) (O'Mahony *et al* 2008) (Figure 9.6.2). One 'provisional' prospecting licence was granted for an area to the west of Waterford Harbour (South Ireland) in order for the collection of the data required to make an application for a full extraction licence (IMI 1999), however no licences are currently in place for the exploration or exploitation of marine aggregates.

A number of statutory changes governing the types of waste that can be disposed of at sea have been implemented over recent years. Since 1994, the dumping of most types of industrial waste has been prohibited and the disposal of sewage sludge was phased out at the end of 1998 under the Urban Waste Water Treatment Directive (91/271/EEC). However the disposal of fish waste can still be licensed if the risk to the environment and the risk to other users are considered to be within safe limits. Dredged material from port and navigation channel excavation and coastal engineering works now constitutes the majority of material that remains eligible for disposal at sea, with the majority of permits granted by DCENR being for the dumping of dredged spoil from ports and harbours (Cronin et al. 2006).

Data detailing the location of all designated disposal sites in the study area was provided to the SEA by the Marine Institute. These 50 sites are shown in Figure 9.6.2. The majority of the sites shown in Figure 9.6.2 have been used for the disposal of dredge spoil derived from new developments or extensions to small harbours and the maintenance dredging of shipping ports and navigation channels. There are currently four designated sites solely for the dumping of fish waste and one site for the dumping of both fish waste and dredge spoil:

- Tuskar (SE Ireland)
- Outer Bantry (SW Ireland)
- Clew Bay (NW Ireland)
- Roaringwater Bay (SW Ireland)
- Rosslare (SE Ireland) (fish waste and dredge spoil)

Maerl Extraction in Ireland

Maerl, a slow-growing calcified red seaweed, is present along Ireland's Atlantic seaboard from Roaringwater Bay (County Cork) to Mulroy Bay (County Donegal). The Galway Bay to Connemara coastline area holds 65-70% of all confirmed maerl beds in Irish waters, with the southwest region (principally Bantry Bay and Kenmare Bay) accounting for a further 20-25%. The remaining beds are situated along the Donegal coastline (MWGI 2006/7). However there is currently only one site licensed for the extraction of dead maerl, near Lonehort in SW Ireland (Figure 9.6.2).

Dead maerl has been commercially harvested for use as agricultural and horticultural fertiliser, soil conditioner and poultry food additive, for use in water filters and in dietary supplements as well as in the pharmaceutical, cosmetics, nuclear and medical industries. The main use of Maerl is as a bulk fertiliser and conditioner for raising the pH of lime-poor soils (MWGI 2006/7).

Following the cessation of maerl extraction activities in the Beara peninsula, West Cork, in the 1950s, commercial extraction recommenced in 1994 with the granting of a licence for a maximum annual extraction of 5,000 tonnes from the dead maerl bed at Lonehort Point. In April 2001, a new 10-year licence was granted to the Lonehort Point operator (Celtic Sea Minerals Ltd) to extract up to 16,000 tonnes of maerl per year (MWGI 2006/7). However the Lonehort site has not been used since 2007 and Table 9.6.3a below shows the amount of maerl removed from this site between 1995 and 2007.

Table 9.6.3a: Maerl extracted (tonnes) per year between 1995 & 2007

Year	Maerl extracted (tonnes)
1995	5,000
1996	5,000
1997	5,000
1998	5,000
1999	No licence
2000	42,590*
2001	
2002	
2003	
2004	
2005	11,900
2006	5,300
2007	1,200

Source: Marine Institute (2010), * No quantities available for individual years 2000 - 2004

9.6.3.4 Key Issues and Future Trends

The resource targeted by the marine aggregate industry is sand and gravel. This is a finite resource yet it is important for beach replenishment, coastal protection and construction. As mentioned in the baseline section above, a number of potential sites have been identified as areas that could be exploited for marine aggregates (O'Mahony *et al* 2008) however no licences are currently in place. It is likely that as the population increases and coastal protection becomes crucial aggregate extraction will extend into those areas where resource is available and environmental sensitivities allow as within the IMAGIN study area of the Irish Sea alone, the marine aggregates resource equates to approximately 5 to 7 billion m^3.

9.7 Seascape

9.7.1 Introduction

This section describes the key components, features and characteristics that make up the various strategic seascape types found within the study area. It refers to statutory designations relating to landscape value. A seascape can be described as a discreet area containing a seaward component, a coastline component and a landward component. It can be defined as 'the coastal landscape and adjoining areas of open water, including views from land to sea, from sea to land and along the coastline[34]'.

[34] Guidance on the Assessment of the Impact of Offshore Wind Farms. Seascape and Visual Impact Report. (DTI, November 2005)

Seascape character is made up of physical characteristics of hinterland, coast and sea as well as a range of perceptual responses to the seascape. Seascape effects are the changes in the character and quality of the seascape as a result of a development. Seascape assessment is, therefore, concerned with the direct and indirect effects upon specific seascape components and features; the more subtle effects on seascape character and the effects upon designated landscapes.

9.7.2 Data Sources

The first stage in defining seascape character types at a national scale (to reflect the strategic nature of this study), involved reviewing the available Landscape Character Assessments (LCAs) commissioned and published by Irish County Councils. This review was informed by a document commissioned by the Heritage Council of Ireland: Landscape Character Assessment (LCA) in Ireland: Baseline Audit and Evaluation 2006 and the 2010 update to this report. The baseline audit set out a review and appraisal of Landscape Character Assessments in Ireland in relation to DoEHLG[35] Guidelines and European best practice. The audit looked at the quality, detail, relevance and availability of landscape character assessments in Ireland. The key findings of the report identified the considerable variation in content, length, presentation and methodology of available LCAs in Ireland. This has a significant bearing on the extent of usable baseline information to inform the seascape assessment for the SEA. Key sources are detailed in Appendix A Table A15 Landscape Character Assessment Review.

9.7.3 Confidence Levels

Based on the criteria and assessments set out in the Baseline Audit and Evaluation report, confidence levels for the currently available Irish LCAs within the study area were established. This enabled a judgement to be made on where adequate baseline information existed. The confidence levels are set out below and presented in Table 9.7.1a.

Table 9.7.1a: Landscape Character Assessment Confidence Levels

Landscape Character Assessment Confidence Levels	Very Low	Minimal or no landscape information available; no assessment has taken place.
	Low	Some landscape information is available; a partial or poor quality landscape character assessment has taken place.
	Medium	Landscape character assessment is available but may be outdated or lack detail.
	High	Landscape character assessment is available that meets contemporary standards and best practice.

The amount of information describing the coastal or seascape character within the different LCAs also varies considerably. Therefore in order to aid the identification of data gaps an assessment of confidence levels in relation to coastal or seascape information was derived during the process of review. These confidence levels are outlined below in Table 9.7.1b.

[35] Department of Environment, Heritage, and Local Government, Ireland

Table 9.7.1b Seascape / Coastal Information Confidence Levels

Seascape / coastal information Confidence Levels	Very Low	No coastal landscape or seascape assessment has taken place; Minimal or no seascape or coastal landscape information available.
	Low	A partial or poor quality landscape assessment has taken place that includes some minimal coastal information.
	Medium	A coastal landscape or seascape character assessment is available but may be outdated or lack detail.
	High	Relevant coastal landscape and/ or seascape character assessment available that meet contemporary standards.

Information on baseline data and confidence levels used in this assessment can be found in Appendix A Table A15. Landscape Character Assessment Review.

9.7.4 Defining Seascape Types

The audit identified the existence of forty nine separate landscape character assessments split over nine counties within the SEA study area. These were all reviewed in order to extract information on the coastal character of the study area and confidence levels applied to ascertain the validity of the data (refer to Tables 9.7.1a and 9.7.1b). Where existing Seascape Assessments are available these were also reviewed and confidence levels applied. Whilst the majority of these LCAs defined coastal types or areas on the basis of the characteristics of the coastline, rather than the character of the marine element or relationship of land and sea, sufficient information on coastal character was generally available to form the basis of defining seascape character types across the study area.

Where either Landscape Character Assessments are not available or where the Confidence Levels were considered to be ‘Very Low’ alternative source material was reviewed to ascertain the characteristics of the coastal landscape to enable the data gaps to be filled and seascape character types to be defined. This is explained further in section 9.5.6.5 below.

The many defined coastal landscape character types from the LCA review were then grouped according to shared characteristics. The geographical spread of these dominant characteristics was evaluated in conjunction with aerial photographs and Ordinance Survey maps of the study area. These new groupings of amalgamated and slightly simplified coastal types were then reviewed in the context of their relationship with coastline and sea to formulate ten draft seascape types with shared dominant characteristics. These seascape types are presented on Figure 9.7.1.

In defining the seascape types it was important that the strategic scale of the assessment was considered. Ireland has a dramatic, varied and constantly changing coastline. Broad judgements have had to be made regarding the component parts of each seascape and a rationale developed in order to generalise and hence incorporate minor character areas set within a generic description of seascape type. Consequently, where a seascape has been deemed for example, to be Seascape Type 6 - Complex Indented Coast, Small Bays and Offshore Islands, there may be the occasional occurrence of a larger bay within the coastline. At a strategic level, this level of detail cannot be mapped without detracting from the clarity of baseline understanding of the study area.

9.7.5 Data Gaps

Where either no Landscape Character Assessments are available (Donegal, Sligo, Kerry and Waterford) or where the applied Confidence Levels were considered to be ‘Very Low’ alternative source material was reviewed to understand the characteristics of the coastal landscape to enable the data gaps to be filled and seascape character types to be defined.

In such instances a desk based assessment was undertaken drawing on development plan information, aerial photographs, OS maps and descriptions of nature conservation designations. The coastal characteristics of the four remaining counties were then determined based on this information and seascape types were subsequently defined. It is recognised that the confidence in these judgements is lower than where Landscape Character Assessment information is available as the LCAs are derived from detailed site based analysis. Due to the strategic nature of this appraisal it is not feasible or appropriate to undertake site survey of these areas. Further information on baseline data used in this assessment can be found in Appendix A Table A15 Landscape Character Assessment Review.

9.7.6 Baseline Description

Ireland has a long coastline that varies from deeply incised bays and loughs, high cliffs, and offshore islands (west coast), river estuaries, sweeping sandy bays (south) to rocky headlands and low lying linear beaches backed by dunes (east coast).

Much of the west coast is exposed and dramatic with mountainous hinterlands interspersed with the low plains and drumlin landscapes. Settlement is often sparse and scattered out with urban areas.

The south and east coasts of Ireland consist mainly of low undulating or flat fertile agricultural land with a higher density of scattered development along with areas of dense urban character around the coastal towns and cities. Along sections of the east coast the coastal edge is divided from the hinterland by road or rail infrastructure.

9.7.6.1 Seascape Types

Table 9.7.1c below provides a description of the eight different seascape types contained within the study area as illustrated on Figure 9.7.1 Irish Seascape Types. Further information on these seascape types can be found in Appendix A, Table A3 Irish Seascape Character Types.

9.7.6.2 Protected Areas

For the purposes of the seascape assessment, importance has been addressed by reference to national, regional and local landscape designations. Absence of such a designation, however, does not infer a lack of quality or importance. Factors such as accessibility and local scarcity can render areas of nationally unremarkable quality, highly valuable as a local resource.

The following national landscape designations have been considered:

- World Heritage Sites (WHS).
- Potential World Heritage Sites (pWHS).
- National Parks.

9.7.6.3 World Heritage Sites (WHS)

The 1972 World Heritage Convention aims to protect the values of cultural or natural sites, which could deteriorate or, worse, disappear, often through lack of funding to preserve them. States Parties to the Convention contribute the necessary financial and intellectual resources to protect World Heritage Sites. There are two World Heritage Sites in Ireland, the Archaeological Ensemble of the Bend of Boyne, which is an inland site and therefore outside the boundary of the study area, and Skellig Micheal located on the coast of County Kerry. This site is illustrated in Figure 9.3.1: Protected Sites.

Skellig Michael, was inscribed onto the World Heritage List by UNESCO in 1996 and is one of three World Heritage sites on the island of Ireland. The WHS designation was made in recognition of its outstanding cultural value as a very early monastic site and remote hermitage in an exceptional state of preservation. Skellig Michael is also internationally renowned as one of the most important sites for breeding seabirds in Ireland.

The Skelligs are steep rocky volcanic islands situated 12k south west of Inveragh Peninsula, County Kerry. The boundary of the WHS does not include the smaller, neighbouring island of Little Skellig or the surrounding sea area. The wild and dramatic setting of the ancient monuments is an integral part of the character and atmosphere of the WHS.

9.7.6.4 Potential World Heritage Sites (pWHS)

Nominations to the World Heritage List are based on a tentative list put forward by a National Government. A tentative list is an inventory of those properties considered suitable on cultural and/or natural heritage criteria of outstanding universal value. Ireland's most recent submission of a tentative list was in April 2010[36]. This most recent tentative list includes seven sites/properties:

- Early Medieval Monastic Sites (Clonmacnoise, Durrow, Glendalough, Inis Cealtra, Kells and Monasterboice).
- The Burren.
- Céide Fields and NW Mayo Boglands.
- The Historic City of Dublin - A Georgian City and its Literary Tradition.
- The Monastic City of Clonmacnoise and its Cultural Landscape.
- The Royal Sites of Ireland (Cashel, Dún Ailinne, Hill of Uisneach, Rathcroghan Complex and Tara Complex).
- Western Stone Forts.

Those sites that relate to the main coastal counties included in the study area are listed in Table 9.7.1d below.

9.7.6.5 National Parks

The term 'National Park' is reserved for areas that have not been materially altered by human exploitation and occupation and where species, geomorphological sites and habitats are of special scientific, educational and recreational interest or which contain a natural landscape of great beauty.

At the time of writing (October 2010) no definitive map information is available on the boundaries of Ireland's National Parks. However, the following National Parks may have coastal areas or significant sea views that contribute to the landscape character of the protected area. Further detail on these National Parks is provided in Table 9.7.1d.

- Glenvaeagh National Park.
- Ballycroy National Park.
- Connamara National Park.
- Burren Uplands National Park.
- Killarney National Park.

[36] http://whc.unesco.org/en/tentativelists/state=ie

9.7.6.6 County Level Landscape Designations

County Level landscape designations are very diverse in scale and format and therefore difficult to assess comparatively. These main designations are listed in Table 9.5.6d: Protected Areas and County Landscape Designations and listed in greater detail in Appendix A, Table A5. Onshore landscape wind capacity studies available at a county level are have not been included in this baseline data as these studies are focused on the effects of land based wind development over wider geographic areas within which the coast and sea comprise a landscape component and therefore are not pertinent to the marine environment.

9.7.6.7 Transboundary Seascape Areas

As part of this SEA it has also been necessary to consider transboundary seascape areas that lie outwith Irish waters but which may be within visual range of the study area. These include areas within the jurisdiction of Northern Ireland and Scotland. The areas identified where potential transboundary effects should be considered are listed below (See Figure 9.7.1 Overview of Irish Seascape Character Types).

- Lough Foyle and Carlingford Lough (Northern Ireland).
- The Antrim Coast from Magiligan Point to Benbanehead (Northern Ireland).
- The south west coast of Islay (Scotland).
- Dudrum Bay and Kilkeel (Northern Ireland).

Further detail of the seascape types in these transboundary areas and key protected area such as the Giant's Causeway World Heritage Site on the north coast of Northern Ireland and the Northern Ireland Areas of Outstanding Natural Beauty (AONBs) that could be affects (The Causeway Coast AONB, The Antrim Coast and Glens AONB, the Mourne AONB and Lecale Coast AONB), are provided in Appendix A.

Table 9.7.1c: Seascape Types

Seascape Type	Location	Physical Characteristics	Quality of Experience
1. Large Open or Partially Open Sea Lough with Raised Hinterland	Lough Foyle (Donegal), Lough Swilly (Donegal), Clew Bay (Mayo), Galway Bay (Galway and Clare) , Mouth of the Shannon (Clare and Kerry) and Carlingford Lough (Louth)	This seascape type comprises large scale sea loughs associated low-lying coastal plain, raised hinterland and headlands. Sea Loughs are typically contained within broad flat bottomed valleys enclosed by raised hinterland with a low lying coastal fringe. Tidal mudflats can be a common component of the seascape. Settlement can vary. The hinterland can comprise low lying agricultural land with scattered rural settlement. Elsewhere dense urban development is concentrated around the head of the sea loughs. Ports and harbours are sometimes located at the Lough heads with associated urban or industrial development.	Large scale open views along windswept low lying shorelines are contained by landmass. Long smaller scale contained views to the open sea framed by headlands are gained from Lough shores. Where there is an absence of urban development, truncated views along the Lough to the open sea give a wild open vista. There are often long views along the Loughs out to the open sea from the raised hinterland.
2. Rugged Peninsulas with drowned valleys	Brandon Head (County Kerry) to Mizen Head (County Cork)	The steep exposed wild coastline with long peninsulas, sounds and islands provides a range of seascape scales and dramatic sea views ranging from small scale tranquil inner loughs and bays to rugged headlands with expansive open views. Long rugged hilly or mountainous ridges are separated by large 'V' shaped drowned valleys narrowing towards the valley head. The outer bay seascape is exposed with rocky promontories and islands. Inner bays are sheltered with numerous small islands and fertile and low lying land sloping down to the shore, scattered farmsteads and scenic coastal roads. There is a deep water harbour with some industrial infrastructure at Bantry Bay.	Outer bays and peninsulas are exposed and dramatic with large scale views framed by headlands and islands. Inner bays are more tranquil with small scale views within and along the lough framed by landmass.
3. Low Lying Plateau Landscape	Hook Head to Rosslare Harbour (Wexford), Courtown to Loughlinstown (Wexford), Arklow Head/ Clogga to Rathdown (Wicklow)	This seascape type provides slightly elevated sea views from flat or low rolling open plateau landscape consisting primarily of agricultural land dropping abruptly at the coastal edge with low cliffs and narrow curving sandy bays with rocky headlands. Widespread ribbon commercial and housing development follow coastal roads along the east coast.	Open and expansive slightly elevated sea views from the coastal edge with low intervisibility from the hinterland in many areas and smaller scale views from bays framed by headlands.

Seascape Type	Location	Physical Characteristics	Quality of Experience
4. Low Lying Coastal Plain and Coastal Estuarine Landscape, Low lying Islands and Peninsulas	Benwee Head to Blacksod Bay (Mayo), Kilkieran Bay (Galway), Toe Head to Cross Haven (Cork), hook Head to Loch Garman (Wexford), Loch Garman to Kilmicheal Point (Wexford), Portmarnock to Dunany Point (Fingal, Meath and Louth), Greencastle to Kilough (Down NI)	This type of seascape is diverse and changeable, ranging from large to medium scale.. The seascape is exceptionally flat and often exposed with generally wide, open views extending far out to sea, often with a high degree of intervisibility between sea and land. Low lying open landscape, with coastal edges comprised of long sandy beaches or strands, sweeping bays, curved sandy beaches or in some instances the foreshore can be rocky and part fragmented, sloping gently upwards to meet the coastal flats beyond. The mouths of low lying with river estuaries sand, gravel or mud flats, salt marsh and shallow inner bays, large bays and flats are sometimes backed by dune systems or may be open to the low mainly agricultural hinterland. These low lying coastal strips may rise to a hinterland of rolling foothills separated from the shore by moorland or agricultural land. Each forms an attractive soft coastal edge typical to this seascape type. The open landscape frequently has an exposed character. Patterns of settlement within this seascape type are generally rural and scattered particularly on the west coast, with areas of ribbon tourism development and isolated housing along coastal roads on the south and east coast. There are some urban settlements at the head of shallow bays or inlets. This seascape type also includes flat or very low lying rolling complex islands and peninsulas consisting of moorland, semi natural or natural grassland with sparse settlement and rocky or boggy moorland.	Typical of this seascape type are wide vistas with extensive sea views with a high degree of intervisibility between land and sea. Where landmass is visible in the far distance this serves to heighten further the sense of scale and openness. The horizontal emphasis adds to the very large sense of scale with uninterrupted sea views creating an interplay of light sea and sky that forms an important component of the local landscape character. Along some linear sandy areas of the east coast intervisibility between the low hinterland and sea varies, where there are extensive dune systems visibility is often limited to a short distance inland.

Seascape Type	Location	Physical Characteristics	Quality of Experience
5. Narrow coastal strip with raised hinterland	Maghera to Killybegs (Donegal), Lambay (Louth)	This seascape is typified by the occurrence of a narrow, often inaccessible, coastal strip backed by raised beach and headlands with expansive elevated sea views from the higher ground. Often the coastline can be indented with a low narrow coastal strip rising to steep hinterland, headlands and incised bays. The landscape is exposed and rugged with scattered rural settlement; small linear developments follow road corridors or clustered adjacent to sheltered bays. In places the coastal strip is divided from the rising hinterland by transportation corridors.	This seascape type is open and expansive with many elevated dramatic views to sea from both the raised hinterland and coastal shelf. There is a sense of exposure to the elements and wildness. The large scale of the seascape is in places heightened by this steeply rising hinterland and elevated viewpoints.
6. Complex Indented Coastline with Small Bays and Offshore Islands	Malin Head to Dunaff Head (Donegal), Fanad Head to Maghera (Donegal), Blacksod bay to Kilkieran Bay (Mayo and Galway), and Arran Islands (Galway).	Typically this seascape contains a varied, complex and incised coastline with steep, undulating hinterland, small bays and cliffs. Pockets of shelter along the exposed coastline by small semi enclosed bays and rugged offshore islands. In some locations the hinterland consists of a drumlin landscape which rolls down to meet a deeply indented shoreline. Traditional settlements and small towns are located at sheltered bays and inlets, with more rural settlement scattered over exposed uplands. The topography of this type of seascape is visually dramatic with ever changing views of the sea.	Due to the complexity of the landform associated with this distinct seascape type, the experience and views continually change. The raised headlands and hinterland are rugged and exposed with some sense of remoteness in localised areas. There are long expansive vistas from raised hinterland and headlands framed by complex shoreline and island landmass. Within the drumlins, small bays and drowned valleys, views can be enclosed with sea framed by an undulating landscape. Here the experience is sheltered and more intimate. From within indented inlets, contained views scaled by landmass give a sense of tranquillity and calm. The associated off shore islands create a rugged profile in a mass of sea when viewed from the shore.

Seascape Type	Location	Physical Characteristics	Quality of Experience
7. Plateaus and High Cliffs	Inishowan Head to Malin Head (Donegal), Downpatrick Head to Benwee Head (Mayo), Loop Head Peninsula (Clare), Bray Head (Wicklow).	This is a wild, rugged and visually dramatic seascape. There is great vertical scale where often a high plateau landscape plunges abruptly to an incised coastal edge. Dramatic series of cliff faces present broken edge to the raised plateau landscapes. Below the cliffs the narrow coastal edge is typically low, flat and in places jagged, comprising a rocky mosaic, complete with rocky peninsulas and occasional small bays.	This seascape type is rugged and visually dramatic with open expansive and elevated views to the sea creating a sense of wildness. The interaction and interplay of weather and changing sea and sky form an integral part of the seascape character. The combination of exposure to the elements and vastness of scale contribute to a sense of drama within the seascape In some locations the plateau edge may be raised with limited views from the rural hinterland out to the open sea.
8. Large Bay	Donegal Bay (Donegal, Leitrim and Sligo), Ballyheigue, Tralee and Brandon Bay (Kerry), Cork Harbour to Loop Head (Cork and Waterford), Dublin bay (Dun Laoghaire) and Dundalk Bay (Louth).	Very large long sweeping bays often with sand dunes, expansive sands and tidal flats and rocky headlands. The scale of the seascape varies from medium to large with very long open views framed by landmass, both across the bay and out to the wide horizon of the open sea.	The effects of scale, light, and water in long uninterrupted vistas framed by landmass are important components of the seascape character within the bay area. The open and expansive long views from the inner shore are contained by views to headlands and distant shorelines creating a foreshortening effect looking across the bay, with long views out to the wide horizon of the open sea.

Seascape Type	Location	Physical Characteristics	Quality of Experience
Type 9 Large River Estuary	Shannon Estuary (Clare, Limerick, Kerry)	Semi enclosed seascape bordered by low flat or rolling estuarine coastal fringe with mudflats and islands, the scale of the seascape varies from small to large with long open views across the estuary framed by landmass and out to the narrow horizon of the open sea. The broad slightly winding Shannon river estuary varies in width along its course widening out as it approaches the enclosing headlands of narrow river mouth. Low flat or rolling estuarine coastal fringe with mudflats and islands, rising to a rolling hinterland. Exposed shorelines are interspersed with sheltered bays.	Large horizontal vistas enclosed by landmass. Islands and vertical elements such as built structures are visually prominent due to the low viewpoint and low profiles of distant shorelines. Commercial and industrial activities **around** the Shannon estuary such as shipping, pylons and the power station at Money Point form dominant visual features.

Table 9.7.1d: Protected Areas and County Landscape Designations

Study Area Counties	World Heritage Sites (WHS) and Potential World Heritage Sites (pWHS)	National Parks	County Landscape Designations
Co. Dublin	Dublin – A Georgian City and its Literary Tradition (pWHS)	-	**Protected Views and Prospects** (Dun Loaghaire). **Protection of Views and Prospects** of special amenity value or special interest.
Co. Wicklow	Early Medieval Monastic Sites (pWHS)	Wicklow Mountains National Park. There are potential long views to the coast and open sea from Wicklow Mountain National Park.	**Areas of Outstanding Natural Beauty (ONB):** Landscape areas which are most vulnerable and sensitive, and which are considered to be of greatest scenic value. **Special Amenity Areas:** Those landscape areas which, whilst not as vulnerable or as sensitive as those areas in the AONB are still subject to pressure for development which could result in a serious deterioration in the landscape. Designation is by Special Amenity Area Order (SAAO). Protection of identified **Views And Prospects** of special amenity value or special interest.

Study Area Counties	World Heritage Sites (WHS) and Potential World Heritage Sites (pWHS)	National Parks	County Landscape Designations
Co. Wexford	-	-	**Vulnerable Landscape:** defined as having very distinctive features with a very low capacity to absorb new development without significant alterations of existing character over an extended area. **Sensitive Landscapes:** defined as landscapes where due to their natural character and open and exposed nature any development will be widely visible.
Co. Waterford	-	-	**Vulnerable:** defined as shores of the main water bodies - lakes, large rivers, coasts, estuaries, promontories and headlands as conspicuous features of the natural landscape visible over a wide area. **Sensitive:** These land-use categories include open and exposed areas which are sensitive due to their natural character therefore any loss to their structure would have a visual impact over a wide area. **Normal:** This land use category includes the main areas of farming and rural residences. **Robust:** These land use categories include towns and built up areas, suburban and other developed areas. **Scenic Routes:** these are protected from obstruction or degradation of the views towards visually vulnerable features or significant alterations to the appearance or character of sensitive areas.
Co. Cork	-	-	**Very High Landscape Value:** defined as scenic landscapes with highest natural and cultural quality, areas with conservation interest and of national importance. Landscapes defined as being of **Very High Sensitivity** are extra vulnerable landscapes (for example an area of national importance) likely to be fragile and susceptible to change. The County Cork Development Plan also includes the identification of **Scenic Areas** and **Scenic Routes**.

Study Area Counties	World Heritage Sites (WHS) and Potential World Heritage Sites (pWHS)	National Parks	County Landscape Designations
Co. Kerry	Skellig Micheal (WHS) Western Stone Forts (pWHS)	Killarney National Park. This National Park is situated between Mangerton Mountain and the MacGillicuddy Reek and has distant views to the Kenmare River Inner Bay.	**Rural Prime Special Amenity Areas:** landscapes which are very sensitive and have little or no capacity to accommodate development. **Rural Secondary Special Amenity:** The landscape of areas in this designation is generally sensitive to development. Accordingly, development in these areas must be designed so as to minimise the effect on the landscape. **Identified Views and Prospects:** these are protected and development, where permitted, should not seriously hinder or obstruct these views. The outer coastal area is defined as being of intrinsic **Natural and Special Amenity Value**. The part of the south coast of the Shannon Estuary is aread for the development of Industry.
Co. Limerick	-	-	Scenic Views and Prospects identified views are protected under a wider set of policies for the landscape character area.
Co. Clare	The Burren (pWHS) Early Medieval Monastic Sites (pWHS) Western Stone Forts (pWHS)	Burren Uplands National Park. This National Park is located inland but may have long views to the coast and open sea.	**Vulnerable Landscapes:** In areas identified as being vulnerable landscapes the Planning Authority will only normally permit proposals for development where the development will not adversely impact upon a significant extent upon the character, integrity or uniformity of the landscape. **Scenic Routes:** These are identified where development which would interfere with views from designated roads will not normally be permitted. **Areas of High Amenity:** These are defined as landscapes of special value or sensitivity within the county, in which inappropriate development would contribute to a significant diminution of the landscape setting of the county. These are designated under a **Special Amenity Area Order (SAAO).**
Co. Galway	The Burren (pWHS) Western Stone Forts (pWHS)	Connemara National Park. This is situated at Diamond Hill and the Twelve Bens with views to the outer coast and islands including Ballynakil Harbour.	**Class 5 - Unique:** Highly Sensitive to all forms of development Class 4 - Special Sensitivity to visually intrusive forms of development. **Class 3 - High Sensitivity:** Identified important views and prospects to be retained. Identified **Protected Views** of special amenity value or special interest

Study Area Counties	World Heritage Sites (WHS) and Potential World Heritage Sites (pWHS)	National Parks	County Landscape Designations
Co. Mayo	Céide Fields and NW Mayo Boglands (pWHS)	Ballycroy National Park. Distant views of the coast may be possible from the Owenduff/Nephin Mountains in the Ballycroy National Park.	**Vulnerable:** defined as areas or principal features that create and sustain the character and distinctiveness of an area. **Sensitive:** landscape with a distinct homogenous character based on natural processes. **Less sensitive:** able to absorb development with limited views. **Protected Views** of special amenity value or special interest. **Highly Scenic** routes indicate public routes from which there are views of natural beauty and interest. Development between the road and foreshore, lakeside or riverside should be subject to strict visual criteria. Scenic routes indicate public routes from which there are views of natural beauty and interest. Development should not substantially alter the character of these views.
Co. Sligo	-	-	**Normal Rural Landscape** with capacity to absorb a wide range of development. **Sensitive Rural landscape** with an intrinsic scenic quality and low capacity to absorb development. **Visually Vulnerable Landscape** with distinctive natural features and low capacity to absorb new development to which a high level of protection is applied. **Scenic Routes:** identified routes with highly scenic views, the overall character of the scenic route has some protection.
Co. Leitrim	-	-	**Area of Outstanding Natural Beauty (AONB)** **Areas of High Visual Amenity (AHVA)**
Co. Donegal	-	Glenvaeagh National Park. There may be long views along the coast and out to sea from Derryveagh Mountains situated inland from Donegal's Coast.	**Area of Especially High Scenic Amenity (EHSA)**

9.8 Climate

9.8.1 Existing Renewable Energy Infrastructure

9.8.1.1 Data Source

The following data sources have been used to inform this section:

- Sustainable Energy Ireland
- Marine Institute

9.8.1.2 Background

Renewable energy development in Ireland is still in the early stages, but a combination of excellent resource and challenging targets means that renewable infrastructure is already part of the Irish marine environment.

Offshore wind is the most developed of the offshore renewable technologies with several companies actively involved in projects in Ireland. Wave and Tidal energy generation is not as far advanced but the Ocean Energy Strategy is in place for its development in Ireland (MI & SEI, 2009).

Figure 9.6.3 accompanies this section.

9.8.1.3 Baseline Description

At present there is only one operating wind farm in Ireland's waters. Phase 1 of Arklow Bank Wind Park was completed in 2002 and is located 10km off the Co. Wicklow coastline on the east coast, it consists of 7 turbines and has a capacity of 25.2MW. Consent is in place for a total of 200 wind turbines with a total capacity of 520MW. Four other offshore wind projects are at various stages of the consent process (see Figure 9.6.3). The proposed Codling Wind Park, comprising 220 turbines located approximately 13km from the east coast, has already been consented for a capacity of 1,100MW and an application has been lodged for an extension of up to 200 more turbines. Oriel, Sceirde Rocks and Dublin Array wind farms have obtained foreshore licenses and are currently awaiting a foreshore lease decision from the Minister. Sceirde Rocks is the only proposed Windfarm not to be located on the east coast, it is approximately 5km offshore of County Galway southwest of Maoinis.

As part of the Ocean Energy strategy a wave device testing centre, for scaled prototypes, has been set up on the north side of Galway Bay, 1 mile south east of An Spideal. The OEDU are also developing a test site for full scale prototypes off the northwest coast of Ireland, near Belmullet. The site will be up to 12km from the shore and the first devices are expected to be on site in the next 3 years.

There are no tidal devices currently installed in Irish waters.

9.8.2 Natural Gas and CO_2 Storage

9.8.2.1 Data Source

The following data source has been used to inform this section:

- SEAI Report on Carbon Dioxide Capture and Storage in Ireland (2006)

9.8.2.2 Baseline Description and Future Trends

Natural gas storage currently only occurs in the Kinsale Head gas field, which began in 2001. However with the ongoing development of the Corrib gas filed it is likely that natural gas storage could also occur in this location.

There are no current proposals for storage of carbon dioxide in Irish waters. However, the Sustainable Energy Authority Ireland (SEAI) has recommended in their report on the Costs, Benefits and Future Potential of CO_2 Carbon Capture and Storage (CCS), that Ireland's CO_2 storage capacity needs to be assessed in detail as a matter of urgency and that resource studies similar to those carried out in Australia and Canada would be of particular benefit. However, legal, safety and public perception concerns must be addressed before real progress can be made in the area. SEAI has also recommended that Ireland join one or more of the many international collaborations working in the technology and application of CCS (SEAI 2006).

To date no survey of Ireland's deep geology has been undertaken. This means that there is currently insufficient data to determine whether there are any suitable aquifers in existence in Ireland or Irish territorial waters for carbon storage. However, there are presently large-scale gas production projects being carried out in Ireland (Kinsale off the south coast, and in the near future at Corrib off the west). Sizeable oil and gas reserves have also been discovered and may soon be developed by two consortia of ExxonMobil, Providence Resources and Sosina over 200 km off the west coast (the prospects are known as Spanish Point and Dunquin) (SEAI 2006).

Section 10: Generic Assessment

10 Generic Assessment

10.1 Introduction

This chapter provides a discussion of the potential generic effects associated with offshore wind, wave and tidal stream developments for survey, installation, operational, maintenance, subsea cables and decommissioning. Information on these main activities/development stages are discussed in Chapter 7: Technologies.

A detailed assessment of the potential effects of offshore wind, wave and tidal developments on sensitive receptors that are known to be present in certain parts of the study area is presented in Chapter 11 (Assessment Area Assessment).

This chapter does not include any mitigation measures. Information on proposed mitigation measures are discussed in Chapter 11 in relation to specific effects identified within each of the Assessment Areas.

10.2 Marine Survey

Survey operations for installation of marine infrastructure, such as wind, wave and tidal developments and associated cabling, can be seen as comprising of three distinct, but inter-dependent phases, geophysical, geotechnical and benthic surveys.

The aim of the geophysical survey is to build up a model of ground conditions and the identification of features on the seabed. The geophysical survey uses methods that are largely ‘remote sensing’ in nature that is they use the transmission and reflection of energy sources, rather than interaction with the seabed, to build up a picture of the seabed.

The geotechnical phase follows the geophysical survey and is an exercise in ground truthing the results of the geophysical survey. This survey acquires samples and uses direct measurements of the seabed to provide quantitative information about materials interpreted from the geophysical survey. The number and type of samples needed are based upon the variety of sediment types and subsurface soils from the geophysical survey.

Finally the benthic survey uses the geophysical interpretation of sediment distribution and identifies marine habitats on the seafloor and the species that are dependent upon these habitats. This survey uses both sampling devices to recover material and also cameras or video to put the different sediments types from the survey into biological context.

Marine surveys are undertaken not just to provide information required for engineering construction issues, but also to ensure that the consent conditions for the natural environment can be met. The potential impact that the equipment used in these survey phases is discussed below.

10.2.1 Water and Soil (Sediment)

Impacts on the water and seabed are through the deployment of sampling devices of which three types are used,

- grab sampling
- coring or boreholes
- cone penetrometer testing

Grab samples recover a small amount of seabed sediments from an area typically around $0.1m^2$. Grabs are used to provide sediment samples for ground truthing of geophysical interpretation and also in the acquisition of benthic samples.

The penetration of the grab will generally only be a few centimetres below the surface – as such their impact on the seabed is very minimal and the area of disturbed seabed is likely to be very quickly returned to equilibrium by the action of currents.

Coring and boreholes both recover samples of seabed sediments. Vibrocores are used to recover cores of material of between 3 to 5 metres depth below the seabed. The depth of penetration will depend upon how strong the sediments are – recovery in sand will be greater than in stiff clays. Vibrocores are used to assess conditions for cable routing where the shallow geology, the material into which the cable will be installed, is of interest. The vibrocore recovered to deck contains the sediments in a plastic pipe and thus preserves the layering of the material.

Other coring methods or drilling of boreholes are used in foundation design and are drilled to 10s of metres in depth. The material is recovered to the surface and thus is a more disturbed sample than the shorter vibrocore. For all core systems the impacts on the seabed relate to the footprint of the unit on the seafloor and the material recovered. Both of these are transitory effects with unconsolidated sediments quickly filling up the hole left by the removed material.

Cone Penetrometer Testing (CPT) uses a frame that is placed on the seabed and then a rod is pushed through the sediments. The tip of the rod has a sensor which provides direct measurements of properties of the sediments as it is pushed through them – such as friction and poor water pressure. CPTs are used for both the shallow geology of interest to cable installation, and also the deep foundation design geotechnical survey. They do not remove material so their impacts are limited to the footprint of the device on the seabed during the testing.

As with all vessel operations there is the potential for impacts on water quality due to a pollution incident from a vessel undertaking a survey. Pollution incidents could be caused by vessel collisions or the accidental release of chemicals held on the vessel and present during the operation, such as hydraulic oil.

Each survey operation will have emergency response plans to deal with such contingencies and vessels are required to adhere to national and international conventions on prevention of pollution.

10.2.2 Biodiversity, Flora and Fauna

Survey techniques for marine renewables are fairly benign in terms of impacts. The reflection seismic geophysical technique needs to penetrate up to about 50 m below the seabed for piled devices (much less for devices attached by clump weights etc). This means that the energy outputs are far lower compared to oil and gas exploration which must penetrate hundreds to thousands of metres below the seabed.

Another source of acoustic energy is the high frequencies used by equipment such as multibeam echo sounders – these are used to determine water depth and also assist in the interpretation of seabed habitats.

The operating frequencies for geophysical equipment used in surveys associated with renewable projects are summarised below, along with peak sensitivity frequencies for some marine mammals (Irish Whale and Dolphin Group, 2005. IWDG made a series of recommendations regarding acoustic noise. The IWDG is non-governmental conservation body, and not a statutory body with powers to enforce guidelines or require that their protocol is followed, however they have provided a document which, in conjunction with the Marine Notice Act No. 15 of 2005 regarding vessel operations (DCMNR 2005), can be incorporated into developing best practice when discussing survey planning with the NWPS, and during the execution of survey works.

Table 10.1: Marine Mammal Sensitivity to Acoustic Survey Frequencies

Data Acquisition	Examples of Equipment	Operating Frequencies	Sensitive Frequencies For Marine Mammals (Peak Sensitivity)
Dual frequency side scan sonar – high frequency setting	Edgetech 2000-CSS and Klein 3000 and 5000	455 kHz to 400 kHz	N/A

Data Acquisition	Examples of Equipment	Operating Frequencies	Sensitive Frequencies For Marine Mammals (Peak Sensitivity)
Bathymetry	Multibeam Echo Sounders - Reson 7101 and Kongsberg EM3002	300 kHz to 204 kHz	N/A
Bathymetry	Single Beam Echo Sounders - Kongsberg MA 1000	200 kHz	N/A
Dual frequency side scan sonar – low frequency setting	Edgetech 2000-CSS Klein 3000	100kHz 132kHz	Harbour Porpoises : 3 to 130 kHz (125 to 130 kHz)
Reflections Seismics (shallow penetration, higher resolution)	Pinger – SES Probe 500 Chirp systems - Edgetech 512	3.5 kHz 12 kHz to 0.5 kHz	Bottlenose Dolphins : 5 to 110kHz (5kHz) Common seals: 4 to 45kHz (32kHz)
Reflections Seismics (higher penetration, lower frequency and resolution)	Boomer - Applied Acoustics AA201 Sparker systems- GeoSpark 200	1.6 kHz 2 kHz to 500Hz	N/A

Source: Sensitive frequencies for marine mammals taken from Irish Whale and Dolphin Group 2005; Reflection seismic frequency taken from Infomar 2010.

The Irish Whale and Dolphin Group (IWDG) have undertaken a review of the potential impacts on cetaceans in Irish waters by the use of multibeam systems. This review also looked at studies of best practice which included frequencies of the other geophysical systems given above. The conclusions reached are that the frequencies that are used during geophysical survey operations have the potential to negatively impact upon marine mammals.

The geotechnical operation has a limited impact on the biodiversity – it is only the footprint of the supports on the seabed that have potential to harm benthic or sessile creatures that are happen to be that section of seabed at the time of equipment landing on the seabed.

The vessels involved in geotechnical and geophysical survey can also potentially have a disturbance impact on sensitive mobile species such as mammals and birds. This is generally likely to be minor and needs to be considered in the context of the vessel activity already taking place in the survey area. In particular, if a vessel approaches a coastal breeding area for seals or birds there is potential for disturbance causing a flight reaction impacting breeding success.

10.2.3 Cultural Heritage including Archaeological Heritage

The potential impacts on cultural heritage during survey operations are likely negligible – there is minimal interaction with the seabed until after completion of the geophysical survey, and as described above the impacts on the seabed during the geotechnical survey are limited only to the footprint of the sampling devices.

Survey methods and data acquired during the geophysical survey phase can be planned in accordance with existing guidelines such as those issued by the Underwater Archaeology Unit of the Department of Environment, Heritage and Local Government. This enables the data to be assessed from an archaeological perspective as part of the consenting process for construction and cable installation.

Geophysical surveys can have positive impacts on cultural heritage as the survey results provide a rich data source from which known sites can be better mapped and new finds can be made.

Likewise the geotechnical survey can be of benefit as it provides samples of sediment from which information about palaeo-environments, the location of former shorelines and river channels can be identified. These help in understanding changes in the land form and human habitation along the coastline at times of lower sea level in the Ice Age.

10.2.4 Population and Human Health

Marine survey operations have limited interaction with humans. The main interaction with other people is restricted to vessels and those working on them.

During the survey there are statutory notices regarding vessel movements for shipping and military notification. Fishing vessels may be impacted by survey operations due to requirements of moving fixed fishing gear. However, this can be managed by the use of a fisheries liaison officer who acts as an interface between the fishing community and the survey company.

At the shore end works across the inter-tidal area can impact on tourism as vessel operations at high tide, or land based works at low tide, have potential to interfere with recreational users. Survey programming can be done in such a way that high amenity beaches are excluded from having works done during busy periods in the summer.

10.2.5 Material Assets

The likelihood of material assets on the seabed being negatively impacted by the survey is very small.

One of the objectives of the geophysical survey is to provide a defined position of where existing seabed infrastructure is located, and the condition it is in regarding burial. The sensors used are able to provide detailed and quality information regarding the location of buried infrastructure. For cables and pipelines installed prior to May 2000, then the geophysical survey can actually provide better information regarding cable location than was available at that time. This is due to improvements in GPS positioning since that date.

Only a very small volume of sediment is removed during geotechnical phase and as such does not represent a negative impact for extraction industries such as aggregate dredging.

As with all vessel operations there is potential for pipelines and cables to be damaged due to emergency deployment of anchors or equipment failure leading to uncontrolled descent of the geotechnical sampling equipment. The risk for this is survey operations is limited by operational procedures and not acquiring samples close to where the cables/pipelines have been located, usually keeping away at least three times the water depth for a cable, or a distance in the order of 500 metres for a gas pipeline.

10.3 Installation

Installation impacts are associated with the construction phase of the project. They are therefore temporary impacts in nature, although for large scale commercial arrays the installation phase could be split across several seasons. At a high level construction can generally be split into the following impact sources:

- Direct physical seabed and habitat disturbance during devices and cables
- Sediment re-suspension during seabed disturbing works
- Contaminant re-suspension during seabed disturbing works
- Underwater noise, particularly during piling activities
- Presence of installation vessels and equipment
- Accidental events (collisions, vessel fuel spills, etc)

Potential impacts of each of these on marine receptors are described in some more detail in this section.

10.3.1 Potential Effects on Water and Soil (Sediment)

10.3.1.1 Bathymetry

No significant effects on seabed bathymetry are expected to result from the development of offshore wind or marine renewable energy during the installation of arrays of marine renewable energy devices.

However, the water depth/availability of the water column for navigation and other sea uses is likely to be affected by the installation of arrays of marine renewable energy devices. The impacts upon shipping and navigation are discussed in the relevant section below.

Potential effects on seabed morphology and coastal processes are discussed in the Geology, Geomorphology and Sediment Processes section below.

10.3.1.2 Geology, Geomorphology and Sediment Processes

The potential for interaction of renewable devices offshore with the geological and broader geomorphological environment is generally low, being confined to small areas where devices are piled into, or moored on, the seabed, and the export cables to shore.

Specific potential impacts on geology and the sedimentary environment are listed below. The effects are assessed purely in terms of the physical geological environment. The associated potential effects on marine wildlife (benthic ecology, fish and shellfish, reptiles, birds and marine mammals) are addressed in the Biodiversity, Flora and Fauna section below.

Increase in suspended sediment: Increase in suspended sediment caused by release of sediment into the water column during installation / decommissioning of devices and their associated export cables. These effects will generally be limited in duration and extent. This is particularly true in the higher energy environments which are more associated with wave and tidal devices than offshore wind, and the dynamic nature of the marine environment, causing continual changes in suspended sediment load.

Change in seabed morphology caused by the piling of seabed fixed devices into the seabed, or physical disturbance during export cable installation (e.g. excavation of sediment and underlying bedrock) has the potential to affect sedimentary structures and bedforms, solid geology or geomorphological features.

Buried power export cables are generally installed within the top couple of metres of unconsolidated sediments or (partially) consolidated glacial drift material. The resulting burial material is mobile and may be subject to dynamic environment and erosion from currents.

Potential effects are likely to be most significant on coastal geologically designated sites. There may also be potential effects on future offshore MPAs that are designated for geological features, although the precise locations of these sites are still to be determined as the designation of these sites is still under review.

Cable trenching activities or the installation of shoreline devices in areas designated as geologically important and geological MPA sites could have a significant adverse effect on the integrity of these areas. However, though cable routeing studies and site selection surveys these sites could be avoided, reducing any potential significant effects to negligible.

10.3.2 Seabed Contamination and Water Quality

The following is a description of the potential effects that the installation of wave, wind and tidal devices and cables could have on water and sediment quality in the study area. It should be noted that, although the marine hydrodynamic environment is generally such that potential contaminants will tend to be dispersed, effectively diluting any potentially harmful inputs, there is still the potential for adverse effects to occur.

Disturbance of natural sediments: Any seabed operation carried out on a sediment substrate is likely to temporarily re-suspend particulate material. At this SEA level it is not appropriate to quantify the potential effects for individual projects, because of the high number of variables involved in determining background and project related suspended sediment levels.

Sediments will be disturbed during the construction phase of offshore wind, wave and tidal arrays during pile driving and cable laying. The coarser fraction of the sediment disturbed is likely to be initially re-deposited on the seabed close to the works, but will remain mobile. Any fine material released in a high energy area will disperse widely with eventual deposition over a large area. Where seabed operations impact low energy sites, fine sediments may be disturbed and large quantities of fine material could be released.

For wave and tidal devices, which will be placed in high energy environments; it is likely that readily disturbed sediments (e.g. unconsolidated silts and muds) will not be present at actual generator sites. Such sedimentary material that does exist at the turbine site is likely to be sand sized or greater, although consolidated clays, deposited under more favourable conditions and subsequently exposed, may be encountered. The increase in suspended sediment load is likely to be local for coarse material, but fine particles may remain in suspension and increase turbidity.

Release of additional sediment during construction: Production of extra sedimentary material on site (for example during drilling to insert piles into bedrock or in the course of trenching operations) is likely to have mainly localised impacts. Contamination to water and seabed sediments from this source is likely to be restricted to changes in particulate material distribution, but there is a possibility of dissolution of newly exposed particulate material through normal weathering reactions. It is unlikely that this will produce any significant change in water quality as only superficial bedrock is likely to be exposed.

Release of contaminants during construction: Various installation activities including grouting drilling or piling operations and vessel movements may necessitate the release of toxic or otherwise hazardous materials, temporarily affecting the water quality of the local environment. The main route for contamination from this source is through the dissolved phase. Release of inert particulate material is discussed above.

Planned use and discharge of chemicals in construction operations will be subject to controls as part of consent requirements. Special conditions (e.g. that all spent or unused muds and cuttings must be transferred ashore for disposal) may be recommended.

It is impossible to predict the nature and quantity of such releases at this time due to a lack of detailed information on the variety of installation operations. Such impacts will have to be assessed on a case-by-case basis for specific developments.

Disturbance of contaminated sediments: The potential adverse effects of disturbing historically contaminated sediments during device and cable installation depend on the nature (e.g. domestic or industrial waste, radionuclides, and munitions) of the potential contamination source and local receptors. However, whilst impacts on water quality resulting from the disturbance of contaminants are most likely to be temporary, depending on the type and amount of material released, potential contaminants could be dispersed over a much wider area and persist within the environment beyond the lifetime of the project.

Accidental release of contaminants: There is a possibility that installation activities may lead to release of contaminants to water and sediments. These could include fuel and lubricating oils, cleaning fluids, paints, specialised chemicals and litter. Contamination from accidental spillages is likely to enter the environment either through the dissolved phase or as low solubility, slick forming organics. The presence of visible litter can lead to failure of bathing waters to reach mandatory standards. Accidental contamination could also result from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays.

It is impossible to predict the nature and probability of accidental contaminant releases at this time, as installation methods will vary from development to development. Any use and discharge of chemicals in maintenance operations are likely to be subject to controls as part of consent requirements. Special conditions regarding storage and disposal may be recommended.

Should navigating vessels be involved in collisions with vessels involved in construction there is an additional effect associated with release of contaminants being carried by the vessel in question.

10.3.3 Biodiversity, Flora and Fauna

10.3.3.1 Protected Sites and Species

Potential effects on protected sites and species include the following:

- Effects on the structure and function of the features of the site
- Effects on site integrity
- Effects on site quality
- Effects on ecological coherence of the existing/proposed network of sites
- Effects on protected species

The more specific nature and significance of effects on protected sites and species will primarily be dependent on the interest features of the site in question, and potential key effects on these are assessed in the relevant sections (Benthic Ecology, Fish and Shellfish, Marine Birds, Marine Mammals and Marine Reptiles).

Where known, sensitivity of protected sites and species in the study area to the potential effects of offshore wind, wave and tidal devices are included in the Chapter 11 and Appendix G: Assessment Area Assessment Matrices.

10.3.3.2 Benthic Ecology

During installation of wind, wave and tidal devices, and cables, benthic communities in the vicinity of installation operations would potentially be affected in the following ways:

Substratum loss and disturbance of species located within the installation area will occur as a result of cable trenching, installation of piles, gravity bases or clump weights, and deployment of anchors and jack-up rigs if used. Indirect effects (increased turbidity and smothering) on the surrounding area would also result from the re-distribution of sediment into the water column. These effects will be localised and temporary and are likely to be most significant for installation of export cables, and devices which require structures to be piled into the seabed. Devices which use gravity bases, anchors and clump weights will have a much smaller effect resulting from disturbance of the seabed and sediment suspension. The effects on benthic fauna will be limited to localised mortality or displacement, where objects come into contact with the sediment and smothering by resettled sediment occurs. Recruitment from adjacent unaffected areas should ensure rapid recovery of benthic species.

Smothering can occur within the immediate vicinity of the seabed disturbing works, as the coarser fraction of the sediment disturbed is likely to be re-deposited on the seabed within about 50 m of the works. This effect is only expected to be temporary, as material deposited will be re-suspended and distributed by natural hydrodynamic processes, and will only affect those species/habitats that are sensitive to smothering.

Increased suspended sediment and turbidity can occur as finer particles travel further from the disturbed area, swept by tidal currents, with potential effects on sessile filter feeders. It is not possible to quantify this effect because of the high number of variables involved in determining background and project related suspended sediment levels. It is likely that the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed into the surrounding environment, and will have a negligible effect on background suspended sediment and turbidity levels, and this is particularly likely for wave and tidal turbines which will generally be placed in high energy environments. The precise effect caused by individual developments would have to be assessed on a case by case basis at the consenting stage.

Contaminated sediments: Disturbance of contaminated sediments is also possible during cable and device installation, should seabed disturbing works be undertaken within an area of contaminated seabed, which may cause potential effects on nearby species that are sensitive to contamination.

10.3.3.3 Fish and Shellfish

Disturbance of mobile species can occur during installation of turbines, devices and cables, as a result of the presence of the installation vessels and equipment (and associated noise) within the vicinity of operations. Should any piling be required for device installation, the noise generated by this activity is likely to have a greater effect as a result of disturbance than for developments where piling is not required. Whilst piling noise would only be produced over a temporary period, for the duration of construction activities, the effects may continue for longer, as fish may not immediately return to an area, particularly if they have been excluded for lengthy periods.

Timing of installation works is also a key factor, as the disturbance effect is likely to be greater during mating aggregations, as it may affect mating activity.

Smothering of fish spawning habitat or shellfish habitat could occur within the immediate vicinity of the seabed disturbing works, as the coarser fraction of the sediment disturbed is likely to be re-deposited on the seabed within about 50 m of the works. This effect is only expected to be temporary, as excess material deposited will be re-suspended and distributed by natural hydrodynamic processes. Based on sensitivity data available from MarLIN most finfish species within the study area are not sensitive to, and are therefore not affected by smothering. Those finfish that are sensitive generally have a low sensitivity. These include certain demersal species: lesser spotted dogfish, thornback ray, common skate, lemon sole and plaice.

The spawning areas of finfish species herring and sandeels are highly sensitive to smothering effects, and a smothering episode on a herring gravel bank, for example, could potentially effect an entire year class in the locality. Shellfish inhabiting the seabed are also generally more sensitive to the effects of smothering. *Nephrops* (Norway lobster), king and queen scallop, cockles and periwinkles are all highly sensitive. Whilst European lobster, edible crab, velvet crab, whelk and mussel have medium to low sensitivity.

Increased suspended sediment and turbidity can occur as finer particles travel further from the disturbed area, swept by tidal currents, with potential effects on filter feeders. King and queen scallop, cockle, mussel, herring and sprat all have a medium sensitivity to increased suspended sediment. All other fish and shellfish species, for which the sensitivity is known, have low or no sensitivity to this effect.

Increased turbidity can have effects on foraging, social and predator/prey interactions. It is not possible to quantify this effect because of the high number of variables involved in determining both background and project related suspended sediment levels and turbidity. It is likely that any sediment temporarily released into the water column during installation will be rapidly dispersed, and the small amounts of sediment released into the water column during turbine and cable installation will have a negligible effect on background suspended sediment and turbidity levels. This is particularly true for wave and tidal turbines which will generally be placed in high energy environment. Due to the strategic nature of this assessment the precise effects of individual developments will have to be assessed on a case by case basis at the consenting stage.

Contaminated sediments: Disturbance of contaminated sediments is also possible during piling and cable and device installation, which may cause potentially detrimental effects on species that are sensitive to contamination. Potential sources of contamination and the associated implications for water quality are described in the Seabed Contamination and Water Quality section above.

Marine noise: Marine fish can produce and hear marine noise which, whilst not fully understood, is thought to be associated with alarm calls and social behaviour. Studies have found that general noise such as is generated by shipping activity can cause an avoidance or attraction reaction in fish (Thomsen, 2006). Noise from wind farm, wave and tidal energy projects therefore has the potential to affect fish in the immediate vicinity of operations. An overview of the expected sources and effects of noise on the marine environment associated with wave and tidal turbines can be found in the Scottish marine renewables SEA (Scottish Executive, 2006) and for wind in a report for Collaborative Offshore Wind Research Into The Environment (COWRIE) (Thomson *et al.* 2006).

The hearing ability of fish varies greatly across species types. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fishes body. The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders.

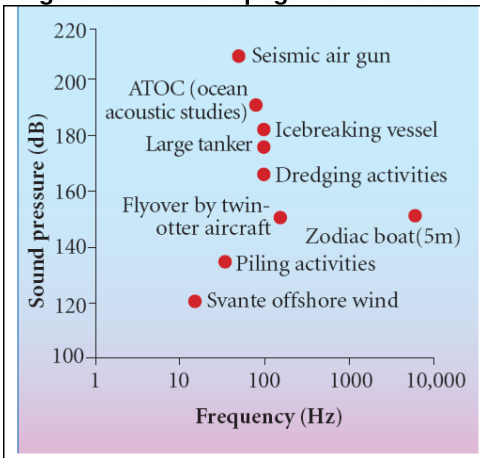
Fish with swim bladders that are coupled by mechanical means to the fishes inner ear have high sensitivity to variations in sound pressure (they can detect sounds over 3 kHz with best sensitivity between approximately 300 to 1000 Hz (Popper *et al.*, 2003)), and can be categorized as sound specialists.

Fish that do not have a mechanical method of coupling the sound induced motions in the fishes body with the inner ear have relatively low sensitivity (they can detect sounds up to 500 – 1000 Hz) with best hearing between approximately 100 and 400 Hz (Popper *et al.*, 2003) to sound pressure variations. These types of fish can be categorised as sound generalists.

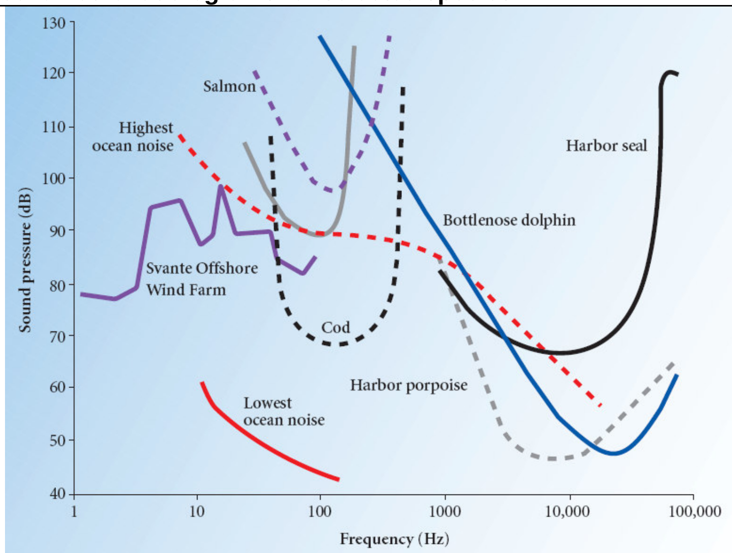
Key sources of noise during installation include shipping machinery, dredging, underwater blasting and pile driving. Pile driving and blasting are anticipated to have the greatest potential effects on marine wildlife. Pile driving can generate very high sound pressure levels that are relatively broad-band (20 Hz - > 20 kHz). Blasting can result in peak pressures of up to 32 kPa (Nedwell, 2004). Cod and herring will be able to perceive piling noise at large distances, perhaps up to 80 km from the sound source. Dab and salmon might detect pile-driving pulses also at considerable distances from the source. Behavioural effects, like avoidance and flight reactions, alarm response, and changes of shoaling behaviour are possible due to piling noise. Also physical effects, like internal or external injuries or deafness up to cases of mortality, may happen in the close vicinity to pile-driving and underwater blasting. Blasting is the noisiest activity considered here, and could be considered alongside the alternative approach of mattressing or rock placement for cable burial in areas of rocky seabed, or possibly to create a flat surface for placement of gravity bases.

Figure 10.1 below gives some examples of noise pressure and pressure and frequency for certain types of underwater activities, and the parameters within which selected species could be expected to exhibit a behavioural response.

Figure 10.1: Anthropogenic noise sources and behavioural audiograms for selected species



A comparison of selected underwater anthropogenic noise sources (peak intensities: Vella, 2002 (adapted from Richardson et al., 1995 and Westerberg, 1999)



Underwater "behavioural audiograms" for selected marine wildlife species Vella, 2002 (adapted from Vella et al., 2001).

10.3.3.4 Birds

Food availability: Construction and decommissioning could potentially damage the benthos and disrupt sediments locally, both of which may lead to changes in the invertebrate fauna and fish stocks. This could reduce food availability for birds, at least in the short term (BirdLife International, 2003).

Collision risk: There is the risk of marine birds colliding with construction machinery and vessels present during the project installation phase. Existing evidence from collisions with shipping activity indicates that whilst birds are generally more manoeuvrable than marine mammals they may also be at risk of collision with vessels, especially at night. Collision can typically occur in two situations – flying birds colliding with the surface structures of ships or ships colliding with birds rafting on the surface. Risk is likely to be low for all species and very low for cormorants since they spend the night on land (Daunt *et al.* 2006a). However, no empirical data are available. There are also no data on strike rates when birds are foraging underwater. Vessels involved in installation of both wave and tidal devices and export cables are likely to be either stationary or travelling considerably slower than commercial shipping vessels whilst involved in construction activities, and therefore the collision risk during construction is likely to be lower than that posed by commercial shipping activity.

Physical disturbance: Physical disturbance to birds in the immediate vicinity of construction activities could potentially have a temporary effect during array and export cable construction. Noise is a key factor in causing the disturbance effect, but the physical presence of the installation vessels themselves can also cause a disturbance effect due to physical and visual intrusion. Bird's likely response to disturbance effects would be to avoid the immediate area during construction, which has implications of foraging and breeding success, stress on individuals and energy budgets. This has been looked at for shore birds, and it is recognised that disturbance may have long term effects if breeding is disrupted, or if birds feeding is disrupted with fitness affected. However, there is no quantified data from which to determine estimated magnitude of effect.

Marine noise: Marine noise during installation could potentially affect marine birds whilst underwater, causing them to become disorientated and affecting their foraging success. Physiological effects could result in temporary or permanent hearing damage. Key sources of noise during installation are shipping machinery, dredging and pile driving. Pile driving is anticipated to have the greatest potential effects on marine wildlife, as it generates very high sound pressure levels that are relatively broad-band (20 Hz - > 20 kHz). Effects on surface feeding birds are likely to take the form of disturbance effects (as described above).

Increased turbidity (reduced visibility): This can occur during seabed disturbing installation activities, as fine particles travel further from the disturbed area, swept by tidal currents. Increased turbidity can have effects on foraging, and predator/prey interactions. The magnitude of this effect will depend on the high number of variables involved in determining both background and project caused suspended sediment levels and turbidity. However, given that the wave and tidal turbines will be placed in high energy environments, it is likely that the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed into the surrounding environment, and will have a negligible effect on background suspended sediment and turbidity levels.

This conclusion will of course have to be re-assessed on a case-by-case basis for specific developments. Marine birds are thought to have a high sensitivity to reductions in visibility.

Disturbance of contaminated sediments is also possible during cable and device installation, which may cause potential detrimental effects on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are assessed in the Seabed Contamination and Water Quality section above.

10.3.3.5 Marine Mammals and Reptiles

Collision risk: There is the risk of seals, cetaceans and turtles colliding with construction machinery and vessels present during the project installation phase. Shipping collision is a recognised cause of marine mammal mortality worldwide, the key factor influencing the injury or mortality caused by collisions being ship size and ship speed. Ships travelling at 14 knots (~7 ms-1) or faster are most likely to cause lethal or serious injuries. Vessels involved in installation of wave, wind and tidal devices and export cables are likely to be either stationary or travelling considerably slower than this whilst involved in construction activities, and therefore the collision risk during construction is likely to be lower than that posed by commercial shipping activity.

Physical disturbance of seals hauled out on land can occur during installation of devices and cables, as a result of the presence of installation vessels and equipment, and the noise they produce in the vicinity of operations. Noise is a key factor in causing disturbance effects (as described below), but the physical presence of the installation vessels themselves can also cause a disturbance effect. In general, ships more than 1,500 m away from hauled out grey or common seals are unlikely to evoke any reactions from seals, between 900 and 1,500 m seals could be expected to detect the presence of vessels and at closer than 900 m a flight reaction could be expected (Brasseur & Reijnders, 1994).

This would be most significant for breeding and moulting seals, hauled out on the coast and on intertidal banks. Breeding seals exhibiting flight reactions could temporarily abandon their young, causing a more significant disturbance effect during the breeding season. Moulting seals spend more time out of the water, and if they are scared into the water they may lose condition as a result of additional energetic costs. Physical disturbance of otters could also occur should disturbing works occur close to the coastal areas where they are present. As for seals, disturbance effects would be greatest during the primary breeding seasons for otters of spring and late autumn.

Marine noise: Acoustic disturbance of seal and cetacean species both in the water, and seals using haulout sites, can occur during installation of wind, wave and tidal devices and cables. Should any piling or underwater blasting be required for device installation, the noise generated by these activities is likely to have a greater disturbance effect than for developments where piling is not required. Whilst piling and blasting noise would only be produced over a temporary period, for the duration of construction activities, the effects may continue for longer, as mammals may not immediately return to an area, particularly if they have been excluded for lengthy periods. This is particularly relevant in constrained areas (such as mouths of estuaries) where loud noise sources may prevent transit, effectively trapping individuals.

The key sources of device construction noise related to site preparation and device installation include: Shipping and machinery; dredging, and pile driving, blasting or drilling. In addition, cable burial requires the use of trenching or jetting machinery in soft sediments, rock cutting machinery in hard sea-beds, or rock or concrete mattress laying may be used to protect cables in areas where they cannot be buried. Noise emitted during pile driving is understood to have the greatest potential effects on marine wildlife (Thomsen et al, 2006). An overview of the expected sources and effects of noise on the marine environment is provided in the Scottish Marine Renewables SEA.

Recent research work has suggested that detection of sound or pressure changes may play an important role in assisting seals to sense their environment and to hunt efficiently. Initial research reported in the Strangford Lough MCT ES (Royal Haskoning, 2005), suggests that seals may rely upon a form of passive sonar through which they sense the environment and form sound “maps” of their seabed surroundings, whilst relying on vision and vibrissae for “close work” associated with hunting.

Acoustic disturbance in the marine environment is an important cause of behavioural disturbance in cetaceans because they use acoustics to navigate, locate prey and maintain social contact. Noise produced during marine construction could potentially interfere with these signals through masking of communication calls, or disruption of foraging clues. This effect should be considered in the context of the many other sources of both natural and anthropogenic noise in the marine environment which could also cause masking effects.

Seals and cetaceans could both be generally expected to be able to hear piling noise up to a distance of 80 km, and behavioural responses could be expected up to 20 km (Thomsen et al, 2006 and Tougaard et al, 2009).In addition, physiological effects on both seals and cetaceans could include temporary or permanent hearing damage or discomfort. Permanent hearing damage in marine mammals is assumed to occur at an exposure of 40 dB above levels in which a temporary threshold shift in hearing occurs. For pinnipeds, this would be 144 dB, while for cetaceans, onset of permanent hearing damage could be expected at sound exposure levels of 198 dB (Southall et al 2007). Permanent hearing damage may be a concern at a distance of 400 m from any pile driving activities for common seal, and 1.8 km for harbour porpoise (Thomsen et al, 2006). However, these figures are likely to vary, depending on site characteristics (e.g. shielding affects of islands and affect of water depth). There is also a risk of injury of death associated with exposure to loud noise sources such as close proximity to piling operations. Some protections under the Habitats Directive and Habitats (NI) Regulations operate on the level of the individual marine mammal rather than at the population level, and pile driving activities without observing appropriate mitigation could be interpreted as “reckless or deliberate disturbance.”

Effects of piling installation noise on harbour porpoise was assessed for the Strangford Lough MCT Seagen project (COWRIE, 2008). Comparison of the measured background noise data with the hearing sensitivity of the harbour porpoise has indicated that this region is a noisy environment for marine animals that are sensitive to high frequency noise. The data for the drilling noise indicated that these species are unlikely to be able to hear noise from the piling operation over the high levels of perceived background noise, highlighting the importance of considering the spectral perception of underwater noise by marine animals when estimating its effect.

The data indicated that the noise does not exceed the 90 dBht level, at which strong and sustained avoidance is expected, at any measured range. The 50 dBht level, at which a mild and brief reaction is expected in a minority of individuals, extends to a maximum range of 115 m. The MCT data indicated that, when taking into account the existing background noise, marine mammals considered are unlikely to be disturbed by the drilling noise unless they are in the close vicinity of the piling activities.

Increased turbidity (reduced visibility) can occur during seabed disturbing installation activities, as fine particles travel further from the disturbed area, swept by tidal currents. Increased turbidity can have effects on foraging, social and predator/prey interactions. The magnitude of this effect will depend on the high number of variables involved in determining both background and project caused suspended sediment levels and turbidity. However, it is likely the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed and will have a negligible effect on background suspended sediment and turbidity levels, this is particularly true for the wave and tidal turbines which will be placed in high energy environments. This conclusion will of course have to be re-assessed on a case-by-case basis for specific developments. Grey and common seals have been identified as having a high sensitivity to reductions in visibility, whilst the cetaceans in the study area have a moderate sensitivity to this effect.

Disturbance of contaminated sediments is also possible during cable and device installation, which may cause potential detrimental effects on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are assessed in the Seabed Contamination and Water Quality section above.

10.3.4 *Cultural Heritage including Archaeological Heritage*

10.3.4.1 Archaeology and Wrecks

The potential for damaging an archaeological site is, in part, related to the ease of finding (and hence avoiding) it. Recent, metal built, wrecks (including aircraft if intact) are likely to be reasonably detectable. Older, wooden, vessels are likely to be fragmentary, sites often consisting only of scattered, mainly metal and ceramic or stone artefacts, possibly buried. Pre-historic landscapes and remains of prehistoric settlement sites are likely to consist of scattered artefacts or structures (often semi-natural) buried beneath considerable layers of sediment. In the latter case recognition is likely to be a major problem.

The following is a description of the potential effects that the installation of wind, wave and tidal devices could have on archaeological sites if directly affected.

Seabed attachment: There is a potential significant adverse effects resulting from the destruction of sites and artefacts, both surface and buried within the seabed footprint of device construction.

Displacement of sediments: While most sedimentary material is unlikely to cause damage to any but the most fragile artefacts, there is a risk of damage when large fragments are displaced. Displaced sedimentary material might bury a site delaying or preventing discovery.

Cable laying operations: There is a potential for negative effects from cabling laying due to damaging to sites and destroying artefacts along the line of trenches.

Exploratory operations: There is possibility of damaging artefacts. Cores should be inspected for presence of archaeological material. Archaeological assessment of survey data collected as part of wave, wind and tidal energy projects could also provide data that could provide archaeological evidence from the marine environment that could contribute to the archaeological record for the area.

10.3.5 *Population and Human Health*

10.3.5.1 Commercial Fisheries

The key difference between effects on commercial fisheries and mariculture is that fin and shell fish farms are static installations and therefore the species exploited cannot temporarily relocate or adapt to take into account effects from installation. This factor is taken into account in the identification of effects below that are specific to commercial fishing activities and the operation of shell and fin fish farms.

The key effects identified relating to commercial fisheries includes direct disturbance of grounds and displacement of fishing vessels. A detailed description of ecological effects relating to fish and shellfish species is presented in Section 10.3.3.3 and 10.4.2.3**.**

Temporary displacement from traditional fishing grounds: Construction and installation of developments could result in fishing vessels being temporarily displaced into different fishing grounds, effectively concentrating fishing effort into a smaller geographical area.

Direct disturbance of fishing grounds: Installation of wave, wind and tidal devices, and associated cables will potentially cause a direct disturbance to commercially targeted fish species in the immediate vicinity of operations. The nature of potential effect on commercial fish and shellfish includes possible noise disturbance, increased suspended sediment, smothering and removal of seabed habitat used by demersal species, species which spawn on the seabed and shellfish.

Disturbance of contaminated sediments is also possible during cable and device installation, which may cause potential detrimental effects on fin and shellfish species that are sensitive to contamination. Potential sources of contamination and the associated implications for water quality are assessed in the Seabed Contamination and Water Quality section above.

Smothering, increased suspended sediment and turbidity, and installation noise effects on fish and shellfish species are described in the Fish and Shellfish section above.

10.3.5.2 Mariculture

This section focuses on additional effects that are specific to mariculture, which are not covered by the Commercial Fisheries section above.

Direct disturbance: Disturbance of mobile species can occur during installation of devices and cables, as a result of the presence of the installation vessels and equipment (and associated noise) in the vicinity of operations. The key disturbing factor for marine fish farms is the noise produced during installation operations, and this is addressed under “marine noise” below.

Disturbance of contaminated sediments: Disturbance of contaminated sediments is also possible during cable and device installation, which may cause potential negative effects on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are assessed in Section 10.3.2 and 10.4.1.3. The potential effect on market confidence in non sensitive, high value species also needs to be considered here, as even in circumstances where there are no significant effects on farmed species, should consumers perceive that farmed fish and shellfish are being affected by contamination as a result of marine wave, wind and tidal development this could have implications for the fish farming industry in Ireland as a whole.

Marine noise: Marine fish can produce and hear marine noise which, whilst not fully understood, is thought to be associated with alarm calls and social behaviour. Noise emissions from installation activities have particular potential significance for mariculture as the fish are unable to employ avoidance reactions.

Pile driving is anticipated to have the greatest potential effects on marine wildlife, as it generates very high sound pressure levels that are relatively broad-band (20 Hz - > 20 kHz). Physiological effects of noise are also possible at very close proximity to the noise source; however this has not been quantified due to lack of data. Should noise producing activities be undertaken in close proximity to fish farms, there is a potential for physiological effects, as farmed fish may not be able to move away from the source of the noise. Experience from marine aquaculture suggests that under stress females can become “egg bound”, resulting in eggs not being released at the anticipated time, and can ultimately result in eggs being reabsorbed or the fish dying. Mariculturalists tend to keep broodstock in quiet areas, and avoid unnecessary loud noises (RPS Energy, 2006).

Atlantic salmon are thought to have poor hearing ability, as their swim bladder is disconnected from their skull/hearing system. However, cod have been identified as being highly sensitive to marine noise, and may be able to detect pile driving pulses at distances of up to 80 km in some situations.

Smothering and increased suspended sediment and turbidity effects are described in detail in the Fish and Shellfish section above.

10.3.5.3 Interference with Military and Aviation Radar

There are no expected effects on radar from the installation of windfarms.

10.3.5.4 Military Activities

Temporary disruption to military exercises and activities during installation of devices and arrays. When installation is underway there will be safety areas around activities which may cause military vessels to have to modify their routes and activities around the installation area. It is also possible that other activities such as firing practice could be disrupted during installation activities

10.3.5.5 Disposal Areas

Consultation with device developers has indicated that they would seek to avoid developing (arrays or cables) close to (e.g. within 500 m of) a disposal site. With this in mind the key potential effects identified are as follows:

Temporary disruption to vessels transiting to and from disposal sites during installation of device arrays and cables located in close proximity to disposal sites. If such an effect occurs, the potential significance of restricting access to the sea disposal sites will be major for ports and harbours both during installation and operation due to the significant financial costs that would be incurred by the port or harbour authority if the distance to the disposal site was increased.

Direct disturbance of previously disposed material where device arrays are located in close proximity to disposal sites. The effects of disturbing contaminated sediments are discussed in Section 10.2.2 Strictly speaking, this is not a direct affect on the activities associated with the disposal site, but it is relevant in terms of potential effects on marine wildlife located in the vicinity of any disturbed sediment. These **effects** are discussed in the Fish and Shellfish section above.

10.3.5.6 Shipping and Navigation

Effects on shipping and navigation can be categorised as effects on safety, and effects on issues related to economics such as journey times and distances, and trade. In terms of safety it is important to note that there are various rules, regulations and guidelines that relate to safety of navigation with regards to any offshore development that are in place to help prevent casualties and collisions. Below is an overview of the potential effects that could occur. It is important to recognise that all offshore activities are subject to various rules and regulations that aim to mitigate the chance of such effects occurring.

Increased journey times and distances: During installation there will be exclusion or avoidance areas in operation around development sites and associated installation activities for the purposes of safety. The introduction of installation vessels and equipment into the study area may require vessels to move around the construction activities potentially increasing journey times and distances. The extent to which journey time or distances are affected will be highly variable depending on the location of the development. Increased journey distances will, of course, lead to increased fuel use with the associated indirect increase in costs incurred by the shipping operator, and increased carbon emissions. The scale of the effect will be dependent on the type of shipping activity – for example a five mile increase in journey will be less of an effect if the journey is 500 miles, than if the journey is only 20 miles.

Displacement of shipping density: The safety areas that will be in place during construction activities will affect shipping density in already constrained areas as vessels will be forced to move around the installation area. In unconstrained areas there will be no measurable effect on shipping density.

Reduced trade opportunities: Temporary reduced access to ports and harbours may occur during construction activities and this would have an effect on trade and supplies.

Reduced visibility: The presence of installation vessels, barges, jack-up rigs and other construction equipment has the potential to obstruct the view of other vessels, navigation features such as lights and buoys and the coastline. This could cause a hazard to shipping in areas where visibility is particularly important for navigation or areas where the topography already constrains visibility.

Collision: The presence of slow moving or stationary installation vessels and equipment is likely to affect the probability of close quarter encounters and collisions with both vessels moving under power and drifting vessels.

The presence of construction activities also has the potential to cause small and recreational vessels to modify their routes to use areas transited by larger vessels, which potentially increases the risk of encounter or collision.

In the unlikely event of a collision occurring there is a risk of extensive and serious environmental effects associated with the spillage of oil and hazardous cargos.

Search and rescue: Search and rescue exercises and operations could take place throughout the study area, for example, in relation to helicopter routes to and from oil and gas offshore platforms. The planning of such activities would need to be adapted to take into account the presence of installation equipment.

10.3.5.7 Recreation and Tourism

The marine environment, landscape and resources play an important role in many tourism and recreation activities in Ireland. Therefore, any impact on the coastal or marine environment through the installation of marine renewable energy devices could potentially have an effect on the tourism industry and recreation. The potential effects are discussed below.

Noise: Noise generated during the installation of the marine devices will potentially have direct and indirect effects on recreation and tourism, although the effects will only be short term. The main sources of construction noise include:

- Presence of vessels
- Piling
- Movement of machinery/device components
- Installation of machinery/device components
- Cable trenching
- Installation of onshore grid connection

The main direct effect of installation noise is related to general disturbance that will be experienced by visitors to key coastal attractions/locations e.g. beaches and coastal paths, and participants in key coastal and marine recreational activities e.g. golf, sailing, swimming and water sports. Installation noise may have adverse effects on the breeding, feeding and migratory patterns of marine wildlife and seabirds, leading to their displacement or avoidance of areas.

This could potentially have an indirect effect on the marine wildlife watching industry and bird watchers. The effect of noise on marine wildlife is discussed in more detail in the Biodiversity, Flora and Fauna section above.

Transportation: There will be a requirement, as part of the installation process, for the transportation of the various components of the marine devices. This will include the movement of device components from the point of production to a port or coastal location for transfer onto deployment vessels. The main effects associated with the transportation of large pieces of machinery include congestion caused by large, slow moving vehicles, increased noise, vibration, air pollution and general environmental disturbance. Due to the predicted size of the marine devices, most will require deployment from harbours that can accommodate vessels with sufficient loading capacity for device deployment. In most cases, access routes to these harbours have been designed to accommodate the movement of large vehicles. There is also potential that the marine vessels could disrupt recreational sailing routes, fishing activities and other water sports.

Landscape, Seascape: The effects on landscape, Seascape are discussed in the Seascape section below. The landscape, seascape and views around the Ireland coastline are intrinsic to the area’s ability to attract tourists and visitors. Installation activities may temporarily affect the general attractiveness of certain areas which could potentially affect visitor’s perceptions and enjoyment of an area.

Access Restrictions: In the interests of efficiency and safety, installation activities may involve some restriction of public access to areas where construction is underway. Depending on location, this may affect sailing activities, diving, open water swimming, water sports and wildlife watching.

Water Quality: The effects of the deployment of marine devices on water quality are discussed in the Potential Effects on Water and Soil section above. In terms of the installation of devices there are a number of potential sources of water pollution including:

- Release of contaminated materials during piling, drilling or grouting
- Vessel fuels – spillage
- Leakage of device lubricants, hydraulic oils
- Antifoulants

Any water pollution arising from the installation of devices could potentially affect bathing water quality and local beaches.

10.3.6 Material Assets

10.3.6.1 Aggregate Extraction and Maintenance Dredging

Whilst there are currently no licensed aggregate extraction areas in Ireland’s waters, there is some interest in potential licensing of future sites. Based on the assumption that future dredging activities will be undertaken under licence, it is likely that the relevant dredging operator will have rights over the licensed extraction area and therefore the installation of renewable energy arrays will not be permitted within any sites licensed for aggregate extraction at the time of determine the renewable array licence. With this in mind the key potential effects identified are as follows:

Temporary disruption to vessels transiting to and from dredging areas during installation of device arrays and cables located in close proximity to aggregate sites. If such an effect occurs, the potential significance of restricting access to the dredging sites will be major both during installation and operation due to the significant financial costs that would be incurred by the aggregate company if the distance to the aggregate site was increased.

10.3.6.2 Oil and Gas Infrastructure

Installation of renewable energy arrays will not be permitted within any sites covered by a Petroleum lease. There may be potential for development within areas identified as Licensing option areas or Exploration licence areas. However, these will need to be determined on a case by case basis at the appropriate time. With this in mind the key potential effects identified are as follows:

Temporary disruption to vessels and helicopters transiting to and from oil or gas platforms during installation of device arrays and cables located in close proximity to sites. If such an effect occurs, the potential significance of restricting access to the sea disposal sites will be major for ports and harbours both during installation and operation due to the significant financial costs that would be incurred by the port or harbour authority if the distance to the disposal site was increased.

10.3.6.3 Cables and Pipelines

Potential effects on pipelines and cables can be summarised as follows:

- Direct damage caused by physical interaction with the cable by anchors, device foundations or cable installation. This would be most likely to occur during installation of development but may also occur during maintenance of devices or cables.
- Reduced access to existing pipelines and cables for maintenance and repair activities during construction of device array and cables.

The avoidance of cables and pipelines is important for a number of reasons. All power cables and most telecommunications cables carry power. Damage to telecommunications cables can lead to extensive disruption of international communications, whilst damage to power cables will interrupt electricity supply. Pipelines may contain flammable oil or gas under pressure and damage to pipelines could result in a hazard to the environment or a hazard from fire or explosion (UKHO, 2006).

In reality the installation of marine renewables devices is unlikely to have any adverse effects on cables or pipelines because the location of existing infrastructure will be considered during the site selection for any development. Additionally, where the cables associated with marine renewable energy developments cross existing pipelines and cables, crossing agreements will be developed which although are a voluntary requirement, become legally binding once signed by all parties. Such agreements seek to ensure the integrity of the new and crossed infrastructure and facilitate ongoing safe access to each cable or pipeline for maintenance and repair activities. In the event that two parties fail to agree terms for a particular crossing agreement, the fallback position is to rely on The United Nations Convention on the Law of the Sea (UNCLOS) to determine liability levels in the event that one party damages the other’s asset (this applies internationally and is ratified by the European Union including Ireland).

Positional accuracy in installing devices may vary slightly according the method employed for fixing the device to the seabed.

The area of within which cables and pipelines could be adversely affected by development has been determined as being a 500 m area either side of the centreline of the infrastructure. This area has been determined based on International Cable Protection Committee (ICPC) guidelines that suggest wind farm developments should avoid cables by 500 m for safety reasons. However, it is recognised that the distance of avoidance required may be less than 500 m in certain circumstances.

In common with the method applied throughout the SEA, potential effects have been determined based on no mitigation (i.e. no avoidance of existing pipelines and cables, and no use of crossing agreements). However, it should be noted that it is standard practice to avoid existing infrastructure or to cross it in accordance with crossing agreements and therefore the effects noted without mitigation are very unlikely to occur in reality.

10.3.7 Seascape

The extent to which the offshore wind farm or device array would affect the seascape varies depending on the various stages of the development and the capacity of the existing seascape to absorb these components. The installation phase of the development would involve temporary and relatively short periods of change and as a result the potential effects on the seascape are not considered to be significant.

10.3.8 Climatic Factors

Gas and carbon storage: It is unlikely that the installation of offshore renewable energy developments could sterilise potential areas for future gas and carbon storage. The majority of areas identified as being suitable for gas and carbon storage exist within geological formations previously utilised for oil and gas extraction and as such will already have infrastructure in place that will limit the use of the area for offshore renewable energy developments. Also, due to the depths at which suitable geological formations occur it is unlikely that the installation of offshore renewable energy developments would have an impact on them (OSPAR 2006). However any future projects would have to identify, through consultation and other sources of data whether there could be potential for the sites to be in a location for future gas and carbon storage.

Carbon footprint of marine renewable energy construction activities: Any generating plant (including renewable energy developments) holds embodied CO_2 which is CO_2 emissions associated with the manufacture of the plant, including raw material extraction and transport. However, the overall effects of the development on climate in terms of carbon emissions (positive and adverse) are considered to be low compared to the emissions relating to the overall operation of a plant. .

10.4 Operation

Operational impacts are likely to operate throughout the design life of the development/array and are therefore generally long term impacts. At a high level operation can generally be split into the following impact sources:

- Physical presence of devices in the water column
- Physical presence of devices on the seabed
- Physical presence of devices above the water surface
- Impacts of operational devices on hydrodynamics and sediment processes
- Noise generated by operational devices
- EMF fields and heat generated by inter-array and export cables

Potential impacts of each of these on marine receptors are described in some more detail in this section.

10.4.1 Potential Effects on Water and Soil (Sediment)

10.4.1.1 <u>Bathymetry</u>

No significant effects on seabed bathymetry are expected to result from the development of offshore wind or marine renewable energy during operation of arrays of marine renewable energy devices.

However, the water depth/availability of the water column for navigation and other sea uses is likely to be affected by the installation of arrays of marine renewable energy devices. The impacts upon shipping and navigation are discussed in Section 10.5.5.

Potential effects on seabed morphology and coastal processes are discussed in the Geology, Geomorphology and Sediment Processes section below.

10.4.1.2 Geology, Geomorphology and Sediment Processes

The potential for interaction of renewable devices offshore with the geological and broader geomorphological environment is generally low, being confined to small areas where devices are piled into, or moored on, the seabed, and the export cables to shore.

The potential interaction of marine renewable devices with the hydrodynamic regime is of greater concern, which may in turn affect the sediment dynamics and thus sediment movements and coastal processes. Sediment distribution around the Irish coast largely mirrors the distribution of tidal current speeds, with gravels where the currents are strongest, and muds where they are weakest. Sediment is transported due to the forces of tide, wind and wave induced currents, where near-bed current exceeds a certain threshold. For sand and gravel the threshold is proportional to the sediment's characteristics particle size and density).

Interactions of structures with hydrodynamic processes can be divided into:

- Localised or Device Scale – on the scale of individual devices.
- Nearfield - within 10 times the diameter for a single structure, or the entire areal extent of an array plus 10 times the array diameter.
- Far-field - to a distance of 1 tidal excursion from a single structure or to a distance of 1 tidal excursion from the geometric centre of an array.

The principal offshore development-specific variables include number, spacing, size and geometry of structures, as well as cable connections and distance to shore.

Offshore renewable structures have the potential to cause variation in tidal and orthogonal/ rip current speeds and water circulation. They may also cause variations in wave energy and height, wave breaking, turbulent wake generation and wave diffraction. Such changes will have effects on the following features/ processes:

- Seabed composition
- Bedforms
- Suspension of sediments/turbidity
- Seabed scour/deposition
- Longshore drift
- Coastal erosion
- Seabed channel morphology

Specific potential impacts on geology and the sedimentary environment are listed below. The effects are assessed purely in terms of the physical geological environment. The associated potential effects on marine wildlife (benthic ecology, fish and shellfish, reptiles, birds and marine mammals) are addressed in the Biodiversity, Flora and Fauna section below.

Change in sediment processes: Modifications to sediment transport pathways in the immediate vicinity of operating devices, and sediment accretion or erosion (scour) of sediment at the site, could occur during the operation of marine devices. This effect could occur both as a result of the physical presence of devices on the seabed acting as a barrier or diversion to sediment transport during device operation (relevant for wind, wave and tidal), or as a result of localised hydrodynamic changes associated with wave or tidal energy removal by the operating device (relevant for wave and tidal devices only).

With regard to effects from the presence of devices, there is a direct relationship between the diameter of wind turbine towers (4-5m) and the extent of scouring (ABPmer, 2002). Estimations of the extent of scour indicate it to be between 6-10 times of the tower diameter (24-50m). Variation in the extent of scouring is a consequence of differences in sediment characteristics and current regime.

Based on specialist advice from the Scottish Marine Renewables SEA, there is potential that the effects of energy extraction on sediment processes could occur up to 50 m from operating wave and tidal devices (Scottish Executive, 2007). This effect is therefore localised to the vicinity of the device array, but will be effective for the operational life of the device. Potential effects can be reduced through the utilisation of scour protection materials.

Changes in coastal processes: In order to assess the potential effects due to energy extraction, reference is made to a study that was undertaken as part of the Scottish Marine Renewables SEA, which looked at the effects that wave and tidal devices have on the energy associated with tidal currents and wave regimes. The aim of this study was to review the existing knowledge relevant to determining how any reductions in this energy could affect marine and coastal processes (Scottish Executive, 2007). The conclusions from this study informed the assessment of effects on seabed sediment and sediment transport from wave and tidal devices.

The main conclusions were that wave and tidal devices could potentially have significant adverse effects on coastal processes, particularly in areas with high levels of erosion, accretion and long-shore drift. However, it is important to note, that due to a number of variables e.g. the timescales of which these changes may occur (medium to very long-term); the extent of the change (slight to large), the distance from shore; the potential for effects to be reduced through careful site design; and the fact that these are only based on a limited number of previous studies; further research is needed to further increase understanding of this issue. This is most likely to be provided through the monitoring of specific developments once commercial scale arrays are starting to be deployed.

Based on current knowledge it is concluded that any potential significant effects of energy extraction on coastal processes could be prevented or minimised by avoiding siting devices where they could affect important sediment transport pathways. Modelling of coastal processes may be required as part of the site selection process to determine exactly which areas would be most sensitive to a possible reduction in energy from tidal flows or the wave regime.

10.4.1.3 Seabed Contamination and Water Quality

The following is a description of the potential effects that the installation and operation of wave, wind and tidal devices could have on water and sediment quality in the study area. It should be noted that, although the marine hydrodynamic environment is generally such that potential contaminants will tend to be dispersed, effectively diluting any potentially harmful inputs, there is still the potential for adverse effects to occur.

During device operation the following impacts are possible:

Accidental release of contaminants: There is a possibility that routine maintenance operations may lead to release of contaminants to water and sediments. As noted above, these could include fuel and lubricating oils, cleaning fluids, paints, specialised chemicals and litter. Contamination from accidental spillages is likely to enter the environment either through the dissolved phase or as low solubility, slick forming organics. In the case of significant oil spills damage can be widespread and long lasting, affecting a wide range of ecosystems and amenities.

It is impossible to predict the nature and probability of accidental contaminant releases at this time, due to a lack of detailed information on device characteristics. Any use and discharge of chemicals in maintenance operations are likely to be subject to controls as part of consent requirements. Special conditions regarding storage and disposal may be recommended.

Accidental contamination could also result from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays.

Contamination – erosion of sacrificial anodes: Sacrificial anodes are designed to corrode, and thus dissolve, in preference to constructional iron and steel, prolonging the useful life of structures exposed to seawater. The technology is widely used in marine construction with no noted adverse effects. However, two of the most commonly used anode materials (Zinc and Aluminium) are potentially toxic to marine organisms and have EQS values of 10 μgl^{-1} and 40 μgl^{-1} respectively. These represent concentrations below which there is not predicted to be any significant environmental effect. In practice anode dissolution rates are sufficiently low that contaminant concentrations are unlikely to approach the EQS in any but the most restricted waters (see Section 5).

Contamination – leakage of hydraulic fluids: During the normal operation of some types of generation system it is possible that there will be minor leakages of hydraulic fluids. Contamination may be through the dissolved phase or in the form of slick forming low solubility liquids. Local water quality may be impacted by the leakage of hydraulic fluids and depending on the nature and quantity of material lost there is a risk of tainting of shellfish. However, it should be noted that developers will seek to avoid such impacts as it will increase the maintenance requirements for the devices. There is currently insufficient information on the uses of such substances and it is therefore not possible to fully quantify the effects.

Contamination – anti-fouling compounds: It is expected that use of antifouling coatings will be minimised as far as possible. In many applications non-toxic materials, which prevent settling of fouling organisms by mechanical means are now available. Assuming non-toxic materials are used no measurable impacts, on water or sediment quality from the use of anti-fouling paints, are predicted. Even if small quantities of toxic materials such as copper are used it is expected that the highly energetic environment in which devices are likely to be located will result in rapid dilution and dispersal.

Disturbance to contaminated sediment resulting from changes in sediment dynamics: As described above, localised changes in sediment dynamics could occur during wave, wind and tidal device operation, resulting in disturbance of natural and contaminated sediments. This impact, if it occurred during operation, is likely to be of a lesser magnitude than the disturbance of contaminated sediments during installation described above.

10.4.2 Biodiversity, Flora and Fauna

10.4.2.1 Protected Sites and Species

Potential effects on protected sites and species include the following:

- Effects on the structure and function of the features of the site
- Effects on site integrity
- Effects on site quality
- Effects on ecological coherence of the existing/proposed network of sites
- Effects on protected species

The more specific nature and significance of effects on protected sites and species will primarily be dependent on the interest features of the site in question, and potential key effects on these are assessed in the relevant sections (Benthic Ecology, Fish and Shellfish, Marine Birds, Marine Mammals and Marine Reptiles).

Where known, sensitivity of protected sites and species in the study area to the potential effects of offshore wind, wave and tidal devices are included in Chapter 11.

10.4.2.2 Benthic Ecology

During device operation the following effects are possible:

Substratum loss due to the presence of piles, gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed. The area of seabed lost is difficult to quantify at the strategic level, as it is dependent on many project specific factors.

Based on discussions with developers, typical array sizes are likely to be typically 2 km^2 for wave arrays (20 – 50 devices), 0.5 km^2 (5 – 20 devices) for tidal arrays, 1-2 km^2 and 50 km^2 for wind (5-250 turbines). Depending on design devices are expected to each occupy a seabed area of between approximately 12m^2 (piles) and 40 m^2 (gravity bases).

Depending on design devices are expected to each occupy a seabed area of between approximately 12m^2 (piles) and 40 m^2 (gravity bases). These numbers give an indication of the scale of effect per device/array, but it is not possible, given the wide range of device types and seabed attachments being considered in this SEA to make estimates of the actual area of seabed that would be lost.

Introduction of hard substrate: Permanent structures on the bottom would replace natural hard substrates or, in the case of previously sandy areas, add to the amount of hard bottom habitat available to benthic algae, invertebrates, and fish. This could attract a community of rocky reef fish and invertebrate species (including biofouling organisms) that would not normally exist at that site. It has been speculated that depending on the location, the newly created habitat could increase biodiversity or have negative effects by enabling introduced (exotic) benthic species to spread. Marine fouling communities developed on monopiles for instance in offshore wind power plants have been found to be significantly different from the benthic communities on adjacent hard substrates (Wilhelmsson *et al*., 2006; Wilhelmsson and Malm, 2008).

Scouring of sediments will occur around the base of any fixed structures or foundations on the seabed such as monopiles (mainly relevant to wind and tidal devices), and clump weights and gravity bases (wave and tidal), which may have potential effects on the existing benthic environment. Over time, sediment conditions will stabilise with finer sediments being lost and the larger sediment fraction remaining allowing recolonisation by species that may have been absent before. Recolonisation may also lead to increased sediment consolidation and stability which would contribute to further recolonisation success. However, this in itself may increase friction levels with a resulting breakdown of consolidated sediment before equilibrium is reached and a new and changed benthic community becomes established. If scour protection is used the difference in faunal composition between before and after construction will be greater than without such protection.

Decrease in water flow resulting from extraction of tidal energy, will potentially effect on habitats and species which are sensitive to changes to tidal flows. The richness and variety of marine life in tidal rapids relies primarily on the strong water currents to carry food in, and waste materials and fine sediments away. Therefore, interruptions of tidal flows are likely to have implications for fauna and flora. Benthic habitats are also potentially affected by changes in sediment patterns as a result of reduction in tidal flows. Whether significant changes in community structure would occur and whether they would be considered deleterious would depend on the degree of change and the nature of the receiving environment. Based on limited existing projects and modelling studies, it is estimated that the extent of the potential effect on tidal energy can extend up to 0.5 km from tidal devices. Maerl beds, *Modiolus* beds, and some deep mud habitats may be highly sensitive to changes to tidal flows.

Decrease in wave exposure resulting from extraction of wave energy**.** Wave exposed habitats, and those consisting of mobile sediments, generally show reduced species diversity. These environments are likely to be resilient to the removal of wave energy. Based on limited existing projects and modelling studies, it is estimated that the extent of the potential effect on wave energy can extend up to 20 km from the wave device. Maerl beds and *Modiolus* beds are highly sensitive to decreases in wave energy.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of potential effects on sediment processes of up to 50 m from devices (Bryden, 2006). Maerl beds are particularly sensitive to effects associated with changes to suspended sediment levels.

Whether changes to wave and tidal energy, and sedimentation patterns would cause significant changes in community structure, and whether they would be considered deleterious would depend on the degree of change and the nature of the receiving environment. Reduction of downstream water flow, if it occurs, is expected to be more significant in straits, tidal rapids and other constricted areas.

There is also the potential for **leaching of toxic compounds** from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from a device. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. Most of the priority habitats likely to be present in the study area for which there is relevant sensitivity information are not particularly sensitive to heavy metal contamination that could result from use of copper based antifoulants or from sacrificial anodes. However, several of the benthic habitats under consideration are known to be sensitive to synthetic chemical contamination that could result from the leaching of hydraulic fluids used for some wave and tidal devices. *Modiolus* beds in particular, are identified as being highly sensitive to synthetic chemical contamination, with very low recoverability rates. The UKBAP for tidal rapids states that species inhabiting tidal rapids may be sensitive to water pollution.

The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small, and it is therefore considered that this potential effect will be of negligible significance. The potential for leakage of hydraulic fluids through accidental storm or collision damage could potentially present a significant adverse effect if it occurred, but it is considered that there is a very low likelihood of such a leakage occurring.

Potentially more significant still are the possible effects that could result from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This effect is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc. It is not possible to make any realistic estimate of the geographical extent of this potential effect, due to the large numbers of variables involved (quantities leaked, metocean conditions, etc) and it is therefore not included in the significance mapping.

There is also potential for **colonisation of structures** such as turbine bases causing increased biodiversity and leading to increased food availability for fisheries. Whilst this therefore has potential to be a positive effect, species colonising underwater structures may lead to undesirable changes in community structure, giving rise to negative effects. On balance, colonisation of underwater structures is generally considered to be of neutral significance.

Electro-Magnetic Fields (EMF): Electric and magnetic fields are produced as a result of power transmission in the inter array cables and the export cable to shore. The devices themselves will also have an electrical signature, however this will be specific to the individual devices e.g. whether the power generator is in the water or on a platform and if there is a riser cable from a device on the seabed. A number of research reports have been undertaken by COWRIE into the likely field strengths and potential effects on marine species (CMACS 2003; CMAS 2005; CMACS 2006). A literature review of research into this area, undertaken for the Scottish Marine Renewables SEA (Scottish Executive, 2006) concluded that marine flora and macro-invertebrates are not sensitive to electric or magnetic fields and no effects from the installation or operation of tidal and wave devices are expected.

10.4.2.3 Fish and Shellfish

Collision risk: The presence of wind turbines should not affect significantly on the movements of juvenile and adult fish. Turbines are relatively narrow in diameter (< 5 m) and widely spaced throughout the array.

However, collision risk is considered to be a key potential effect during wave and tidal device operation, and it is considered, bearing in mind the wide range of devices that may be deployed, that almost all species of marine finfish are at some risk of collision impacts. Whilst it is considered that pelagic fish will be the most likely to be affected by collisions with devices, demersal species make vertical migrations and could therefore also be potentially affected. A review of collision risk undertaken as part of the Scottish Marine Renewables SEA identified that certain parallels can be drawn between known collision risks and the responses of fish encountering existing hazards (shipping, fishing gear interactions, killer whale tail swipes). However, there is considerable lack of empirical knowledge on this risk, and it is important to bear in mind that turbine blades, either of the horizontal or vertical axis type present a threat quite unlike any that marine fish have previously experienced. Therefore, whilst an overview of the factors likely to influence collision risks posed by marine renewable devices is summarised in this section, it is not possible to fully quantify this risk based on the current state of knowledge.

The group of species at risk will vary depending on the type of device and its location within the water column. Demersal fish, spending all their time near the sea bed will not be affected by the moving parts of wave power generating devices that act at the surface. It is possible that they may benefit from the habitat structure provided by the foundations and or moorings for these devices. Some demersal species (Plaice or cod for example) may interact with turbines in mid water when they make excursions up the water column when using tidal stream transport during migration. Some devices, vertical axis turbines for example, may be placed in foundations on the sea bed in shallow water. Demersal species could be at particular risk from these devices.

Pelagic species of fish will be at some risk of interaction with all types of device. Their diurnal vertical migration behaviour forces them to occupy all depths in the water column at some time during the day.

In addition there are a number of other parameters that can be expected to affect the degree of collision risk:

- Size: Very small fish and larval fish with very low inertia experiencing viscous flow regime are more likely to follow the flow streamlines around moving parts and thus avoid collision. The collision risk increases with increasing fish size, and the greatest collision risk, as far as fish size is concerned, is therefore expected to apply to basking shark.
- Schooling behaviour: Schooling species may be at greater risk than those with a solitary habit. A school could be regarded as a large "super organism" rather than behaving as individual. Schools of fish move together in polarised formations and their predator escape behaviour is coordinated. Responses may lead to some individuals evading contact with turbine blades; whilst others could be directed into the path of a blade.
- Life stage: Juveniles are likely to be more at risk than adults because of reduced sensory and mobility abilities and/or experience.
- Season: Species at most risk will also vary with season, due to seasonal change in geographic distribution, migrations and spawning periods.
- Fixed submerged structures (such as vertical or horizontal support piles, ducts & nacelles) are likely to attract marine life in the manner of artificial reefs or fish aggregating devices (FADs).
- Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column.
- Collision risk is expected to be influenced by the nature of the environment where the turbines are located:
- Open water: Deployment of devices in the open sea will present the least risk unless the spacing between devices increases the risk of encounter (see above). However, water depth at the point of deployment will be critical and turbines need to be raised far enough off the bottom to reduce interaction with benthic fish.
- High flow environments: High flows can combine with swimming speeds to produce high approach velocities and consequently reduced avoidance or evasion response times. In high flow environments, fish may hold station in front of a device until they reach exhaustion and then passively be swept downstream towards it. This assertion is based on research undertaken into fishing methods, and why fish become swept into trawling nets (Wardle 1986, Walsh, 2003, Breen M. 2004, Jamieson, et al. 2006).
- Sounds: Deployment within sounds increases risk of encounter and subsequent collisions.
- Loughs: Locating turbines in Lough entrances could prevent passage through the entrance into or out of a sea loch and therefore exclude fish from a loch or cause their retention within the loch. This effect would be of particular significance for migratory species such as salmonids and eels. Although it is unlikely that complete exclusion or retention will result, a reduction in numbers passing through could have a significant effect on the diversity of sea loch communities.
- Turbidity: Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines themselves increase turbidity. This is because of the turbines' reduced visibility, and also because turbid waters are actively selected by many fish species, possibly as a refuge from predators.

Some initial modelling was undertaken as part of the Scottish Marine Renewables SEA to assess the potential encounter rate between a hypothetical array of 100 horizontal axis, 8 m radius turbines operating off the Scottish coast and existing populations of herring. The model incorporated a number of assumptions about the vertical distribution of herring, their swimming speeds and distribution. As escape (avoidance and evasion) behaviours by the fish to marine renewable devices are currently unknown it was also assumed that the fish were neither attracted to nor avoided the immediate area around the turbine. The model predicted that in a year of operation device encounters would occur for 2% of the Herring population between Cape Wrath and the Mull of Galloway.

However, this is a simplistic approach to quantifying collision risk, as marine fish are likely to show behavioural responses to the presence of marine renewable devices. Whilst the ability of fish to perceive their environment is well understood, their behavioural reactions to marine renewable devices are not. At long range they have the option to avoid the area of device placement (i.e. swim around) and at closer range they can evade the particular structures (i.e. dodge or swerve).

The balance between avoidance and evasion responses will depend on a product of the distances that these animals will be able to perceive the devices and their subsequent behavioural reactions. Fish sense their environment using sight, hearing, and chemoreception. Their ability to detect devices will depend on the sensory capabilities of the species and the visibility and level of noise emitted by the device. The potential for animals to escape collisions with marine renewable devices will also depend on their body size, social behaviour (especially schooling), foraging tactics, curiosity, habitat use, and underwater agility.

Ecological effects resulting from fish interactions with devices can be expected to range between: no effects to the potential removal or injury of individuals, and, if rates are sufficiently high, declines in populations. If avoidance responses occur then habitat exclusion is possible while if structures provide foraging opportunities then this could cause positive effects.

Based on discussions with developers, typical array sizes are likely to be typically 2 km^2 for wave arrays (20 – 50 devices), 0.5 km^2 (5 – 20 devices) for tidal arrays, 1-2 km^2 and 50 km^2 for wind (5-250 turbines). Depending on design devices are expected to each occupy a seabed area of between approximately 12m^2 (piles) and 40 m^2 (gravity bases).

Hydraulic impacts: Fish can also potentially suffer injury or mortality through pressure changes occurring within the turbine as water is sucked through it. This effect is only relevant for shrouded tidal devices such as venturi devices, which use shrouding to constrict the flow, thus leading to a pressure low after the constriction. Possible impacts can result from shear, pressure flux or cavitation effects, which can cause damage to gills, eyes, gill bladder, decapitation, or general pulping of body tissues and internal haemorrhages. Significant impacts of this type have been observed for tidal barrage or fence projects, such as the La Rance (Dadswell and Rulifson, 1994). However tidal barrages and fences are not being considered within the Strategic Action Plan or this SEA.. Possible impacts associated with shrouded turbines can be addressed by using screens to prevent marine organisms from entering the device.

Habitat exclusion: The presence of wind, wave and tidal arrays could cause loss of habitat during device operation. Devices may exclude fish from a suitable feeding habitat by providing a physical or perceptual barrier, or producing levels of noise that results in avoidance behaviour. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat, with associated effects on feeding and breeding success, stress on individuals and energy budgets. Based on discussions with developers, typical array sizes are likely to be 2 km^2 for wave and 0.5 km^2 for tidal arrays, and 50 km^2 for wind arrays.

Whilst it is considered that alternative feeding areas may be available to these species, the array will create a net loss of feeding area and removal of food resource, depending on the means of securing the device to the seabed. There may also be a knock-on effect on adjacent fish populations arising from increased competition for prey species in adjacent areas.

However the installation of marine turbines may also create new habitat that could potentially be colonised by benthic species and affect the availability of prey species in the vicinity of turbines.

Substratum loss: The presence of wind turbines, wave and tidal devices, gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed, will cause loss of seabed habitat during device operation. The area of seabed lost is impossible to quantify at the strategic level, as it is dependent on many project specific factors.

Based on discussions with developers, it is estimated that a typical wave or tidal array is likely to comprise 20 – 50 wave devices, or 5 – 20 tidal devices each occupying a seabed area of between 12 m^2 and 40 m^2 depending on the mooring method involved. A very approximate estimate of the area of seabed lost for each array would therefore range between 0.24 – 2 km^2 for a wave array and 0.06 – 3 km^2 for a tidal array. A typical wind array would comprise 5 – 250 wind devices each occupying 12 m^2 which could affect approximately 0.06 – 0.8 km^2 of seabed.

This effect is only directly relevant for shellfish and benthic spawners such as sandeels and herring, although there could be a knock-on effect on other fish species by affecting their benthic food resources. In addition there is a potential effect from loose lying mooring cables, affecting the three dimensional structure of the seabed, which is important for juvenile fish and a range of demersal fish species.

Decrease in water flow resulting from extraction of tidal energy, will potentially affect habitats and species which are sensitive to changes to tidal flows and wave exposure. Based on limited existing projects and modelling studies, it is estimated that the extent of potential effect on tidal energy can extend up 0.5 km from tidal devices. This effect mainly applies to shellfish which range from low – medium sensitivity to changes to tidal flows. However, as herring spawn on gravel beds created by high water flow, herring spawning areas are also likely to be sensitive to this effect.

Decrease in wave exposure resulting from extraction of wave energy**.** Wave exposed habitats, particularly those facing the full force of the Atlantic swell and those consisting of mobile sediments, generally show reduced species diversity and are likely to be resilient to the removal of wave energy.

Based on limited existing projects and modelling studies, it is estimated that the extent of potential effects on wave energy can extend up to 20 km from the wave device. This primarily applies to shellfish which generally have a low to medium sensitivity to removal of wave energy. Cockles are highly sensitive to changes in wave exposure. In addition nearshore juveniles of Plaice, Cod and Saithe have a low to medium sensitivity to changes in wave exposure.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of potential effects on sediment processes of up to 50 m from devices. King scallop, queen scallop, cockle, mussel, herring and sprat have a medium sensitivity to this potential effect. All other fish and shellfish species commonly found in the study area, for which the sensitivity is known, have low or no sensitivity to this.

Contamination: Leaching of toxic compounds from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from the device is a potential effect during device operation. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. For most of the finfish species likely to be present in the study area, sensitivity to this effect is not known. Shellfish species present in the study area have a generally low to very low sensitivity to heavy metal and synthetic chemical contamination that could result from use of copper based anti-foulants or from sacrificial anodes.

The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small. The potential for leakage of hydraulic fluids through accidental storm or collision damage could potentially present a significant effect if it occurred, but it is considered that there is a very low likelihood of such a leakage occurring. Potentially more significant still are the potential effect from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This effect is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc.

Marine noise: Marine fish can produce and hear marine noise which, whilst not fully understood, is thought to be associated with alarm calls and social behaviour, and studies have found that general noise such as that generated by shipping activity can cause an avoidance or attraction reaction in fish. Noise from offshore wind, wave and tidal energy projects therefore has the potential to affect fish in the immediate vicinity of devices. There is a wide diversity in hearing structures among fishes, resulting in different auditory capabilities across species. Herring and Cod have been identified as being highly sensitive to marine noise.

A specialist study undertaken for the Scottish Marine Renewables SEA modelled the potential for permanent and temporary hearing damage to result from operating tidal devices. This study was based on the likely noise generated from a single type of device and therefore may not be applicable across all devices. It does, however, provide an indicative estimate of the levels of noise involved. The study concluded that, for the tidal device, if the most sensitive receptor were to spend 30 minutes within 16 m of tidal device it might suffer permanent hearing damage. The assessment also indicated that 8 hours within 934 m could result in temporary hearing damage. These findings were based on generic threshold curves that were used to determine potential effects for a range of species and sensitivities. However, evidence suggests that it is unlikely that an animal would choose to stay in close proximity to the source of a loud noise (Tougaard, *et al*. 2003).

Based on the available information, the noise produced during operation of wave devices is considered to be less than for tidal, and the risk of permanent hearing damage is considered negligible. For temporary hearing damage, the maximum predicted range for an exposure of 8 hours is only 6 meters, so the risk of an animal experiencing Temporary Threshold Shift (TTS) from a single 1 MW wave device of this type is insignificant. It should be noted, however, that this analysis did not include structural noise from the wave device, which is unknown.

During operation of offshore wind turbines the main source of underwater noise is transmitted into the water from the tower as structural noise. An overview of the expected sources and potential effects of noise on marine fish is provided in a report for COWRIE (Thomson *et al*. 2006). Their modelling concluded that species such as dab and salmon might detect operational noise of a wind turbine at relatively short distances of no more than 1 km.

The area of audibility for cod and herring will be larger, perhaps up to 4-5 km from the source. The level of behavioural response within this detection area is not well understood. However, it is likely to occur only at very close ranges. Research conducted by Westerberg (1994, 2000) at the Svante wind farm in Sweden found that that European eels passing a single (220 kW) wind turbine at a distance of 0.5 km did not substantially change their swimming behaviour. Wahlberg and Westerberg (2005) estimated the range to which fish can be scared away from a wind turbine to be only 4 m.

The construction of offshore wave, wind and tidal arrays and their maintenance during operation can also involve/require relatively high amount of ship-traffic for carrying parts and for the maintenance of construction platforms etc. These are likely to contribute to varying sound levels and frequency characteristics depending on ship size and speed.

Electro-Magnetic Fields (EMF): Wind farm development has led to considerable interest in electromagnetic effects from export and interturbine cables on marine species, especially elasmobranchs, but also other fish and marine mammals (Gill *et al*., 2005). Magnetic fields are produced from AC or DC current passing through the conductor. Magnetic field strength generated during electricity cable operation is variable, and dependent on a number of factors including cable alignment and configuration. Electric fields can be produced in water passing through the magnetic field surrounding a cable. Electric fields can be almost completely blocked from emanating externally by the shielding effect of a cable's structure. The magnetic field from the Nysted wind park cable to shore was approximately 5 microtesla (μT), at 1 m above the cable; the natural magnetic field in Denmark is 45 μT (Tougaard *et al.,* 2006).The strength of both magnetic and electric fields decreases with distance from the source, and field strength at the seabed surface would therefore be dependent on the depth to which cables are buried.

Electric and magnetic fields are produced as a result of power transmission in the inter array cables and the export cable to shore. The devices themselves will also have an electrical signature, however this will be specific to the individual devices e.g. whether the power generator is in the water or on a platform and if there is a riser cable from a device on the seabed. These have the potential to affect migration and prey detection in certain electro-sensitive fish species such as elasmobranchs (sharks and rays). A number of research reports have been undertaken by COWRIE into the likely field strengths and potential effects on marine species (CMACS 2003; CMAS 2005; CMACS 2006). A literature review of research into this area, undertaken for the Scottish Marine Renewables SEA (Scottish Executive, 2006) concluded the following:

- Electrical and magnetic fields generated by the operation of offshore wind, wave and tidal devices are likely to be small and within the variation range of naturally occurring fields in the study area, but detectable to electro/magnetosensitve species. Burial of the cables will offer a protective barrier to electro/magnetosensitive species from the strongest magnetic and induced electric fields generated next to the cable.

- Marine teleost (bony) fishes do not react to electric field strengths of less than 6 V/m (several orders of magnitude greater than the estimated field strength from the inter array and export cables). No effects are expected.
- Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical export cable but the field would not cause an avoidance reaction. Furthermore, there is no evidence to indicate that existing cables have caused any significant effect on elasmobranch migration patterns.
- Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. There is currently no evidence from existing cables to suggest that navigation and migration in these species is unlikely to be affected by the magnetic field produced by the operation of wave and tidal devices.

However, significance of potential effects cannot be quantified on the basis of current information.

Fishing exclusion areas: There is potential for positive effect on fish resources should the wave, tidal or wind array be excluded from fishing activities, as this could create spawning grounds and nursery areas that will be able to exist undisturbed by commercial fishing activity. Furthermore, with sensitive design wave and tidal installations could potentially form artificial reefs.

Barrier to movement: There is the potential that arrays of devices may form a barrier to the usual migration and transit patterns of marine finfish, either because of collision risk, aversive reactions to operation noise or perceptions of devices and associated infrastructure. This is particularly relevant in constrained areas (such as mouths of Loughs).

10.4.2.4 Birds

Collision risk: Bird collision risk with offshore wind turbines is predominately limited to the operational phase and is influenced by a range of factors including species sensitivity, weather and visibility conditions, the location of bird populations adjacent to the wind farm, bird flight behaviour (height above sea level etc) and migration routes and flight routes to feeding areas that could potentially occur within the array. Collision risk is expected to be greater closer inshore as this will increase the proximity to flight paths by birds moving between feeding areas (e.g. scoters), feeding and roosting (e.g. waders and wildfowl) or breeding and feeding areas (e.g. seabird colonies), and larger-scale movements along the coast or migration landfall or departure. Further offshore, any large concentrations of birds are most likely to be present in response to food availability e.g. at tidal upwellings which concentrate plankton and shoals of fish, around fishing vessels, and when birds are rafting during feather moult.

A study at Nysted offshore wind farm (160 MW, 72 turbines) investigating whether long-lived geese and ducks can detect and avoid a large offshore wind farm demonstrated that the percentage of flocks entering the wind farm area decreased significantly (by a factor 4.5) from pre-construction to initial operation. At night, migrating flocks were more prone to enter the wind farm but counteracted the higher risk of collision in the dark by increasing their distance from individual turbines and flying in the corridors between turbines. Overall, less than 1% of the ducks and geese migrated close enough to the wind turbines to be considered to be at any risk of collision.

A combination of visual and radar studies in Germany (Hüppop *et al.* 2003, cited in Bird Life International, 2003) showed that considerable migration over the sea occurs at heights occupied by wind turbines, especially during low visibility (fog, rain, darkness) when birds fly at lower altitude.

Low-flying flocks of eiders were rarely seen to pass within 500m of the wind turbines during daytime, and avoidance behaviour was observed, with some birds altering direction 3-4kms before reaching the Utgrunden wind farm to fly around it (Pettersson 2002 cited in Birdlife International, 2003). No collisions were observed during this study, but it was difficult to judge whether this means collisions have not occurred on the basis of visual observations and limited radar tracking. Whilst the available evidence suggests that birds will in many cases change their behaviour to avoid collision with offshore windfarms, residual risks remain, particularly in areas with large numbers of migrating birds passing through, possible changes to route and altitude in response to the prevailing weather conditions. Avoidance behaviour also becomes more difficult in a scenario of multiple wind farms.

Collision risk is also considered to be a key potential effect during wave and tidal device operation, and it is considered that, bearing in mind the wide range of devices that may be deployed, all species of birds using the study area are at some risk of collision with devices. However, there is considerable lack of empirical knowledge on this risk, and it is important to bear in mind that turbine blades (tidal energy devices), either of the horizontal or vertical axis type presents an underwater threat quite unlike anything that marine birds have previously experienced. Therefore, whilst an overview of the factors likely to influence collision risks posed by marine renewable devices is summarised in this section, it is not possible to quantify this risk based on the current state of knowledge. It is also worth noting that wave devices and venturi tidal devices that do not have rotating blades are considered to pose a lower collision risk than horizontal and vertical axis tidal turbines.

Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column. Cables, chains and power lines extending up through the water will have smaller cross-sectional area than vertical support structures and so produce reduced flow disruption and fewer sensory cues to approaching diving birds. Instead of being swept around these structures, mammals are more likely to become entangled in them.

Marine birds have means of escaping moving or stationary hazards. The response of marine birds to a wave or tidal scheme will depend on whether it is detected above or below the surface and how close the object is before the animal detects it, and whether it is interpreted as a hazard that needs to be avoided.

Above the surface: If schemes are visible from above the surface, birds in flight will probably operate broadly similar avoidance tactics to those employed when encountering other natural and man-made obstructions i.e. by taking alternative flight routes and avoiding obstructions to a greater degree at night (Desholm & Kahlert 2005).

Below the surface: Similar avoidance tactics are likely to be employed by diving birds when they detect a stationary or moving object as flying birds when detecting obstructions. More drastic avoidance behaviours are likely to be required if an object is only detected very late, especially if the bird is in the path of a turbine blade. Birds have a moderately fast burst speed, which, although considerably slower than the speed of the outer edge of blades (Fraenkel 2006), would enable escape under many situations where the bird manages to move out of the path of the blades.

Collision risk is also expected to be influenced by the nature of the environment where the turbines are located, proximity to protected areas/SPAs, foraging behaviour and encounter rates.

Open waters: The above concerns are likely to be of general relevance to schemes placed in open waters, which will potentially be equally visible from all directions (device orientation notwithstanding) both above and below the water surface to marine birds. However, marine birds do not fly evenly and in all directions across open water, and are aggregated in relation to oceanographic conditions and prey availability (Daunt, *et al*. 2006b). Thus, detailed data on the use made of the area by birds, including travelling and underwater foraging trajectories, would be required to further understand this issue.

Sounds and channels: Device location and orientation are likely to be particularly important where topography restricts options for bird avoidance behaviours e.g. sounds and channels. This is true both for birds in flight and underwater. In such cases, detailed data are required on how birds use the area. Sounds are used for both activities by marine birds (Daunt 2006c). For birds in flight, in the majority of cases, heading will be longitudinal to the sound, so a parallel design is likely to be preferable to a series design for schemes that protrude above the sea surface. It is less clear which design is likely to increase collision risk among underwater foraging birds. All other things being equal, devices placed in series are more likely to have an effect on marine birds in sounds and channels since topography will be more likely to restrict avoidance options, especially in cases where the array spans the width of the sound or channel.

Sea loch entrances: Sea loch entrances are likely to be regions of high tidal currents, so are likely to be important areas for foraging (Daunt 2006c). The relative risk of parallel and series placement is unclear for foraging birds, but as with sounds the added component of topography may result in a greater risk associated with a series placement, in particular if it spans the width of the sea loch entrance.

Flow characteristics: Most species are attracted to areas of high flow because of good foraging opportunities (Daunt *et al*. 2006b). Risk of collision will be increased if renewable schemes alter the flow characteristics, especially if such changes create new foraging opportunities for marine birds, since this may affect the manoeuvrability and underwater swimming agility of the birds. However, no empirical data exist. Risk will be higher among diving than surface feeding species. However, overall risk associated with change in flow characteristics is likely to be linked to the extent to which birds feed at night.

Water depth: Collision risk will depend on the extent to which species and devices are distributed through the water column. Thus, diving species will be at greater risk of collision with subsurface rotating turbines and mooring cables than surface feeding species, which would be at a lower risk of interaction, and therefore potential effect, with floating devices, and above surface structures as these do not use rotating blades.

Empirical data exist on the depth usage of a range of species including European shags, northern gannets, northern fulmars, common guillemots, razorbills and Atlantic puffins (Wanless *et al*. 1988; Harris *et al*. 1990; Wanless *et al*. 1991; Garthe *et al*. 2000; Garthe & Furness 2001; Daunt *et al*. 2003; Daunt *et al*. 2005; Daunt *et al*. 2006b). In general, depth distribution depends on maximum foraging depth, with shallow divers spending most time near the sea surface and progressively less time at depth, whereas deep divers, which are principally benthic feeders, showing a bimodal depth distribution with peaks of time spent at the sea surface and at deep depths and less time spent at intermediate depths.

Water quality: Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines increase turbidity, because of their reduced visibility. Birds vision can be affected by small levels of turbidity (Strod *et al*. 2004). However, no data exist on collision risk in relation to turbidity. Diving species will be more at risk of collision in turbid waters than surface feeding species, and night-time feeders more at risk than daytime foragers.

Ecological effects resulting from bird interactions with devices can be expected to range from: no effects to the potential removal or injury of individuals, and, if rates are sufficiently high, to declines in populations as a result of adverse effects on foraging and breeding success, stress on individuals and energy budgets. A bad injury or break to an appendage that is critical to forging could be expected to result in the death of the bird in question. However, there is no quantified data from which to determine estimated magnitude of effect.

Airborne noise: Airborne noise is only an issue for offshore windfarms. It is produced from the movement of the blades through the air, and the consequent transmission of power and momentum in the nacelle. This can result in avoidance of the operating turbines by birds, which is discussed in more detail under “collision risk”.

Marine noise: As for construction noise, noise produced during operation of wave, wind and tidal devices could also potentially disrupt prey location and underwater navigation in marine birds, or even result in temporary or permanent hearing damage. Whilst the noise levels likely to be generated during wave, wind and tidal device operation are currently not known operation noise is expected to be considerably less in magnitude than construction noise. The potential noise sources during device operation include: rotating machinery, flexing joints, structural noise, moving air, moving water, moorings, electrical noise, and instrumentation noise.

Habitat exclusion: The presence of wind, wave and tidal arrays will cause loss of habitat during device operation. Devices may exclude birds from a suitable foraging habitat by providing a physical or perceptual barrier, or producing levels of noise that results in avoidance behaviour. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat, with associated effects on foraging and breeding success, stress on individuals and energy budgets. Based on discussions with developers, typical array sizes are likely to be 2 km^2 for wave and 0.5 km^2 for tidal arrays, and 50 km^2 for wind arrays.

Evidence from wind farm projects indicates that many species, most notably diver and sea-duck have been displaced some 2 – 4 km from wind farm areas, and this wider displacement effect is thought to be due to the birds perceptual reaction to turbines or maintenance vessels.

Whilst it is considered that alternative foraging areas may be available to these species, the array will create a net loss of foraging area and removal of food resource, depending on the means of securing the device to the seabed. There may also be a knock-on effect on adjacent bird populations arising from increased competition for prey species in adjacent areas.

However the installation of marine turbines may also create new habitat that could potentially be colonised by benthic species and affect the availability of prey species in the vicinity of turbines.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of potential effects on sediment processes of up to 50 m from devices.

Contamination: Leaching of toxic compounds from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from the device is a potential effect during device operation. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small.

Marine birds are particularly sensitive to contamination by oil based compounds which may be included in the hydraulic fluids used by some devices. The oil damages the plumage causing it to lose its waterproofing (Wernham *et al.* 1997). Furthermore, considerable physiological damage occurs as a result of marine birds ingesting oil. The susceptibility of species is dependent on their distributions and general behaviour, in particular the proportion of time spent on the sea surface in relation to time spent flying and on land. Devices which use hydraulic systems will normally be designed such that at least two seal or containment failures are required before a leaking fluid reaches the sea. It is not possible to be definitive for every device listed in this document as a number of them are still at concept stage and this aspect is a matter for detailed design. However, the industry's design guidelines (Carbon Trust, 2005), if followed, would lead a developer to minimise risks of hydraulic fluid leakage. Potentially more significant still are potential effects from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This effect is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc.

It is not possible to make any realistic estimate of the geographical extent of this effect, due to the large numbers of variables involved (quantities leaked, metocean conditions, etc).

Creation of resting and breeding habitat: Wind turbines and wave and tidal devices with surface structures, may offer roosting or nesting sites for birds. Man-made objects are frequently used as perching posts by a range of species, notably gulls, terns, gannets and cormorants. They may also provide breeding locations to these same species.

Foraging opportunities: Turbine bases and marine renewable devices, with associated seabed moorings and vertical structures, will potentially function as artificial reefs or fish aggregating devices. In changing the habitat they therefore have the potential to also change the distribution of marine seabirds. Their structures may offer enhanced opportunities for foraging for some species. The action of moving parts may scatter schooling prey or injure fish or squid and thus draw in opportunistic foragers. However, there is the potential for increased bird collision risk if birds are attracted into an array by greater food abundance, for example terns and gannets whose plunge-diving feeding behaviour may bring them into the rotor swept area of wave or tidal turbines. Furthermore, fisheries refuges may attract fishing vessels into the area.

10.4.2.5 Marine Mammals and Reptiles

Collision risk is considered to be a key potential effect during wave and tidal device operation, and it is considered that, bearing in mind the wide range of devices that may be deployed, all species of marine mammals are at some risk of collision effects. Whilst a distinction can be drawn between species that forage in the water column, or at the seabed, they all breathe at the surface and so regularly transit the water column. Certain parallels can be drawn between known collision risks and response of mammals encountering existing hazards (shipping, fishing gear interactions, killer whale tail swipes), and a review of this information was undertaken as part of the Scottish Renewable SEA. However, there is considerable lack of empirical knowledge on this risk, and it is important to bear in mind that turbine blades, either of the horizontal or vertical axis type, present a threat quite unlike anything that marine mammals have previously experienced. Therefore, whilst an overview of the factors likely to influence collision risks posed by marine renewable devices is summarised in this section, it is not possible to quantify this risk based on the current state of knowledge.

Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column. Cables, chains and power lines extending up through the water will have smaller cross-sectional area than vertical support structures and so produce reduced flow disruption and fewer sensory cues to approaching mammals. Instead of being swept around these structures, mammals are more likely to become wrapped around or entangled in them.

Being highly mobile underwater, marine mammals have the capacity to both avoid and evade marine renewable devices. This is as long as they have the ability to detect the objects, perceive them as a threat and then take appropriate action at long or short range. However there are several factors that compromise this ideal scenario.

Detection failure: The broad acoustic, visual and hydrographic signatures of marine renewable devices are at present poorly understood. Other than the visual appearance of devices, the need for efficient energy conversion will encourage the development of devices that produce as little extraneous energy signatures as possible. This is in direct contrast to any warning stimuli required by the animals at risk. There is therefore a key conflict between the stimulus output from the devices and perceptual acuity of the animals at risk. The distances that animals perceive, and hence can take avoiding/evasive action will therefore depend on this ratio. Environmental circumstances such as darkness, turbid water, background noise from rough weather or ship noise may all effect perception distances and hence escape options.

Diving constraints: Marine mammals are accomplished divers and typically dive close to aerobic dive limitations. This means that animals do not have unlimited time and manoeuvrability underwater and may have few options other than upwards at the end of a dive. In addition to this, buoyancy varies among marine mammals from negative to neutral to positively buoyant. Irrepressible positive buoyancy is a particular problem for whales when surfacing from depth and therefore constrains manoeuvring options.

Group effects: whales and dolphins travelling or feeding together may be at greater risk than those with a solitary habit. A group could be regarded as a large “super organism” rather than behaving as individuals. Responses may lead to some individuals evading contact with turbine blades; whilst others could be directed into the path of a blade.

Attraction: It is quite possible that marine renewable devices will not be perceived as a threat but instead attract marine mammals as a result of devices acting as Fish Aggregating Devices (FADs) or artificial reefs. It is also possible that species such as seals and small delphinids will be attracted to renewable devices should they injure or disorientate their prey. Certain more “curious” species, such as common and grey seals may actually be attracted to devices, whilst other more timid species (such as harbour porpoise) may tend to be more wary of devices. The age of individuals may also be relevant, as juveniles may also be more likely to investigate novel features. It is therefore likely that the more timid species or individuals that have had previous negative interactions with devices will show the strongest avoidance reactions.

Confusion: We do not yet know how marine mammals will respond to perceiving a marine renewable device, especially one with moving parts. It is quite possible that they will simply swim around it but it is also possible that they will respond in an inappropriate way. This is particularly likely for devices with gaps that move relative to the animal’s trajectory such as ducted / shrouded turbines. In arrays, an escape response from one device may put the animal into a collision path with another.

Distraction: Marine mammals undertake a variety of activities underwater from simple transits, social interactions to complex foraging tactics. It is likely that during some of these occasions the animals’ awareness of objects in the water column will be compromised. A particular example is the range detection problem encountered by echolocating cetaceans. When acoustically locked onto prey they reduce the interpulse intervals of their echolocation clicks such that they become acoustically blind to objects at greater distance than their intended prey. Therefore cetaceans feeding around submerged devices run an enhanced risk of close encounters without active acoustic detection.

Illogical behaviour: It is commonly believed that marine mammals have a high capacity for intelligent behaviour and as such would act logically when faced with a threat. However, there are many examples where this is not the case. The reticence of dolphins to leap the head line of tuna nets is a prime and ecologically significant example.

Disease and life stage: It is likely that most collisions will involve young, old, diseased or disorientated individuals. As long as marine renewable devices do not significantly attract marine mammals for enhanced foraging opportunities, juveniles are likely to be more at risk than adults because of reduced sensory and mobility abilities and/or experience, whilst old, ill or disorientated individuals will have reduced abilities to detect the threat or escape from it once perceived.

Size: Smaller mammals (such as grey and common seals) are more likely to follow the flow streamlines around moving parts and thus avoid collision. The collision risk increases with increasing size.

Season: Collision risk will also vary with season, due to seasonal change in migrations and pupping periods. Some species, such as the baleen whales and warm water dolphins typically increase in abundance during the summer and autumn, whilst most other species are resident and show only local changes in distribution.

Collision risk is also expected to be influenced by the nature of the environment where the turbines are located:

Open water: Deployment of devices in the open sea will present the least risk unless the spacing between devices increases the risk of encounter. The effects of devices on marine mammal habitat exclusion are likely to be localized to the area of placement.

***High flow environments*:** High flows can combine with swimming speeds to produce high approach velocities with consequently reduced avoidance or evasion response times. Many marine mammals (particularly harbour porpoises and bottlenose dolphins) are attracted to areas of high flow to forage.

***Sounds*:** Sounds between land masses are often used by marine mammals as transit corridors, and because they present good opportunities for foraging, as fish also use them for transit. Deployment within sounds increases risk of encounter and subsequent collisions.

***Loughs*:** Interactions between marine mammals and devices placed at the mouths of sea loughs are likely to be similar to those for sounds, but will only have an effect on local rather than transiting species.

Water quality: Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines increase turbidity, because of the reduced visibility.

Some initial modelling was undertaken for the Scottish Marine Renewables SEA to assess the potential encounter rate with a hypothetical scenario involving 100 horizontal axis 8 m radius turbines operating off the Scottish coast and existing populations of harbour porpoise.

The model incorporated a number of assumptions about the vertical distribution of porpoises, their swimming speeds and distribution. As escape (avoidance and evasion) behaviours by porpoises to marine renewable devices are currently unknown it was also assumed that the animals were neither attracted to nor avoided the immediate area around the turbine. The model predicted that in a year of operation device encounters would occur for 3.6% of the harbour porpoise population between Cape Wrath, the Mull of Galloway.

Whilst collision risk therefore presents a potential effect of major significance on cetaceans, it should be borne in mind that this is a simplistic approach to quantifying collision risk, as marine mammals are likely to show behavioural responses to the presence of marine renewable devices. Whilst the ability of marine mammals to perceive their environment is well understood, their behavioural reactions to marine renewable devices are not. At long range they have the option to avoid the area of device placement (i.e. swim around) and at closer range they can evade the particular structures (i.e. dodge or swerve).

The balance between avoidance and evasion responses will depend on the distances that these animals will be able to perceive the devices, and their subsequent behavioural reactions. Their ability to detect devices will depend on the sensory capabilities of the species, and the visibility and level of noise emitted by the device. The potential for animals to escape collisions with marine renewable devices will also depend on their body size, social behaviour, foraging tactics, curiosity, habitat use, and underwater agility.

Ecological effects resulting from mammal interactions with devices can be expected to range from: no effects, to the potential removal or injury of individuals, and, if rates are sufficiently high, to the decline in population numbers**.**

Marine noise: As for construction noise, noise produced during operation of wind, wave and tidal devices could also potentially disrupt prey location, navigation and social interaction behaviour in marine mammals, or result in temporary or permanent hearing damage. Whilst the noise levels likely to be generated during wave and tidal device operation are currently not known, operation noise is considered to be considerably less in magnitude than construction noise. The potential noise sources during device operation include: rotating machinery, flexing joints, structural noise, moving air, moving water, moorings, electrical noise, and instrumentation noise.

Operational noise of wind turbine of 1.5 MW should have only minor influence as the detection radii for harbour porpoises and seals is rather small. However, since operational noise of larger turbines cannot be assessed reliably yet, these results are preliminary. It is very likely that larger turbines are noisier resulting in much larger areas of noise influence. At 100 m distance turbine noise would be audible to both harbour porpoises and common seals. At 1,000 m the signal to noise ratio is too low for detection in harbour porpoises. In common seals, detection might be possible at distances greater than 1,000 m in the 125 – 160 Hz range.

A specialist study undertaken for the Scottish Renewable SEA modelled the potential for permanent and temporary hearing damage to result from operating devices. This study was based on the likely noise generated from a single type of tidal and wave device and therefore may not be applicable across all wave and tidal devices, or wind devices. It does, however, provide an indicative estimate of the levels of noise involved. The study concluded that, for the tidal device, if the most sensitive receptor were to spend 30 minutes within 16 m of tidal device it might suffer permanent hearing damage. The assessment also indicated that 8 hours within 934 m could result in temporary hearing damage. These findings were based on generic threshold curves that were used to determine potential effects on a range of species and sensitivities. However, evidence suggests that it is unlikely that an animal would choose to stay in close proximity to the source of a loud noise (Tougaard, *et al*. 2003).

Based on the available information, the underwater noise produced during operation of wave and wind devices is considered to be less than for tidal, and the risk of permanent hearing damage is considered unlikely – however it should be noted that the current information on wave devices relates to measurement of a single device on a single day. For temporary hearing damage the maximum predicted range for an exposure of 8 hours is only 6 metres, so the risk of an animal experiencing Temporary Threshold Shifts (TTS) from a single 1 MW wave device of this type is insignificant. It should be noted, however, that this analysis did not include structural noise from the wave device, which is unknown.

Marine life may exhibit avoidance reactions to underwater noise at levels much lower than the permanent and temporary hearing damage thresholds described above. It should therefore be noted that arrays of devices may appear as impenetrable barriers to an animal, perhaps separating them from feeding grounds, even though there may be plenty of room between devices for the animal to pass without experiencing damaging noise levels. In addition noise produced during operating devices has the potential for “masking effects” disrupting prey location, navigation and social interaction.

Barrier to movement: There is the potential that device arrays may form a barrier to the usual migration and transit patterns of marine mammals, either because of collision risk, aversive reactions to operation noise or perceptions of devices and associated infrastructure. This is particularly relevant in constrained areas (such as mouths of sea loughs) where loud noise sources may prevent transit, effectively trapping individuals.

Habitat exclusion*:* The presence of wave, wind and tidal arrays will cause loss of habitat during device operation. Devices may exclude mammals from a suitable habitat (both marine foraging habitats and, in the case of seals, terrestrial breeding habitats) by providing a physical or perceptual barrier or producing noise that results in avoidance behaviour. Cetaceans may also be excluded from areas used as nursery or breeding areas, migration/travelling routes and socialising areas. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat.

Based on discussions with developers, typical array sizes are likely to be 2 km^2 for wave and 0.5 km^2 for tidal arrays, and 50 km^2 for wind arrays.

Decrease in water flow resulting from extraction of tidal energy will potentially effect on species which are sensitive to changes in tidal flows. Seals have been shown to use their vibrissae to sense small-scale hydrodynamic vibrations and flow vortices in the water column. They are thought to use this sense to track the wake of prey organisms swimming through the water column. Its use for navigation or detecting larger objects is unknown. The existence of a similar sense in cetaceans is unknown.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of effects on sediment processes of up to 50 m from devices. Grey and common seals have been identified as having a high sensitivity to reductions in visibility, whilst the cetaceans in the study area have a moderate sensitivity to this effect. However, many seals live in areas of almost persistent turbidity e.g. the southern North Sea, The Wash, Thames Estuary etc. It is therefore unlikely that increased turbidity would be a significant issue, although the effects for a Irish seal encountering suddenly or persistently turbid water is not known.

Contamination: Leaching of toxic compounds from sacrificial anodes, antifouling paints or leakage of hydraulic fluids (if present) from the device is a potential effect during device operation. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. Seals and cetaceans in the study area generally have a low sensitivity to contamination, although the sensitivity rises to medium around seal breeding sites. However, as top predators seals and cetaceans are more susceptible to various substances building up to higher levels in their bodies.

The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small, and it is therefore considered that this potential effect will be of negligible significance. It is not possible to make any realistic estimate of the geographical extent of this effect due to the large numbers of variables involved (quantities leaked, metocean conditions, etc).

Accidental leakage of hydraulic fluids may be more significant, should they occur through storm damage, device malfunction or collision with navigating vessels. Devices which use hydraulic systems will normally be designed such that at least two seal or containment failures are required before a leaking fluid reaches the sea. It is not possible to be definitive for every device listed in this document as a number of them are still at concept stage and this aspect is a matter for detailed design. However, the industry's design guidelines (Carbon Trust, 2005), if followed, would lead a developer to minimise risks of hydraulic fluid leakage. Potentially more significant still are the potential effects from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This impact is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc.

Electro-Magnetic Fields (EMF): Electric and magnetic fields are produced as a result of power transmission in the inter array cables and the export cable to shore. The devices themselves will also have an electrical signature, however this will be specific to the individual devices e.g. whether the power generator is in the water or on a platform and if there is a riser cable from a device on the seabed. A number of research reports have been undertaken by COWRIE into the likely field strengths and potential effects on marine species (CMACS 2003; CMAS 2005; CMACS 2006).

A literature review of research into this area, undertaken for the Scottish Marine Renewables SEA (Scottish Executive, 2006) concluded that there is no evidence that magnetic fields from existing cables have influenced migration of cetaceans. However, matrices of cables within arrays may produce a more concentrated EMF effect than individual export cables.

The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, for example, migration of the harbour porpoise in and out of the Baltic Sea necessitates several crossings over operating subsea HVDC cables in the Skagerrak and western Baltic Sea without any apparent effect on its migration pattern (Basslink, 2001). There is no apparent evidence that existing electricity cables have influenced migration of cetaceans, but further study is thought warranted (Gill *et al.*, 2005).

There is no evidence that seals are sensitive to electromagnetic fields.

Haul out sites: If surface structures have horizontal surfaces near water level then there is potential that seals will use them as haul out sites. Whilst this could be viewed as a positive effect, increasing the area available for seals to haul out, there may be risks of injury associated with getting onto/off the structures and any contact with exposed moving or articulated parts.

Increased Foraging Opportunities: Wave, wind and tidal devices, with associated seabed moorings and vertical structures, will potentially function as artificial reefs or fish aggregating devices. In changing the habitat they therefore have the potential to also change the distribution of marine mammals. Their structures may offer enhanced opportunities for foraging for some species. This could occur because, in tidal flows these structures will produce eddies and areas of slack water which predators could use to shelter when ambushing prey. Otherwise the action of moving parts may scatter schooling prey or injure fish or squid and thus draw in opportunistic foragers such as seals and small cetaceans. There is, however, no guarantee that animals will be able to take advantage of this, as it will depend on their feeding techniques, prey choice and adaptability. Therefore, whether these opportunities would enhance the foraging prospects for such species for the better or attract them into otherwise dangerous situations is not yet clear.

10.4.3 Cultural Heritage including Archaeological Heritage

10.4.3.1 Archaeology and Wrecks

No significant effects to archaeological sites are anticipated during routine operation of wind, wave and tidal energy extraction systems, beyond the possibility of deeper burial of a site if there is an increase in local sedimentation rates, covered under sediment displacement.

10.4.4 Population and Human Health

10.4.4.1 Commercial Fisheries

The key difference between effects on commercial fisheries and mariculture is that fin and shell fish farms are static installations and therefore the species exploited cannot temporarily relocate or adapt to take into account effects from operations. This factor is taken into account in the identification of effects below that are specific to commercial fishing activities and the operation of shell and fin fish farms.

The key effects identified relating to commercial fisheries includes direct disturbance of grounds and displacement of fishing vessels. A detailed description of ecological effects relating to fish and shellfish species is presented in the fish and shellfish section**.**

Permanent displacement from fishing grounds during array and cables operation: The footprints of a wind, wave or tidal device array have been estimated to be 50 km2, 2 km2 and 0.5 km2 respectively, and certain types of commercial fishing activities may therefore be permanently excluded from a 50 m buffer around the array area.

The actual magnitude of this effect will be dependent on the availability of alternative grounds for fishermen to exploit, and also any potential positive effect fisheries exclusion may have on fish stocks.

Although fishing over cables is not prohibited - snagging a cable represents a safety hazard for the fishing vessel and damaging a cable is an offence under the United Nations Law of the Sea. Therefore it could be assumed that the area in which the cables are installed will not be attractive for mobile, invasive fishing methods (i.e. beam trawls, bottom otter trawls) once the cable has been installed. Therefore it is predicted that vessels operating such gear will be displaced due to the installation of power cables over a swathe of approximately 300 m for each device array (an array may have up to three export cables, each separated by 100 m).

Increased pressure upon fishing grounds: Displacement of fishing effort on a long term basis could have an indirect effect upon fish stocks and competition between fishing vessels and other sectors, depending on the scale of displacement and availability of fishing grounds. If fishing effort were to be concentrated in small areas stocks could become depleted and competition between vessels and/or sectors may mean that the viability of certain fisheries in certain areas is compromised. This effect would be particularly acute for inshore waters and communities dependent on fishing.

Effects on the fish resource in the study area could also affect the exploitable species available to fishermen, and the following effects on fish species are discussed in detail in the Fish and Shellfish section above:

- Substratum loss due to the presence of gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed
- Decrease in water flow; decrease in wave exposure
- Changes in suspended sediment levels and turbidity
- Electric and magnetic fields
- Contamination and marine noise effects

10.4.4.2 Mariculture

This section focuses on additional effects that are specific to mariculture, which are not covered in the Commercial Fisheries section above.

Substratum loss due to the presence of gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed. The area of seabed lost is impossible to quantify at the strategic level, as it is dependent on many project specific factors. The footprints of a typical wave, tidal or wind device array have been estimated to be 2 km2 and 0.5 km2, or 50 km2 respectively.

EMF: Electricity cables produce small electric and magnetic fields, which have the potential to affect migration and prey detection in certain electro-sensitive fish species such as elasmobranchs (sharks and rays).

Marine noise: As for construction noise, noise produced during operation of devices could also potentially cause fish to become “stressed”, or maybe result in temporary or permanent hearing damage in particularly close proximity. Noise emissions from operation of devices have particular potential significance for mariculture as the fish are unable to employ avoidance reactions.

However, the marine environment is noisy with ambient noise arising from wave action, natural sediment movements, action of wind and rain on the sea surface and noise from wildlife. This ambient noise combines with manmade noise produced from sources such as shipping, and fishing sonar to produce background noise which varies with different locations due to the influences of the existing seabed geology and bathymetry. Noise generated during wave, wind and tidal array operation will contribute to existing background noise.

A specialist study for the Scottish Marine Renewables SEA modelled the potential for permanent and temporary hearing damage to result from operating devices. This study was based on the likely noise generated from a single type of tidal and wave device, and therefore may not be applicable across all devices, it does, however, provide an indicative estimate of the levels of noise involved.

The study concluded that, for the tidal device, if the most sensitive receptor were to spend 30 minutes within 16 m of tidal device it might suffer permanent hearing damage. The assessment also indicated that 8 hours within 934 m could result in temporary hearing damage. These findings were based on generic threshold curves that were used to determine the potential effects on a range of species and sensitivities. Whilst evidence suggests that it is unlikely that an animal would choose to stay in close proximity to the source of a loud noise (Tougaard, et al. 2003), this option may not be available to caged fish in fish farms. The exposure period of 8 hours that was assessed in this study should also be considered against the production cycles for marine fish farms – typically less than 1 year for farmed trout, around 1.5 years for farmed salmon, and 2-5 years for farmed halibut and cod.

Based on the available information, the noise produced during operation of wind and wave devices is considered to be less than for tidal, and the risk of permanent hearing damage is considered negligible. For temporary hearing damage, the maximum predicted range for an exposure to an operating wave device of 8 hours is only 6 metres, so the risk of an animal experiencing a Temporary Threshold Shift (TTS) from a single 1 MW wave device of this type is insignificant. It should be noted, however, that this analysis did not include structural noise from the wave device, which is unknown. At a distance of 1km from a 2MW wind turbine, the operational noise merges with the ambient noise (see the Fish and Shellfish section above).

10.4.4.3 Interference with Military and Aviation Radar

Aviation operations may be affected by wind farm development in two ways; the physical obstruction caused by the turbines and the effect that the turbine structure and rotating blades may have on communications, navigation and surveillance (CNS) systems (including radar and meteorological radar) and other equipment, referred to as technical sites (DTI 2002).

The performance of **civil radar** may be degraded by the electromagnetic signal generated by turbine motion. Resulting effects include false radar responses and the masking of objects in the sky in the lee of wind farms. Turbine density, individual turbine size, construction material and blade shape are factors which may influence the degree to which radar is effected (DfT 2008b). Certain civilian and military aerodromes and technical sites are officially safeguarded to ensure that their operation is not compromised by developments such as wind farms. NERL has made available map data indicating the likelihood of interference from wind turbines on its radar network for a range of blade tip heights (20 to 140m).

Air defence radar systems: The main effects that wind turbines can have on air defence operations are upon the ability of the surveillance and command and control systems to detect and identify aircraft approaching, over-flying or leaving Ireland.

10.4.4.4 Military Activities

Long term disruption to military exercises and activities during operation of device arrays. It is not expected that cables from the array to the shore will have any noticeable long term effect on military activities. However, if a device array is located close to or within a practice or exercise area this could potentially have a long term effect on military activities, depending on how these activities are distributed within the exercise area. Operating devices could cause vessels involved in military exercises to use alternate locations within the area, or cause longer journey times due to the need to avoid operating devices.

10.4.4.5 Disposal Areas

Consultation with device developers has indicated that they would seek to avoid developing (arrays or cables) close to (e.g. within 500 m of) a disposal site. With this in mind the key potential effects identified are as follows:

Long term disruption (in terms of increased journey lengths and times) to vessels transiting to and from disposal sites due to the existence of a device array. Developers have indicated that they would seek to avoid disposal sites by a distance of approximately 500 m.

10.4.4.6 Shipping and Navigation

Effects on shipping and navigation can be categorised as effects on safety, and effects on issues related to economics such as journey times and distances, and trade. In terms of safety it is important to note that there are various rules, regulations and guidelines that relate to safety of navigation with regards to any offshore development that are in place to help prevent casualties and collisions. Below is an overview of the potential effects that could occur. It is important to recognise that all offshore activities are subject to various rules and regulations that aim to mitigate the chance of such effects occurring.

The effects of the operation of offshore wind and marine renewable energy devices upon shipping and navigation are very similar to the installation effects. The key difference is the scale (installation footprint versus development footprint) of the effect and duration of effects (temporary during installation versus long term during device life).

Increased journey times and distances: Vessels will be required to move around marine renewable energy developments and associated safety or avoidance areas potentially increasing journey times and distances. The extent to which journey time or distances are affected will be highly variable depending on the location and size of the development and the type of journey being disrupted. Increased journey distances will potentially lead to increased fuel use with the associated indirect increase in costs incurred by the shipping operator, and increased carbon emissions.

The footprints of wind, wave or tidal device arrays have been estimated to be 50km^2, 2 km^2 and 0.5 km^2 respectively. There is a possibility that bottom mounted tidal devices that have sufficient clearance above them will not present an obstruction to shipping. However, risks associated with the placement of, and continued navigation over, such devices will have to be assessed on an individual project basis but as an example, tidal devices with approximately 50 m clearance could be tolerable in certain locations. Maintenance visits would still be required to service such devices and these would require vessels to move around them.

Displacement of shipping density: The presence of renewable energy developments will affect shipping density in already constrained areas as vessels will be forced to move around the device area. In unconstrained areas there will be no measurable effect on shipping density.

Reduced trade/supply opportunities: Long term reduced access to ports and harbours could have a long term effect on trade opportunities and access to supplies.

Reduced visibility: The presence of devices has the potential to obstruct the view of other vessels, navigation features such as lights and buoys and the coastline. This could cause a hazard to other shipping in areas where visibility is particularly important for navigation or areas where the topography already constrains visibility.

Collision: The presence of stationary wave, wind and tidal device arrays is likely to increase the probability of collisions with both vessels moving under power and drifting vessels.

There is also a very small risk that moored devices could break free of the moorings under extreme weather conditions. It should be noted that although this is a credible risk due to the nature of extreme weather events, the industry will always seek to ensure the risk is as low as reasonably manageable and insurers will also require that risks are minimised and mitigated as far as possible.

In the event of a collision occurring there is a risk of extensive and serious environmental effects associated with the spillage of oil and hazardous cargos.

Search and rescue: Search and rescue exercises and operations could take place throughout the study area. The planning of such activities would need to be adapted to take into account the presence of arrays of devices.

Compass deviation: There is potential for magnetic interference with ships compasses from the cables associated with renewable energy developments. However, Medium Voltage AC (132kV or lower) three-phase transmission cables are typically used for renewables projects and the time varying magnetic fields from each phase tend to cancel each other out. In the case of HVDC cables the (static) magnetic field can have an effect on a nearby compass but this reduces dramatically with distance from the cable. Depth of burial and water depth therefore will affect the levels of magnetic compass deviation at the sea surface.

The orientation of the cable also influences the effect of the magnetic field emitted due to the magnetic field of the earth – a cable running from east to west will have less effect than one that runs north to south. Due to the way the magnetic field decreases with distance from the cable, compass deviation is only likely to be an issue in very shallow and intertidal areas which are typically areas of low activity for shipping.

Radar, communications and positioning systems: There is potential for offshore wind farms to have adverse effects on the use of radar for navigational safety and marine communications due to the height to which the turbines protrude above the surface of the water. Wave and tidal array are less likely to have a negative effect on radars as the devices generally do not protrude above the surface of the water to heights of the offshore wind turbines.

A study was undertaken by MCA into potential for interference with marine radar, communications and positioning systems for the North Hoyle windfarm project (MCA and Qinetiq, 2004). The study concluded that only significant cause for concern was the effect of wind farm structures on shipborne and shorebased radar systems. It was determined that the large vertical extent of the wind turbine generators returned radar responses strong enough to produce interfering side lobe, multiple and reflected echoes. While reducing receiver amplification (gain) would enable individual turbines to be clearly identified from the side lobes - and hence limit the potential of collisions with them – its effect would also be to reduce the amplitude of other received signals such that small vessels, buoys, etc., might not be detectable within or close to the wind farm.

Bearing discrimination was also reduced by the magnitude of the response and hence the cross range size of displayed echoes. If on passage close to a wind farm boundary or within the wind farm itself, this could in some circumstances affect a vessel's ability to fully comply with the International Regulations for the Prevention of Collisions at Sea and might also affect the performance of its automatic radar plotting aid (ARPA). With respect to the multiple and reflected echoes produced when wind farm structures lie between the observing radar and a relatively high sided vessel, gain reduction will have similar effects to those described above. If, as in the trial undertaken, a shore or platform based radar is intended to detect and track traffic in port approaches, Vessel Traffic Systems or in the proximity of offshore oil or gas installations, the effects could be significant. Standard exclusion areas of 500 m during construction and 50 m during operation, developers can apply for a safety area around the renewable development.

Site specific traffic intensity studies and consultation with the Irish Coast Guard and relevant ports authorities will need to be undertaken for specific developments to determine the level of shipping collision risk of specific development sites, and acceptable proximity on a case by case basis.

10.4.4.7 Recreation and Tourism

The marine environment, landscape and resources play an important role in many tourism and recreation activities in Ireland. Therefore, any impact on the coastal or marine environment through the operation of marine renewable energy devices could potentially have an effect on the tourism industry and recreation. The potential effects are discussed below.

Noise and Vibration: In terms of the operation of the marine devices, the majority of the effects of noise will be on the marine environment, although shoreline devices generate noise which could potentially affect land based receptors.

As with installation noise, operational noise may have an adverse effect on the breeding, feeding and migratory patterns of marine wildlife and seabirds, leading to their displacement or avoidance of areas. This will potentially have an indirect effect on the marine wildlife watching industry and bird watchers. The effect of noise on marine wildlife is discussed in more detail in Section 10.3.

Landscape, Seascape: The effects on landscape, Seascape are discussed in 10.6.2. The landscape, seascape and views around the Ireland coastline are intrinsic to the area's ability to attract tourists and visitors. The presence of marine devices in certain locations may affect people's perceptions and enjoyment of an area.

Safety and collision risk: The effect of marine devices in terms of safety and collision risk is discussed in 10.5.5 in relation to shipping and navigation, Section 10.3.5 with respect to marine mammals and10.3.4 with respect to Birds. Submerged, partially submerged and sub-aerial devices all present a potential hazard to other users of the marine environment as collisions could cause damage to vessels and danger to the health and safety of people in the area. Increased risk of collision with structures at sea could act as a deterrent to recreational sailors or water sports enthusiasts.

Access restrictions: In order to avoid potential collisions, areas in which devices are located may require access restrictions to be imposed. Such restrictions may have a negative effect should they prevent access to specific sites or areas of coastline which are of special interest. There is also potential for wave, wind and tidal energy projects to cause cruising routes to become 'squeezed' into commercial navigation routes and effects on sailing and racing areas.

Disturbance to wildlife: As mentioned previously in terms of noise and vibration, the operation of marine devices may lead to the disturbance and potential displacement of marine wildlife or seabirds. Other factors potentially affecting marine mammals and birds include: habitat loss; disturbance, disruption or loss of food sources and feeding areas; physical severance or obstruction of migratory routes; population pressures if certain species are forced into smaller areas or predator habitats. The displacement of marine wildlife or birds could have negative effects on marine wildlife watching operators and bird watchers. The effects of marine devices on birds and marine mammals are discussed in detail in the Biodiversity, Flora and Fauna section above.

Energy extraction: The potential implication of energy extraction on recreation and tourism are associated with how energy extraction affects coastal processes and how these effect local beaches. Potential effects on coastal processes and geomorphology are described in the relevant section. Concerns have been raised by the surfing community in general that extraction of wave resources could potentially affect wave energy at the coast, with the associated effects on surfing. However, the percentage of wave energy extracted by the offshore wave devices is negligible in comparison with the wave energy lost by increased bottom friction in the shallowing water as the waves approach the shore, and exploitation of offshore wave energy is not expected to have a negative effect on recreational surfing.

Creation of tourist attractions: There is potential that the marine devices themselves could have positive effect on recreation and tourism by becoming key tourist attractions. With increased awareness of climate change and the opportunities for gaining firsthand experience of the evolution of new technologies, the attraction of marine devices which are accessible (and visible) could be potentially high in the short-term. Interest is likely to decrease as wave, tidal and wind power become more commonplace.

10.4.5 Material Assets

10.4.5.1 Aggregate Extraction and Maintenance Dredging

Whilst there are currently no licensed aggregate extraction areas in Ireland's waters, there is some interest in potential licensing of future sites. It is assumed that the licence holder will have rights over the licensed extraction area and therefore renewable energy arrays will not be permitted within any sites licensed for aggregate extraction at the time of determine the renewable array licence. With this in mind the key potential effects identified are as follows:

Long term disruption (in terms of increased journey lengths and times) to vessels transiting to and from dredging sites due to the existence of a device array. Developers have indicated that they would seek to avoid dredging sites by a distance of approximately 500 m.

Sterilisation of unlicensed mineral resources: Areas licensed for marine renewable energy development will not be available for subsequent exploitation for aggregate resources during the operational life of the array.

10.4.5.2 Oil and Gas Infrastructure

Renewable energy arrays will not be permitted within any site marked as a Petroleum lease area, Licensing option area or Exploration licence area for oil or gas exploitation that are in place at the time the renewable array licence is determined. With this in mind the key potential effects identified are as follows:

Long term disruption (in terms of increased journey lengths and times) to vessels and helicopters transiting to and from sites due to the existence of a device array. Developers have indicated that they would seek to avoid oil and gas platforms by a distance of approximately 500 m.

Sterilisation of unlicensed mineral resources: Areas licensed for marine renewable energy development will not be available for subsequent exploitation for oil and gas resources during the operational life of the array.

10.4.5.3 Cables and Pipelines

Potential effects upon pipelines and cables can be summarised as follows:

- Direct damage caused by physical interaction with the cable by anchors, device foundations or cable installation. This would be most likely to occur during installation of development but may also occur during maintenance of devices or cables.
- Reduced access to existing pipelines and cables for maintenance and repair activities during construction of device array and cables, and operation of devices and cables.

The avoidance of cables and pipelines is important for a number of reasons. All power cables and most telecommunications cables carry power. Damage to telecommunications cables can lead to extensive disruption of international communications, whilst damage to power cables will interrupt electricity supply. Pipelines may contain flammable oil or gas under pressure and damage to pipelines could result in a hazard to the environment or a hazard from fire or explosion (UKHO, 2006).

In reality the installation of marine renewables devices is unlikely to have any adverse effects on cables or pipelines because the location of existing infrastructure will be considered during the site selection for any development. Additionally, where the cables associated with marine renewable energy developments cross existing pipelines and cables, crossing agreements will be developed which although are a voluntary requirement, become legally binding once signed by all parties. Such agreements seek to ensure the integrity of the new and crossed infrastructure and facilitate ongoing safe access to each cable or pipeline for maintenance and repair activities.

In the event that two parties fail to agree terms for a particular crossing agreement, the fallback position is to rely on The United Nations Convention on the Law of the Sea (UNCLOS) to determine liability levels in the event that one party damages the other's asset. (This applies internationally and is ratified by the European Union including Ireland).

Positional accuracy in installing devices may vary slightly according the method employed for fixing the device to the seabed.

The area of within which cables and pipelines could be adversely affected by development has been determined as being a 500 m area either side of the centreline of the infrastructure. This area has been determined based on International Cable Protection Committee (ICPC) guidelines that suggest wind farm developments should avoid cables by 500 m for safety reasons. However, it is recognised that the distance of avoidance required may be less than 500 m in certain circumstances.

In common with the method applied throughout the SEA, potential effects have been determined based on no mitigation (i.e. no avoidance of existing pipelines and cables, and no use of crossing agreements). However, it should be noted that it is standard practice to avoid existing infrastructure or to cross it in accordance with crossing agreements and therefore the effects noted without mitigation are very unlikely to occur in reality.

10.4.6 Seascape

Renewable energy technology is a rapidly evolving field, appearance and scale of potential future development is accordingly difficult to predict with accuracy. When considering the potential effects of device characteristics on the existing seascape we have taken a precautionary view, basing assessment of the sensitivity to change, magnitude and on effects prior to mitigation.

There are a number of ways in which the device arrays may affect the seascape resource, as detailed below.

- The scale and form of the array could prove inappropriate and intrusive in the context of the existing seascape;
- The arrays could introduce activity, features and forms out of keeping with the seascape;
- The arrays could involve the loss or fragmentation of important and distinctive seascape components, features and characteristics; and
- The introduction of an array in a nationally designated seascape could affect the integrity of a national resource.

The extent to which the device array would affect the seascape varies depending on the various stages of the development and the capacity of the existing seascape to absorb these components. The construction and decommissioning phases of the development would involve temporary and relatively short periods of change and as a result the effects on the seascape are not considered to be greater than the permanent operational effects and are consequently not considered below. The operational phases of the development when the devices are installed in the water would, however, result in more permanent and potentially significant effects and it is these operational effects on the seascape, which are described below. It should be noted that whilst submerged devices are not considered to result in potential significant effects the buoys and lighting associated with these device arrays have been assessed as there is the potential for them to affect the seascape.

10.4.6.1 Potential Effects on Seascape

The following section provides an assessment of the potential effects that the different device types could have on the seascape resource of the study area during operation, these potential effects are summarised in Table 10.1 below and illustrated in Figures 12.15, 12.16 and 12.17. It should be noted that all potential effects identified in the table below are considered during the operational phase of the development and the confidence level for all effects is low (refer to Chapter 6).

Table 10.2: Potential Effects of Wind Turbines on Seascape Character

Seascape Types	Sensitivity to Change	Magnitude of change			
		Large	Medium	Small	Negligible
		<15km	15-24km	24-35km	35Km+
1 – Large Open or Partially Open Sea Lough with Raised Hinterland	High	Substantial	Substantial	Moderate	Slight Neutral
2. Rugged Peninsulas with drowned valleys	High	Substantial	Substantial	Moderate	Slight Neutral
3. Low Lying Plateau Landscape	Low/Medium	Moderate	Slight - Moderate	Slight Neutral	Neutral
4. Low Lying Coastal Plain and Estuarine Landscape, Low lying Islands and Peninsulas	Low/Medium	Moderate	Slight - Moderate	Slight Neutral	Neutral
5 - Narrow Coastal Strip with Raised Hinterland	High	Substantial	Substantial	Moderate	Slight Neutral
6 – Complex Indented Coast, Small Bays and Off Shore Islands	High	Substantial	Substantial	Moderate	Slight Neutral
7 – Plateaus and High Cliffs	High	Substantial	Substantial	Moderate	Slight Neutral
8 – Large Bay	High/ Medium	Substantial	Moderate	Slight	Slight Neutral
Transboundary Seascape Types					
T.1- Large Open or Partially Open Sea Lough with Raised Hinterland	High	Substantial	Substantial	Moderate	Slight Neutral
T.2-Low Lying Coastal Plain	Low/Medium	Moderate	Slight - Moderate	Slight Neutral	Neutral
T.3 Plateaus and High Cliffs	High	Substantial	Substantial	Moderate	Slight Neutral
T.4- Rugged Coastal Shelf and Headlands with Open Views to Sea	High	Substantial	Substantial	Moderate	Slight Neutral

Table 10.3: Potential Effects of Wave (on Surface Linear) Arrays on Seascape Character

Seascape Types	Sensitivity to Change	Magnitude of change			
		Large	Medium	Small	Negligible
		0-5km	5-10km	10-15km	15 Km+
1 – Large Open or Partially Open Sea Lough with Raised Hinterland	Medium	Moderate Substantial	Moderate	Slight	Neutral
2. Rugged Peninsulas with drowned valleys	High	Substantial	Mod - Substantial	Moderate	Slight

Seascape Types	Sensitivity to Change	Magnitude of change			
		Large	Medium	Small	Negligible
		0-5km	5-10km	10-15km	15 Km+
3. Low Lying Plateau Landscape	N/A	N/A	N/A	N/A	N/A
4. Low Lying Coastal Plain and Estuarine Landscape, Low lying Islands and Peninsulas	Low/Medium	Moderate	Slight	Slight - Neutral	Neutral
5 - Narrow Coastal Strip with Raised Hinterland	Medium/ High	Substantial	Moderate	Slight - Moderate	Slight- Neutral
6 – Complex Indented Coast, Small Bays and Off Shore Islands	Medium/ High	Substantial	Moderate	Slight - Moderate	Slight- Neutral
7 – Plateaus and High Cliffs	High	Substantial	Mod - Substantial	Moderate	Slight- Neutral
8 – Large Bay	Low/Medium	Moderate	Slight	Slight - Neutral	Neutral
Transboundary Seascape Types					
T.1- Large Open or Partially Open Sea Lough with Raised Hinterland	Medium/High	Mod – Substantial	Moderate	Slight - Moderate	Slight- Neutral
T.2-Low Lying Coastal Plain		N/A	N/A	N/A	N/A
T.3 Plateaus and High Cliffs	High	Substantial	Mod - Substantial	Moderate	Slight- Neutral
T.4- Rugged Coastal Shelf and Headlands with Open Views to Sea	Medium/ High	Substantial	Mod - Substantial	Slight - Moderate	Neutral

Table 10.4: Potential effects of Wave (Oscillating Surge) Arrays on Seascape Character

Seascape Types	Sensitivity to Change	Magnitude of change			
		Large	Medium	Small	Negligible
		0-5km	5-10km	10-15km	15 Km+
1 – Large Open or Partially Open Sea Lough with Raised Hinterland	Medium/High	Moderate Substantial	N/A*	N/A*	N/A*
2. Rugged Peninsulas with drowned valleys	High	Substantial	N/A*	N/A*	N/A*
3. Low Lying Plateau Landscape	N/A	N/A	N/A	N/A	N/A
4. Low Lying Coastal Plain and Estuarine Landscape, Low lying Islands and Peninsulas	Medium	Moderate	N/A*	N/A*	N/A*

Seascape Types	Sensitivity to Change	Magnitude of change			
		Large	Medium	Small	Negligible
		0-5km	5-10km	10-15km	15 Km+
5 - Narrow Coastal Strip with Raised Hinterland	Medium/High	Moderate Substantial	N/A*	N/A*	N/A*
6 – Complex Indented Coast, Small Bays and Off Shore Islands	Medium	Moderate	N/A*	N/A*	N/A*
7 – Plateaus and High Cliffs	Medium/High	Moderate Substantial	N/A*	N/A*	N/A*
8 – Large Bay	Medium	Moderate	N/A*	N/A*	N/A*
Transboundary Seascape Types					
T.1- Large Open or Partially Open Sea Lough with Raised Hinterland	N/A	N/A	N/A	N/A	N/A
T.2-Low Lying Coastal Plain	N/A	N/A	N/A	N/A	N/A
T.3 Plateaus and High Cliffs	N/A	N/A	N/A	N/A	N/A
T.4- Rugged Coastal Shelf and Headlands with Open Views to Sea	N/A	N/A	N/A	N/A	N/A

Table 10.5: Potential Effects of Tidal (On Surface Point) Arrays on Seascape Character

Seascape Types	Sensitivity to Change	Magnitude of change			
		Large	Medium	Small	Negligible
		0-5km	5-10km	10-15km	15 Km+
1 – Large Open or Partially Open Sea Lough with Raised Hinterland	Medium /High	Mod – Substantial	Moderate	Slight - Moderate	Slight- Neutral
2. Rugged Peninsulas with drowned valleys	High	N/A	N/A	N/A	N/A
3. Low Lying Plateau Landscape	Low/Medium	Moderate	Slight	Slight - Neutral	Neutral
4. Low Lying Coastal Plain and Estuarine Landscape, Low lying Islands and Peninsulas	Medium	Moderate	Moderate	Slight	Neutral
5 - Narrow Coastal Strip with Raised Hinterland	Medium/ High	Substantial	Moderate	Slight - Moderate	Slight- Neutral
6 – Complex Indented Coast, Small Bays and Off Shore Islands	Medium/High	Substantial	Moderate	Slight - Moderate	Slight- Neutral
7 – Plateaus and High Cliffs	High	Substantial	Mod - Substantial	Moderate	Slight- Neutral

8 – Large Bay	Low/Medium	Moderate	Slight	Slight - Neutral	Neutral
9. Large River Estuary	Medium	Moderate	Moderate	N/A*	N/A*
Transboundary Seascape Types					
T.1- Large Open or Partially Open Sea Lough with Raised Hinterland	Medium/High	Mod – Substantial	Moderate	Slight - Moderate	Slight- Neutral
T.2-Low Lying Coastal Plain	N/A	N/A	N/A	N/A	N/A
T.3 Plateaus and High Cliffs	High	Substantial	Mod - Substantial	Moderate	Slight- Neutral
T.4- Rugged Coastal Shelf and Headlands with Open Views to Sea	High	Substantial	Mod - Substantial	Moderate	Slight- Neutral

10.4.6.2 Potential Effects of Offshore Wind Developments

Due to the scale and form of Offshore Wind Turbines the significance of effect within 15 km offshore for most seascape types with wind resources would be substantial.

The low lying coastline and large horizontal vistas of Seascape types type 3 Low Plateau Landscape, 4 Low Lying Coastal Plain and transboundary seascape T2 Low Lying Coastal Plain are the least sensitive to this type of development and the significance of effect within 15 km would be Moderate reducing to slight neutral after 24km from the shore.

Seascape types 1 – Open Sea Lough, 2 Rugged Peninsulas, type 5 – Narrow Coastal Strip with raised Hinterland, type 7 – Plateaus and Cliffs, type 8 Large Bay and transboundary types 1 Open Sea Lough, T3 Plateaus and High Cliffs and T4 Rugged Coastal shelf have the lowest capacity for characteristics of Off Shore Wind Turbines with Substantial effects within 24km dropping to moderate effects after 24 km.

10.4.6.3 Potential Effects of Wave (Surface Linear) Arrays

Within 5km of the coastal edge all seascapes with wave resources would be subject to Substantial - to Moderate effects as a result of such devices (dependant on sensitivity) however this would drop to Moderate to Slight /Neutral effects after 10km.

The large horizontal scale and low viewpoint of Seascapes type 4 Low Lying Coastal Plain, and 8 Large Bay would be most able to accommodate characteristics of Wave (On Surface Linear) devices with moderate effects within 5km of the coast dropping to slight neutral effects after 10 km.

Wave (On Surface linear) devices would have moderate substantial effects within 0-5 km of seascape types 1 Large Open Sea Lough, and transboundary type T1 Large Open Sea Lough. The enclosing topography and raised viewpoints from the elevated hinterland, dropping to slight to slight moderate after 10km. The Seascapes type 2 Rugged Peninsulas, 5 Narrow Coastal Strip with Raised Hinterland, 6 Complex Indented Coast, 7 Plateaus and High Cliffs and transboundary types, T3 Plateaus and High Cliffs and T4 Rugged Coastal Shelf with Headlands, have the lowest capacity for Wave (On Surface Linear Structure) Structures with significance of effects ranging from Substantial within 5km dropping to Moderate to Moderate Substantial after 10 km. This is due to the greater potential visibility of wave (Surface Linear) devices from elevated viewpoints along the coastal edge and the more intimate scale of seascape framed by headlands and islands.

10.4.6.4 Potential Effects of Wave (Oscillating Surge) Devices

Offshore elements of Wave Oscillating Surge devices are likely to be located in inshore waters 0-5km from the coast due to the requirement to site equipment at depths of 10-15m. Due to the lower profile and intermittent visibility of offshore elements effects of offshore elements are likely to be less than the effects of linear wave devices. However as the effects of fixed onshore elements of the device will remain constant and may be the most noticeable element of the device, effects of the fixed coastal structure are therefore equivalent to effects at 0-5 km.. All the following effects are therefore assumed to be within 0-5km of the coastal edge.

This type of device would have moderate effects on seascape types 4 Low Lying Coastal Plain, 6. Complex Indented Coastline and 8 Large Bay, as offshore arrays may conflict with the complex coastal edges or bays while the fixed on shore structures may introduce visually prominent new element in conflict with the local landscape / seascape character.

Seascape types 1 Large open Sea Lough, 5, Narrow Coastal Strip with Raised Hinterland and 7. Plateaus and High Cliffs have potential for moderate substantial effects b due to elevated panoramic views over an extended area with potential for onshore fixed structures to be in conflict with local seascape and landscape character.

Type 2 Rugged Peninsulas has the lowest capacity for Wave (Oscillating Surge) devices due to the combination of extensive and elevated panoramic views from headlands and hinterland with the complex coastal edge and reduced seascape scale of drowned valleys. The topography would potentially render devices in inshore waters visually prominent over an extended area with potential for onshore fixed structures to conflict with vulnerable and unique seascape qualities.

10.4.6.5 Potential Effects of Tidal (On Surface Point) Arrays

Within 5km of the coastal edge all seascapes with tidal resources would be subject to Substantial - to Moderate effects as a result of such devices (dependant on sensitivity) however this would drop to Moderate to Slight Neutral effects after 10km.

The Seascape types most able to accommodate these device characteristics are type 3 Low Plateau Landscape, and type 8 Large Bay due to the large horizontal scale. Effects of Tidal (On Surface Point) Devices within 5km would be moderate dropping to slight -neutral after 10km.

In Seascape Type 4 Low Lying Coastal Plain, and Type 9 Large River Estuary, the low lying coastline could potentially increase the prominence of Tidal (On Surface Point) Devices as a new vertical element against the horizon or distant shoreline. Consequently effects would be moderate dropping to slight after 10km. For devices located within Type 9 Large River Estuary the reduced scale and enclosing topography make it unlikely that devices could be sited more than 10 km from the shore.

Due to the long elevated views from the hinterland and reduced scale Seascape types 1 Large Open Sea Lough, 5 Narrow Coastal Strip with raised Hinterland, 6 Complex indented coast with Islands, and transboundary type T1 Large Open Sea Lough would be subject to moderate substantial to substantial effects within 5km of the coast dropping to slight moderate effects after 10km.

Seascape types 7 Plateaus and High Cliffs and transboundary types, T3 Plateaus and High Cliffs and T4 Rugged Coastal shelf with Headlands, have the lowest capacity for Tidal (On Surface Point Devices) with effects ranging from Substantial within 5km dropping to Moderate after 10 km, as Tidal (On Surface Point Devices) could potentially create a noticeable focal point in the extensive elevated panoramic views of the open sea, where none previously existed.

10.4.7 Climatic Factors

In terms of assessing the potential effects of offshore wind and marine renewable energy in terms of climate factors four main areas have been identified:

- Gas and carbon storage sites
- Changes in the marine environment that can affect the operation of marine devices directly (i.e. marine renewable energy devices are vulnerable to climate change in various ways)
- Changes in the environment that can affect how devices interact, and therefore potentially affect particular environmental receptors.
- The amount of carbon saving or offsetting of developing renewable energy sources.

These potential effects are discussed below.

Effects on marine devices: Examples of the direct impact on the devices might include changes in output (e.g. wave devices affected by changes in mean wave height) and durability associated, for instance, with frequency of extreme storms.

Effects of climate change on the environmental effects of devices: Examples of indirect impact of climate change include the possibility that changing sea temperatures will significantly alter the ecological profile of the area, and the interaction between the renewable energy devices and this new ecology is thus a consideration.

Carbon Savings: It is often desirable to quantify the consequent reduction in greenhouse gas emissions to the atmosphere resulting from a given energy strategy or project. The idea behind this is that the electricity generated by offshore renewable energy developments offsets the electricity that would otherwise have been generated by another technology. This allows the contribution of the strategy or individual projects towards targets for decarbonisation of the economy to be quantified. It does not, however, quantify the reduced impact on climate change as national progress on carbon emissions is only significant in the context of a concerted global movement in the same direction. Assessing the reduction in greenhouse gas emissions caused by a strategy or project is not a straightforward process, as the results depend on a number of assumptions discussed below.

Load Factor: The installed capacity of a generating device, or group of devices, refers to its maximum output. However, there are significant periods during which it will generate below this level, or even not at all, during periods when wave/tidal conditions are well below their peak, or during maintenance downtime.

The load factor is the average power output, over a period of one year, expressed as a percentage of the installed capacity. There are a range of influences on the load factor, including local meteorological conditions (for wind and wave devices); the nature of the tidal currents; the design of the equipment; and the reliability of the equipment. Given that a number of the technologies/devices are still at the earlier stages in their development, a proportion of this information is uncertain.

A report for the UK DTI in 2003 suggested load factors of 33% to 38% at for offshore wind at average speeds of 8.5 to 9.5m/s, allowing for 20% losses (downtime, wake losses, etc.). An approximate figure of 40% is often used in discussions of load factor for marine devices (wave and tidal). However, as technologies develop and new devices emerge that are more effective, efficient and reliable is it likely that these load factors will increase.

Displaced Capacity: Identifying the tonnage of CO_2 emissions displaced for each MWh generated is a complex process. This is mainly due to the challenges in determining which (non-renewable energy) power generators have been displaced as different power generators all have very different rates of CO_2 emission.

For example, it might be argued that if a coal fired power station were reaching the end of its life as offshore wind and marine renewable energy developments begin to establish themselves then the offshore renewable energy sources are replacing the coal fired generator, which has a high emissions factor (tonnes of CO_2 emitted per MWh generated). However, if the coal fired power station closed because it had reached the end of its operating life, then potentially the capacity displaced by the offshore wind and marine renewable energy developments is that capacity which would otherwise have been constructed to replace the coal fired station. This could in some cases by a more carbon efficient Combined Cycle Gas Turbine (CCGT) station or a carbon efficient fossil fuel power station fitted with carbon capture and storage.

10.5 Decommissioning

Decommissioning impacts are likely to be similar to those during installation if the array is removed, or similar to the impacts associated with presence of devices during operation if the decision is taken to leave devices in situ. This is a decision that will be taken at the appropriate time, taking into account legislation in place at the time, and the comparative impacts of each approach. Removal of devices could cause a greater impact than leaving them in place due to the loss of hard substrate that has been utilised by benthic algae, invertebrates, and fish as additional habitat.

10.6 Summary

The following tables summarise the potential impacts for each receptor type during each phase of the project described in this chapter. For all tables the development phase has been described as either:

- CD = Construction/decommissioning impact – devices
- CC = Construction/decommissioning impact - cables
- OD = Operation/decommissioning impact – devices
- OC = Operation/decommissioning impact – cables

Table 10.6: Summary of the Potential Effects on Geology, Geomorphology and Sediment Processes

Effect	Technology	Development Phase	Direct/ Indirect	Duration	Extent
Increase in suspended sediment	Wave / Wind / Tidal	CD CC	Direct	Temporary	Negligible
Change in seabed morphology	Wave / Wind / Tidal	CD CC	Direct	Long term (device life)	Within array area Cable route
Change in sediment processes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	50m
Change in coastal processes	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Unknown and variable

Table 10.7: Summary of Potential Effects on Water and Sediment Quality

Effect	Technology	Development Phase	Receptor	Direct/ Indirect	Duration	Extent
Disturbance of natural sediments during construction	Wave / Wind / Tidal	CC CD	Water quality	Direct	Temporary (during installation)	Coarser fraction of material likely to settle within 50m Fine material will spread widely, but with negligible effect
Release of additional sediments during construction	Wave / Wind / Tidal	CC CD	Water quality	Direct	Temporary (during installation)	Impossible to quantify but likely to be similar to natural sediment

Effect	Technology	Development Phase	Receptor	Direct/ Indirect	Duration	Extent
Release of contaminants during construction	Wave / Wind / Tidal	CD OD	Water quality	Direct	Temporary (during installation)	Unquantifiable but likely to be negligible in practice
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Water quality Shellfish waters Bathing waters	Direct	Temporary (during installation)	Not possible to quantify – unlikely to occur in practice
Accidental release of contaminants	Wave / Wind / Tidal	CD CC OD	Water quality Shellfish waters Bathing waters	Direct	Temporary (during installation)	Impossible to quantify, could be significant and widespread
Contamination – erosion of sacrificial anodes	Wave / Wind / Tidal	OD	Water quality	Direct	Long term (device life)	Negligible
Contamination – leakage of hydraulic fluids	Wave / Wind / Tidal	OD	Water quality Shellfish waters Bathing waters	Direct	Long term (device life)	Design dependant
Contamination of anti-fouling compounds	Wave / Wind / Tidal	OD	Water quality	Direct	Long term (device life)	Negligible
Changes in sediment dynamics	Wave / Wind / Tidal	OD	Water quality	Indirect	Long term (device life)	Dependant on individual site conditions
Disturbance of natural sediments (Operation)	Wave / Wind / Tidal	OD	Water quality	Indirect	Long term (device life)	Dependant on individual site conditions
Disturbance of contaminated sediments (operation)	Wave / Wind / Tidal	OD	Water quality	Indirect	Long term (device life)	Dependant on individual site conditions

Table 10.8: Summary of Potential Effects on Benthic Ecology

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Substratum loss (construction)	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Smothering	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	50m
Increased turbidity	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Increased suspended sediment	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Decrease in wave exposure	Wave / Tidal	OD	Direct	Long term (device life)	Up to 20km
Decrease in water flow	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Up to 500m

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Substratum loss (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Within array area: wave - 4 km2; tidal - 0.5 km2
Changes in turbidity	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Changes in suspended sediment	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Indirect	Long term (device life)	Negligible
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Temporary (during installation)	Negligible
Accidental contamination (Hydraulic Fluids or vessel cargo/fuel)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

Table 10.9: Summary of Potential Effects on Fish and Shellfish

Effect	Technology	Development phase	Direct / indirect	Duration	Extent
Disturbance	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Smothering	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	50 m
Increased turbidity	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Increased suspended sediment	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Marine Noise (Construction)	Wave / Wind / Tidal	CD CC OD	Direct	Temporary (during installation)	80 km
Collision risk	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Study area
Substratum loss	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Within array area Wave: 0.24 – 2 km2 Tidal: 0.36 – 2 km2
Decrease in wave exposure	Wave / Wind / Tidal	OD	Direct	Long term (device life)	20 km
Decrease in water flow	Wave / Wind / Tidal	OD	Direct	Long term (device life)	500 m
Changes in turbidity	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Changes in suspended sediment	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible

Effect	Technology	Development phase	Direct / indirect	Duration	Extent
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
EMF	Wave / Wind / Tidal	OC	Direct	Long term (device life)	Within array area
Marine noise (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Up to 80 km
Fishing exclusion areas (positive effect)	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Impossible to quantify
Barrier to movement	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

Table 10.10: Summary of Potential Effects of Marine Birds

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Collision risk (construction)	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Construction area (unknown)
Physical disturbance	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Construction area (unknown)
Marine noise (construction)	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Unknown
Increased suspended sediment and turbidity (reduced visibility)	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Collision risk (operation)	Wave / Wind / Tidal	OD	Direct	Temporary (during installation)	Within array area: wave - 2 km2; tidal - 0.5 km2
Marine noise (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Unknown
Habitat exclusion	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Within array area: wave - 2 km2; tidal - 0.5 km2
Increased turbidity (reduced visibility)	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
Creation of resting and breeding habitat	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
Foraging opportunities	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Impossible to quantify
Increased predation (mink)	Wave / Wind / Tidal	OD	Indirect	Long term (device life, and beyond)	Impossible to quantify

Table 10.11: Summary of Potential Effects on Marine Mammals and Reptiles

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Collision Risk (construction)	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Array size (2 km2 – wave; 0.5 km2 - Tidal – 50 km2 - wind)
Physical Disturbance	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	900m from seal colonies
Marine Noise (construction)	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	At least 20km for porpoises (may vary between species)
Increased suspended sediment and turbidity	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Collision Risk (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Array size (2 km2 – wave; 0.5 km2 - Tidal – 50 km2 - wind)
Marine Noise (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Unknown (development specific)
Habitat exclusion	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Array size (2 km2 – wave; 0.5 km2 - Tidal – 50 km2 - wind)
Decrease in water flow	Wave / Wind / Tidal	OD	Direct	Long term (device life)	500m
Increased turbidity (reduced visibility)	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
EMF	Wave / Wind / Tidal	OC	Direct	Long term (device life)	Negligible
Haulout	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
Increased foraging opportunities	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Impossible to quantify
Barrier to movement	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

Table 10.12: Summary of Potential Effects on Archaeological Sites

Effect	Technology	Development phase	Direct / Indirect	Duration	Extent
Seabed attachment	Wave / Wind / Tidal	CD	Direct	Permanent	Within disturbed area
Displacement of sediments	Wave / Wind / Tidal	CD CC	Indirect	Temporary to Permanent	Within sediment area
Cable laying operations	Wave / Wind / Tidal	CC	Direct	Permanent	Cable trench
Exploratory operations	Wave / Wind / Tidal	CD CC	Direct	Permanent	Extent of work

Table 10.13: Summary of Potential Effects on Commercial Fisheries

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Direct disturbance of fishing grounds	Wave / Wind / Tidal	CC,CD	Direct	Temporary (during installation	Cable device and installation area
Temporary displacement from traditional fishing grounds	Wave / Wind / Tidal	CC,CD	Direct	Temporary (during installation	Cable device and installation area
Long term displacement from traditional fishing grounds	Wave / Wind / Tidal	OC,OD	Direct	Long term	Array size (2 km2 – wave; 0.5 km2 - Tidal – 50 km2 - wind) and potentially cable swathe
Increased pressure upon fishing grounds	Wave / Wind / Tidal	OC, OD	Indirect	Long term	Depends on scale of development in relation to fishing grounds

Table 10.14: Summary of Potential Effects on Mariculture

Effect	Technology	Development Phase	Direct /Indirect	Duration	Extent
Smothering	Wave / Wind / Tidal	CC,CD	Direct	Temporary (during installation	50m
Increased turbidity	Wave / Wind / Tidal	CC,CD	Indirect	Temporary (during installation	Negligible
Increased suspended sediment	Wave / Wind / Tidal	CC,CD	Indirect	Temporary (during installation	Negligible
Marine noise (construction)	Wave / Wind / Tidal	CC,CD	Direct	Short term (installation)	80km (maximum)
Marine Noise (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	1km (tidal device based on 8 hours exposure) Negligible (wave device)
Substratum loss	Wave / Wind / Tidal	OD	Direct	Long term (device life)	20km
Decrease in wave exposure	Wave / Wind / Tidal	OD	Direct	Long term (device life)	500m
Decrease in water flow	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Changes in turbidity	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Changes in suspended sediment	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Disturbances of contaminated sediment	Wave / Wind / Tidal	CC,CD	Indirect	Temporary (during installation	Negligible
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

Table 10.15: Summary of Potential Effects on Military Activities

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Disruption to activities during installation	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation areas
Disruption to activities during operation	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Array size (2 km2 – wave; 0.5 km2 - Tidal – 50 km2 - wind) and potentially cable swathe

Table 10.16: Summary of Potential Effects - Disposal Areas

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Disruption to access during installation	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Direct disturbance of contents of disposal sites	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Dependent of area of overlap between disposal site and array
Disruption to access during operation	Wave / Wind / Tidal	OC OD	Direct	Long term (device life)	Array size (2 km2 – wave; 0.5 km2 – tidal; 10km2 - wind) and potentially cable swathe

Table 10.17: Summary of Potential Effects - Shipping and Navigation

Effect	Technology	Development Phase	Direct /Indirect	Duration	Extent
Increased journey times and distances (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	500 m around installation activities
Displacement of shipping density (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Focussed around device arrays if located in areas of high shipping density
Reduced trade/supply (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Focussed around device arrays if located in vicinity of entrances to ports and harbours
Reduced visibility (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Focussed around device arrays where visibility is key to navigation
Collision (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Installation area
Search and rescue	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Focussed around device arrays
Increased journey times and distances (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	50 m around device array
Displacement of shipping density (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Focussed around device arrays if located in areas of high shipping density
Reduced trade/supply (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Focussed around device arrays if located in vicinity of entrances to ports and harbours
Reduced visibility (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Focussed around device arrays where visibility is key to navigation
Collision (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Unknown (development specific)

Effect	Technology	Development Phase	Direct /Indirect	Duration	Extent
Search and rescue	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Focussed around device arrays
Compass deviation (operation)	Wave / Wind / Tidal	OC	Direct	Long term (device life)	Cable routes
Radar, communications and positioning systems (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	50 m around device array (depends on proximity of shipping routes)

Table 10.18: Summary of Potential Environmental Effects on Recreation and Tourism

Effect	Technology	Direct/ Indirect	Duration	Extent
Installation Effects				
Noise Generation	Wave / Wind / Tidal	Indirect	Short term	Unknown
Transportation	Wave / Wind / Tidal	Direct	Temporary	Array area, access routes (marine and land)
Effect on Seascape	Wave / Wind / Tidal	Indirect	Temporary	Effects possible up to 5 to 15 km from shore depending on the device type and seascape character.
Safety and Collision Risk	Wave / Wind / Tidal	Direct	Temporary	Array area
Access Restrictions	Wave / Wind / Tidal	Direct	Temporary	Area around array area. Section of coastline
Reductions in Water Quality	Wave / Wind / Tidal	Indirect	Temporary – Permanent	Unknown
Operation Effects				
Generation of Noise	Wave / Wind / Tidal	Indirect	Permanent	Unknown
Effect on Seascape	Wave / Wind / Tidal	Indirect	Permanent	Effects possible up to 5 to 15 km from shore depending on the device type and seascape character.
Safety and Collision Risk	Wave / Wind / Tidal	Direct	Temporary	Array area
Access Restrictions	Wave / Wind / Tidal	Direct	Temporary	Area around array are
Disturbance to Wildlife	Wave / Wind / Tidal	Indirect	Permanent	Unknown
Energy Extraction	Wave / Wind / Tidal	Indirect	Permanent	Unknown
Creation of Tourist Attraction (positive effect)	Wave / Wind / Tidal	Direct	Permanent	Unknown

Table 10.19: Summary of Potential Effects – Aggregate Extraction and Maintenance Dredging

Effect	Technology	Development Phase	Direct /Indirect	Duration	Extent
Disruption to access during installation	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Disruption to access during operation	Wave / Wind / Tidal	OC OD	Direct	Long term (device life)	Array size (2 km2 – wave; 0.5 km2 – tidal; 10km2 - wind) and potentially cable swathe
Sterilisation of unlicensed aggregate resource areas	Wave / Wind / Tidal	OC OD	Direct	Long term (device life)	Array size (2 km2 – wave; 0.5 km2 – tidal; 10km2 - wind) and potentially cable swathe

Table 10.20: Summary of Potential Effects - Oil and Gas Infrastructure

Effect	Technology	Development Phase	Direct /Indirect	Duration	Extent
Disruption to access during installation	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Disruption to access during operation	Wave / Wind / Tidal	OC OD	Direct	Long term (device life)	Array size (2 km2 – wave; 0.5 km2 – tidal; 10km2 - wind) and potentially cable swathe
Sterilisation of unlicensed oil and gas resource areas	Wave / Wind / Tidal	OC OD	Direct	Long term (device life)	Array size (2 km2 – wave; 0.5 km2 – tidal; 10km2 - wind) and potentially cable swathe

Table 10.21: Summary of Potential Effects on Cables and Pipelines

Effect	Technology	Development phase	Direct /Indirect	Duration	Extent
Direct damage	Wave / Wind / Tidal	CC CD OD OC	Direct	Temporary (during installation or maintenance activities)	Up to 500m from cable and device area
Reduced access	Wave / Wind / Tidal	CC CD OD OC	Direct	Temporary (during installation or maintenance activities) – permanent if development is sited too close to pipelines or cables	Up to 500m from cable and device area

Section 11: Assessment of Assessment Areas

11 Part 2: Assessment Area Assessment

11.1 Introduction

This chapter presents the results from Part 2 of the assessment of effects. The focus of this part of the assessment is to assess in greater detail (although still strategic) the potential effects that the development of offshore wind (fixed and floating) and marine renewable energy developments (wave and tidal) would have on the marine and coastal environment and other marine users in the main Assessment Areas identified in Chapter 8.

This part of the assessment is concerned with identifying the likely interactions and potential effects that could occur as a result of developing certain types of offshore renewable energy in particular locations. It does not take into account the likely size or configuration of individual developments, as these aspects of offshore wind and marine renewable energy development are examined as part of the cumulative assessment (Part 3) the results of which are presented in Chapter 12.

The main results from this assessment are presented in Appendix G and are based on the following information:

- Device characteristics (offshore wind (fixed and floating) and marine renewables) discussed in Chapter 7;
- Assessment Areas based on key areas of potential resource and areas of developer interest as discussed in Chapter 8;
- Baseline characteristics for each of the SEA topics discussed in Chapter 9; and
- Generic environmental effects identified in Chapter 10.

11.2 Assessment Areas

The main aim for this part of the assessment is to provide information in relation to the potential environmental effects that could occur as a result of the development of the main areas of resource (offshore wind, wave and tidal) that are present within Irish waters. The findings from this assessment focus purely on the main type and distribution of potential effects that are likely to occur within each of the Assessment Areas listed below. This information is then used to inform Part 3 of the assessment which assesses the potential environmental effects that varying levels of development e.g. numbers of commercial scale developments and total Megawatts produced, would have on the environment within each of the Assessment Areas, and ultimately across all Assessment Areas within Irish waters.

The focus for the cumulative assessment (Part 3: Chapters 12 and 13) is to provide information to assist the Ocean Energy Development Unit (OEDU) which is part of SEAI and the Department of Communications, Energy and Natural Resources in the preparation of the Offshore Renewable Energy Development Plan (OREDP). This information includes the assessment of ‘scenarios’ for the long term development of offshore renewable energy in Irish Waters. Further information on the specific development scenarios is provided in Chapter 2 and Chapter 12.

11.2.1 Identification of the Assessment Areas

Based on the review of available resources (offshore wind, wave and tidal) presented in Chapter 7, it was identified that both offshore wind and wave resources are present within the majority of Irish waters. Tidal resources, by comparison, tend to occur in smaller, more discrete areas, mainly off the east coast and along the north coast where tidal currents are generally strongest. Given the large extent of both offshore wind and wave resources within the wider study area it was determined necessary to break the study area up into smaller areas or parts in order to make the study area and the assessment of the main areas of resource more manageable.

The study area (defined in Chapter 1: Introduction) and illustrated in Figure 1.1 was therefore divided into a total of seven separate assessment areas. These are listed in Table 11.1 below and illustrated in Figures 11.1 to 11.4. The key factors used to identify these Assessment Areas include:

- The extent of the available resource (theoretical and technical) for offshore wind, wave and tidal based on the information presented in Chapter 8 and illustrated in Figures 8.1 to 8.3.
- Development/operating parameters and constraints associated with each of the technologies as discussed in Chapter 7 and summarised below.
- Feedback from individual developers on current and possible future areas of interest for developments.
- Review of current development patterns taking into account technical feasibility of where development is likely to occur.

The assessment areas identified in Table 11.1 below extend out from the coast (mean high water mark) to a distance of 100km. Consequently the Assessment Areas do not cover entire study area which extends out to the 200m depth contour (which is further than 100km from the coast in some areas off the west and south coast) and to the territorial limit on the east coast (12nm). The 100km limit for the Assessment Areas reflects the current upper length limit of AC export cable technology (i.e. for greater distances DC cables will be required, with converter stations on land to convert to AC).

Table 11.1: Assessment Areas

Assessment Area	Technology	Location
1	Wind	East Coast - North
2	Wind & Tidal	East Coast - South
3	Wind[1]	South Coast
4	Wind & Wave	West Coast - South
5	Wind & Wave	West Coast
5a	Tidal[2]	Shannon Estuary
6	Wind & Wave & Tidal	West Coast - North

Note 1: Wave is not considered in Assessment Area 3, as although there is some offshore technical resource here it was considered to be too far offshore for development within the timeframe of the SEA. It was decided to only consider wave in the more accessible near shore wave resource areas on the southwest, west and northwest coast where developer interest is predicted to be initially focussed (Assessment Areas 4, 5, 6).

Note 2: Only those areas of significant tidal resource suitable for the development of commercial tidal arrays were considered in the assessment. It is recognised that there are a number of smaller discrete areas of tidal resource around the Irish coast. However, due to their scale these areas were only considered to be more suitable for demonstration or test projects rather than full scale commercial developments. The exception to this is the Shannon Estuary where both developers and environmental authorities have indicated that there is interest in the development of a commercial scale tidal array in this area.

11.2.2 Development Outside the Assessment Areas

Although the main focus for this part of the assessment (Part 2) and the cumulative assessment (Part 3) is to assess the potential environmental effects of commercial scale projects within the main Assessment Areas, it should be noted that **the SEA does not preclude any development (demonstration, pre-commercial or commercial) occurring outside of these assessment areas**. Potential effects of developments outside the main Assessment Areas have been identified as part of the Generic Assessment (Chapter 10). Additionally all future developments (excluding those that have already been granted Foreshore Leases or have submitted a Foreshore Lease Application) would still have to be considered on a case by case basis and project level consenting requirements will still apply e.g. EIA. This would apply to demonstration and pre-commercial projects as well as commercial developments.

11.3 Presentation of Assessment Results

There are a number of different variables that have been taken into account in this part of the assessment. These include the key information listed above (e.g. device characteristics, baseline data and assessment area), the individual SEA topics listed in Chapter 1 and possible mitigation measures that can be implemented to avoid, reduce or offset adverse effects.

To illustrate how the different variables have been taken into account in the assessment of the different assessment areas the results have been presented in a series of assessment tables. Each of the tables (Appendix G) includes the following information:

- SEA topics where potential strategic environmental effects could occur.
- Type of the potential effect.
- Phase of the development during which potential effects are likely to occur e.g. installation, operation, maintenance and decommissioning.
- Device characteristics that are likely to give rise to potential effects.
- Device type (wind, wave or tidal).
- Assessment of potential effect (effect without mitigation).
- Summary of key environmental sensitivities (from baseline data) and description of potential effects.
- Description of possible project level mitigation that could be implemented to reduce, avoid or offset potential adverse effects.
- Assessment of likely (residual) effect (effect with mitigation).

11.3.1 Assessment Criteria

To assist with reviewing the results presented in Appendix G (Tables G1 to G2) the assessment criteria presented in Chapter 6: Assessment Method is reproduced below.

Table 11.2: Assessment Criteria for Assessment of Assessment Areas

Potential Effect	Assessment Criteria
Significant Adverse	The precise measure for significant adverse effect varies across the different SEA topics. This is reflected in the results presented in Chapters 11 and 13. However, in general, the key factors influencing the potential for a significant adverse effect to occur generally include: ▪ Permanent, long term or irreversible change in baseline conditions e.g. reduction in quality of baseline environment or negative effect on baseline features (receptors).

Potential Effect	Assessment Criteria
	▪ Direct and indirect negative effect on baseline features of international or European importance e.g. habitats, species and sites designated under the EU Habitats or Birds Directives, where habitats and species are known to be sensitive to interactions from marine devices/offshore wind developments. ▪ Direct and indirect negative effects on baseline features of national importance (e.g. habitats or species of national value/importance) where habitats and species are known to be sensitive to interactions from marine devices/offshore wind developments. ▪ Direct, long term or permanent exclusion from, or disruption to, recognised shipping/navigation channels or fishing grounds of international, European or national importance. It should be noted that each SEA topic, and the baseline environment/features (receptors) associated with that topic, have been considered on a case by case basis. The criteria listed above are generic and have been subject to modification during the assessment to reflect specific characteristics of the baseline environment within Irish waters. However, any modifications will be reflective of the main principles of an assessment of significant adverse effect listed above.
Negative	As above, the measure of negative effect varies across the different SEA topics. However, in general, the key factors influencing the potential for a negative effect to occur include: ▪ Temporary, short term or reversible change in baseline conditions e.g. reduction in quality of baseline environment or effect on baseline features (receptors). ▪ Direct effect on baseline features that are not designated under international, European or national legislation but which are known to be sensitive to interaction with marine devices/offshore wind developments. ▪ Indirect, temporary or short term, disruption to, or exclusion from, main (international, European and national) shipping and navigation channels and fishing grounds. ▪ Direct, long term or permanent disruption to, or exclusion from, local shipping and navigation routes and fishing areas.
Negligible (positive or negative)	Negligible effects are identified where there is likely to be change in baseline, or effect on a baseline feature (receptor), but the level of change/effect will be indiscernible/very slight. Negligible effects may be positive or negative.
Neutral	Neutral effects are identified where the potential effect on the baseline features (receptor) are both positive and negative, thus balancing the overall effect on an SEA topic.
No Effect	The development of marine renewable energy/offshore wind developments in Irish waters will have no effect (e.g. cause no change in baseline conditions).
Positive	The development of marine renewable energy/offshore wind will have a positive effect on the baseline environment/features.
Unknown	Where there is insufficient information available to accurately determine the level and type of potential effect these have be classed as 'unknown' effects. Unknown effects are likely to occur where there is: ▪ A lack of baseline data. ▪ Limited knowledge on how offshore wind (fixed and floating); wave and tidal developments interact with particular baseline features/characteristics. ▪ A lack of knowledge as to whether certain baseline features (receptors) are sensitive to interactions from offshore wind (fixed and floating), wave and tidal developments.

11.3.2 Mitigation Measures

The mitigation measures suggested in Appendix G Tables Appendix G1 to G6 reflect standard good practice in terms of marine development (e.g. standard controls to be implemented during the installation and maintenance of devices based on examples from other marine sectors) and also take into account specific site selection criteria (e.g. avoidance of potential effects though the siting of commercial arrays outside, or away from, designated/protected sites and sensitivity receptors). The mitigation measures that have been suggested are specific to potential effects, receptors and device types.

11.4 Key Findings from the Assessment of the Assessment Areas

Table 11.3 below provides an overview of the main potential effects identified within the Assessment Areas. These are assessed in greater detail in Tables Appendix G1 to G6.

Table 11.4 provides an overview of the main sensitive receptors against which the potential effects summarised in Table 11.3 have been assessed. These are discussed in more detail in the assessment tables (Appendix G Tables Appendix G1 to G6).

Table 11.3: Summary of Potential Effects

Summary of Potential Effects	
Water Soil and Sediment: Geology, Geomorphology, Sediment Processes and Water Quality	**Scouring:** There is potential that the presence of structures on the seabed, in particular piled foundations could lead to localised scouring of the seabed, in particular where the sediment comprises sand and gravel such as in Assessment Areas 1 and 2. Likely significant adverse effects could be reduced by through careful site selection informed by hydrodynamic modelling at the project stage. **Energy extraction:** Likely significant adverse effects on coastal process resulting from the extraction of energy from the existing wave and tidal regime could be reduced or avoided through careful site selection and modelling. **Accidental contamination** from all technologies and vessels as a result of storm damage or failure or collision – should this occur it would have significant adverse effects on water quality, birds, marine mammals, marine reptiles, benthic ecology and fish and shellfish. However, the likelihood of this occurring is low and the risks of contamination from developments can be reduce through appropriate designs and integration of mechanisms to protect against contamination should a device get damaged or failure occur.
Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles	**Substratum Loss:** All three technologies could potentially have significant adverse effects on benthic habitats and species due to substratum loss resulting from the attachment of devices to the seabed and the installation of export cables. These effects are likely to be most significant for piled devices and gravity bases. However, likely significant adverse effects could be avoided/reduced with increased information on species and habitat distributions and appropriate siting of devices and routeing of export cables to avoid sensitive habitats and species. **Habitat Exclusion:** All three technologies could lead to habitat exclusion through occupying areas of the seabed, surface and water column. The overall effect of this is unknown. However, it is likely to be more significant in areas where there are sensitive benthic communities and areas used for breeding (marine mammals), feeding (marine mammals, fish and seabirds) and spawning (fish). Potential likely significant adverse effects could be avoided or reduced by siting developments outside protected sites, breeding, feeding and spawning areas. **Collision Risk:** the potential effects of collision with operational wave and tidal devices on marine mammals, marine reptile's, larger fish species and seabirds (diving and pursuit) are unknown. However, it is likely that these effects will be more significant for tidal devices than wave devices which generally have lower rates of motion and less moving parts. With increased information on species distributions and their interactions with tidal devices and appropriate siting of devices the potential for likely significant adverse effects could be reduced.

Summary of Potential Effects	
Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles	**Collision Risk from Operational Windfarms:** Operational offshore wind farms could potentially have a likely significant adverse effect on birds in flight, in particular on key migratory routes. This is discussed in the assessments in relation to specific wind Assessment Areas. The potential effects of marine mammals, marine reptiles, fish and seabirds colliding with offshore wind turbine foundation structures is likely to be negligible and the level of harm would be low given there are no moving parts. **Noise from the Installation of Piled Devices:** In terms of the installation of devices the most significant source of noise is from the piling of offshore wind and tidal turbine foundations. Noise from piling activities can have significant adverse effects on marine mammals, marine reptiles, fish and possibility seabirds (diving and pursuit feeders) in terms of habitat exclusion, disorientation and physical damage from noise vibrations (mainly in fish such as cod). Although likely significant adverse effects can be reduced by avoiding breeding and spawning seasons, using marine mammal observers and implementing measures such as exclusion areas, passive noise monitoring, pingers or bubble curtains there is still potential for significant adverse effects to occur. **Noise from the Operation of Tidal Devices:** In terms of the three technologies, tidal devices currently have the greatest potential to generate underwater noise from the frequent and regular movement of submerged turbines (wave moving parts tend to be located on or above the surface and wind moving parts are all above the surface). Noise from operational tidal devices could potentially affect fish, marine mammals and seabirds (diving and pursuit) in terms of habitat exclusion, barriers to movement (see below) and disorientation. However, the likely significance of these potential effects is currently unknown due to limited information/monitoring data from operational devices and absence of commercial scale developments. **Barriers to Movement:** There is still uncertainty over the potential effects of commercial arrays (all device types) on marine mammals, marine reptiles and fish (particularly migratory species e.g. salmon) in terms of creating barriers to movement. Barriers to movement are more likely to occur in constrained areas e.g. Lough mouths, inter-island channels and around headlands. These tend to coincide with areas of tidal resource. The potential causes of barriers to movement include noise from arrays/devices, a perceived risk of harm and presence of physical barriers, which are more likely be caused by tidal developments although large wave arrays may create physical barriers. Therefore, although the precise effects in terms of barriers to movement are unknown. **Hydraulic Impacts:** There is potential that the pressure differentials created by shrouded tidal devices could lead to internal injury or mortality of fish. Although the precise nature of the effects are still unknown, there is potential for adverse effects to be avoided by using screens to prevent fish entering the devices and avoiding migratory routes and spawning and nursery areas. Through the implementation of this mitigation there should be no significant adverse effects on fish.

Summary of Potential Effects	
Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles	**EMF:** Whilst there is no evidence that operating power cables have caused a change to behaviour and migration for marine fish and mammal species, there is evidence that some species of fish can detect electric fields, and circumstantial evidence that cetaceans can detect magnetic fields. Given that most of the existing anecdotal evidence demonstrating lack of an avoidance reaction is based on operating single interconnectors, there is potential that cumulatively a number of interturbine cables within arrays or export cables could cause a more concentrated effect. However, furher research is needed to quantify the likely significance of this effect.
Cultural Heritage Including Archaeological Heritage	**Damage or loss of archaeological remains/ historical features:** there is potential that device installation and cabling activities could have a significant adverse effect on archaeological sites and features (marine and coastal). However, with site investigations prior to construction and the appropriate siting of devices and routing of cables, any potential effects should be avoided or substantially reduced. Any residual effects are likely to be negligible.
Commercial Fisheries, Shellfisheries and Aquaculture	**Direct disturbance of commercial fishing grounds:** the physical presence of devices or noise generated by piling activities and the operation of devices could potentially have a significant adverse effect on fishing grounds. However, through appropriate siting of developments and avoidance of key fishing rounds any likely significant adverse effects should be avoided. Any residual effects are likely to be negative to negligible. **Long term displacement from fishing grounds:** The presence of an offshore renewable energy development in certain locations could lead to the displacement of fishermen from key fishing grounds. Although, through the appropriate siting of developments potential adverse effects could be reduced the likely significance of the effect depends on the importance of the fishing ground and whether displacement would lead to increased pressure on stocks in other areas. **Recovery of fish stocks:** the exclusion of commercial fishing activities from certain areas could have a positive effect on the recovery of fish stocks in certain locations. **Disturbance and smothering to fish farms (shell and fin):** the main shellfish and fin fish farming areas are classified as technical constraints in terms of development to be avoided by any offshore renewable energy developments. However, there is still a need to consider the potential effects of routeing export cables near to/through shell or fin fish farmed areas in terms of substratum loss or disturbance and smothering from sediment. All shell and fin fish farms would need to be avoided as part of the design of the detailed cable routes to prevent any likely significant adverse effects from cabling activities.

Summary of Potential Effects	
Population and Human Health: Ports, Shipping and Navigation	**Reduced navigational safety**: the presence of offshore renewable energy developments (all types) in navigational and shipping channel can affect navigational safety and increase the risk of collision either directly or by displacing vessels into areas where there is a higher intensity of vessels movements. The likely significance of these effects depends on the type of development and the intensity of vessel movements in certain locations. In terms of the device types the level of displacement is likely to be greater for offshore wind and wave developments as these tend to occupy larger areas than tidal developments which have much higher energy densities and therefore occupy smaller areas. Wind and wave devices also occupy entire water column (wind) or sea surface (wave) where as tidal devices could potentially be fully submerged at depths which would allow shipping and tidal developments to co-exist. In areas of high vessel movements, any adverse residual effects are likely to be significant. In areas of lower vessel densities the likely significance of any potential effects is likely to reduce to negative or negligible. **Increased navigational safety:** in some locations the presence of an offshore renewable energy development may act as a navigational aid by marking out and creating an area of exclusion around potentially hazardous areas of water such as submerged sandbanks. However, the likely significance of this potential effect will depend upon the number of vessel movements in an area and the overall effects of the development in terms of wider displacement of vessel movements into other, shipping channels.
Population and Human Health: Recreation and Tourism	**Direct disruption to recreational activities:** there are a number of marine and coastal recreational activities that occur within all of the Assessment Areas across the study area that could potentially be directly affected or disrupted by commercial offshore renewable energy developments. These include recreational cruising/sailing areas and routes, areas of recreational sea angling/fishing, and key watersport locations for surfing/windsufing and dingy sailing. The likely residual significance of these effects depends on the sensitivity and importance of the activity in a certain areas. Any likely significant adverse effects can be reduced by siting developments outside the main sailing and watersports areas. Navigational aids may also be required for developments located near to main recreational sailing routes to reduce the potential for collision risk. **Indirect effects on recreational assets/features:** potential effects on wildlife, bathing water quality and seascape/visual amenity are covered under the specific topics. However, there is potential that any likely significant adverse effects on these features would also have indirect effects on these important recreational assets. Measures to reducing or avoiding likely significant adverse effects are discussed in reference to the relevant SEA subjects.

Summary of Potential Effects	
Population and Human Health: Aviation and Military Exercise	**Aviation collision risk:** there is potential for aircraft to collide with devices that protrude above the surface water (mainly offshore wind developments). The potential effects of this collision risk are likely to be adverse significance where developments are located on main flight paths to and from airports. There is also a potential for collision with search and rescue operations (helicopter and plane). However, the likely significance of these potential effect can be reduced by siting developments away from major flight paths and search and rescue deployment areas and ensuring offshore wind turbines are lit with aviation lights in accordance with the 'Offshore Wind Farms Conspicuity Requirements' (OAM 09/02). **Radar interference:** potential effects from radar interference are only likely to be generated by offshore wind farm developments as wave and tidal devices generally do not protrude more than a few meters above the water surface. Offshore wind developments located within areas identified as having 'Potential to Interfere' (NERL areas), could potentially have a likely significant adverse effects on radar interference. However, given that there are no 'Potential to Interfere' areas within any of the Assessment Areas the likely significance of any potential effects on radar interference is unknown, although it is likely that these effects would be negative where there is potential for a development to cause intermittent signal deflections or shadowing where radar becomes weaker behind turbines. **Disruption to military activities:** although some information is available, the precise nature of the defence activities that occur within each of the Assessment Areas is currently unknown. Further consultation with the Department of Defence would be required at the EIA stage for any project in the study area in order to ascertain the potential effects on military activities and the likely significance of those effects.
Population and Human Health: Dredging and Disposal Areas	**Access restrictions to existing dredging and disposal sites:** depending upon the location of offshore renewable energy developments, these could potentially restrict access to existing dredging and disposal sites. However, any likely significant adverse effects on these areas would be avoided or significantly reduce through the implementation of exclusion areas around the dredging and disposal areas and other recognised good practice. **Sterilisation or restricted access to potential aggregate dredging or extraction areas:** when identifying locations for future offshore renewable energy developments it will be necessary to identify all potential aggregate dredging/extraction sites. Further consultation will be required at the project EIA stage to determine the likelihood for the sites to be taken forward as dredging or extraction areas and the likely timescale for these activities to take place in order to determine the potential effect of an offshore renewable energy development on that resource.

Summary of Potential Effects	
Population and Human Health: Landscape and Visual	**Effects on seascape:** in general the potential effects of offshore windfarm developments on seascape and visual amenity are likely to be of greater significance than wave and tidal developments as a much larger proportion of the development is visible above the water surface. However, wave and tidal developments could also potentially have likely significant adverse effects on seascape and visual amenity depending on their scale, distance off shore and the sensitivity and character of the receiving seascape. For example operating conditions for some technologies may only be found in nearshore/coastal locations where as other technologies operate in much deeper offshore locations, where potential effects on seascape and visual amenity are likely to be less significant due to the greater distance from shore. Most of the Irish coast is considered to be of moderate to high seascape value with the west coast being of particularly high seascape value. Therefore it is likely that, in these more sensitive locations, offshore wind farm developments and some wave and tidal developments depending on the type of device used, could potential have likely significant adverse effects on seascape and visual amenity. However, the overall significant of the potential effects depends in a range of factors including distance from shore. More detailed seascape and visual assessments would be required at the project stage for any development to determine the actual likely significance of any development in any of the Assessment Areas. Where significant adverse effects are likely to occur these could be reduced by increasing the distance of the development from shore or changing the configuration/layout or siting of a particular development.
Material Assets: Oil and Gas Infrastructure and Cables	**Direct damage to cables and oil and gas pipelines:** A number of cables and pipelines pass through the different assessment areas. Although direct damage to a cable or pipeline would have significant adverse effects as telecommunications or gas and electricity supplies could be severely disrupted, there are recognised guidelines (ICPC), protocols (e.g. crossing agreements) and buffer areas (usually 500m) that would have to be adhered to by developers. Application of these guidelines, protocols and buffer areas would avoid or significantly reduce the risk of adverse effects occurring. **Access restrictions to “Licensing Option” and “Exploration Licence” areas.** As with potential future aggregate dredging/extraction sites, further consultation will be required at the project EIA stage to determine the likelihood for further exploration to taken place in certain areas or for an areas to be developed and the likely timescale for these activities to take place in order to determine the potential effect of an offshore renewable energy development on that resource.

Summary of Potential Effects	
Climate: Renewable Energy Developments and Gas Storage	**Positive effects on combating climate change:** the development of offshore renewable energy will have a positive effect on climate change in terms of combating potential adverse effects that are attributed to climate change offsetting carbon emissions from other sources of electricity e.g. coal or gas powered power stations. **Sterilisation of gas storage areas:** although the viability and practicalities of storing gas and carbon offshore are still being investigated there is potential that, in the future appropriate sites could be located within Irish waters. At present no specific areas of gas or carbon storage have been identified within the main Assessment Area or wider study area. However, there is potential that the presence of piled devices (offshore wind, wave or tidal) could sterilise potential future areas of search for gas and carbon storage. Given that there are no identified areas within the study area at present the potential effects on the sterilisation of these areas is unknown.

Table 11.4: Summary of Key Sensitive Receptors

Water Soil and Sediment: Geology, Geomorphology, Sediment Processes and Water Quality		
Assessment Area	Sensitive Receptors	
	Seabed Sediment and Geology	Sources of Contamination
Assessment Area 1	▪ The offshore geology within this assessment area is Basement and some Triassic in the south of the area. ▪ Seabed sediments are predominantly, sand, muddy sand and mud in the north of the assessment area, becoming slightly sandy gravel and sandy gravel in the south. ▪ Characterised by a softer coastal landscape than the western Atlantic coasts with stretches of sand dunes, shingle and estuarine mud.	▪ There are four non compliant and eight mandatory compliant bathing water sites within this assessment area ▪ There is one sewage sludge disposal site located within the 12nm limit in the south of this assessment area
Assessment Area 2	▪ The geology within this assessment area is a mixture of Basement and Triassic. ▪ Seabed sediments are a mixture of sandy gravel and sand throughout this assessment area. Areas of Diamicton are located further offshore outside of the 60m contour. ▪ There is an area of undifferentiated solid rock around the headland to the south of Wexford which is in the far south of this assessment area. ▪ Characterised by a softer coastal landscape than the western Atlantic coasts with stretches of sand dunes, shingle and estuarine mud.	▪ All bathing water quality sites with the exception of one site in the far north of the assessment area at Bray are compliant with the guidance. ▪ There is a fish waste and fish waste and dredge spoil disposal site located in the far south east this assessment area at Wexford
Assessment Area 3	▪ The geology within this assessment area is a mixture of Basement and Triassic. ▪ Within the east of the assessment area the seabed sediments are predominantly sand, slightly gravelly sand and some areas of sandy gravel. Closer inshore within the 60m contour there are areas of bedrock and coarse sediment, mixed sediment and Rock and Diamicton. ▪ The west of the study area has to the west of Kinsale has not yet been categorised. ▪ Characterised by a softer coastal landscape than the western Atlantic coasts with stretches of sand dunes, shingle and estuarine mud.	▪ There is one bathing water site at Dungarvan which is none compliant. A further four sites are mandatory compliant. ▪ There is an industrial waste disposal site off the coast at Cork within the 60m contour ▪ There is a methanol disposal site located on the south outside of the 12nm limit within this assessment area
Assessment Area 4	▪ The geology within this assessment area is Basement ▪ Not all areas with this assessment area have been categorised by the INFOMAR. Areas within Dunmanus Bay and Bantry Bay have been classified as mud and sandy mud and sand and muddy sand. A large area outside of the 60m contour has also been categorised as mud and sandy mud with areas of bed rock. ▪ Coastline characterised by cliffs, islands, rocky shores and storm beaches.	▪ All bathing water sites are compliant with the guidance within this assessment area ▪ There are two fish waste disposal sites at Clear Island and to the south of Skellig Rocks
Assessment Area 5	▪ The geology of this assessment area is predominantly Upper Palaeozoic in the south and Basement in the north. There are some areas of Triassic on the edge of the study area and an intrusive body in the far west of the study area. ▪ Very few areas within this assessment area have been classified by INFOMAR. An area to the west of Kerry Head has been classified as containing a mixture of coarse sediment, sand and muddy sand and bedrock. A second area in Galway Bay has been classified as containing mud and sandy mud and sand and muddy sand. ▪ Small areas in Clew Bay and Blacksod Bay have also been classified. ▪ Coastline characterised by cliffs, islands, rocky shores and storm beaches.	▪ There are two bathing water sites within this assessment area that are non compliant these are at Kilkieran Bay and Killadoon, a further two are classified as mandatory compliant. ▪ There is a fish waste disposal area within Clew Bay.
Assessment Area 6	▪ The geology in this assessment area is a mixture of Basement and Upper Palaeozoic. There are some areas of Igneous Rock off the north coast and Triassic around the edge of the study area. There is one intrusive body located off on the western edge of the study area. ▪ A large area of seabed sediments within the north of this assessment area has been classified by INFOMAR, the majority of which has been classified as coarse sediment. ▪ A small section of Donegal Bay has also been classified where the sediments have been identified to be sand and muddy sand and bedrock with some areas of till. ▪ Coastline characterised by cliffs, islands, rocky shores and storm beaches.	▪ There are no non compliant bathing water quality sites within this assessment area. There is one mandatory site at Silgo Bay.

Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles			
Assessment Area	**SEA Subject**	**Sensitive Receptors**	
Assessment Area 1	**Benthic and Intertidal Ecology**	Key benthic habitats ▪ Intertidal mudflats (e.g. Dundalk Bay), potential maerl beds (Carlingford Lough), sea-pen and burrowing megafauna communities (Irish Sea Muds), Zostera beds (Carlingford Lough), potential biogenic and rocky reef habitat.	▪ SACs designated for benthic habitats and species: ▪ Dundalk Bay SAC, Carlingford Shore SAC, Boyne Coast and Estuary SAC, Rogerstown Estuary SAC, North Dublin Bay SAC, South Dublin Bay SAC, Malahide Estuary SAC, Baldoyle Bay SAC. Sandbanks which are slightly covered by seawater at all times ▪ Bennet, Burford, Kish, Frazer
	Fish and Shellfish	Fish species: ▪ There are a number of Basking Shark sightings throughout this assessment area, however these are not as prevalent as the sightings within assessment areas 3, 4 and 6. ▪ Mackerel nursery areas area located throughout this assessment area, there are no mackerel spawning areas. ▪ Cod nursery areas are located throughout this assessment area, generally within the 12nm limit with the exception of in the north where these areas are also outside. Cod spawning areas are also present within the same boundaries. ▪ Haddock nursery areas are located throughout this assessment area with the exception of the far south and east. Spawning areas are located within the 12nm limit. ▪ A small area of a Herring nursery area is located within the 60m contour in the north of this assessment area ▪ Horse Mackerel nursery areas are located throughout this assessment area, however, there are no spawning areas. ▪ Whiting nursery areas are located throughout this assessment area with the exception of the far south. Spawning areas are generally located within the 12nm limit. ▪ Other pelagic fish species, Atlantic salmon, sea trout and eels are also present.	Shellfish species: ▪ *Nephrops,* cockles, razor clams, periwinkles
	Seabirds	Special Protection Areas (SPAs): ▪ Howth Head Coast SPA, Ireland's Eye SPA, Lambay Island SPA, Rockabill SPA, Skerries Islands SPA, Carlingford Lough SPA, Stabannan-Braganstown SPA, Dundalk Bay SPA, Boyne Estuary SPA, River Nanny Estuary and Shore SPA, Rogerstown Estuary SPA, Broadmeadow Sowrds Estuary SPA, Baldoyle Bay SPA, North Bull Island SPA, Sandymount Strand/Tolka Estuary SPA, Dun Laoghaire-Rathdown SPA, Dalkey Islands Ramsar Sites: ▪ Dundalk Bay, Rogerstown Estuary, Broadmeadow Estuary, Baldoyle Bay, North Bull Island, Sandymount Strand/Tolka Estuary.	Important Bird Areas (IBAs): ▪ Carlingford Lough IBA, Dundalk Bay IBA, Boyne Estuary IBA, Nanny Estuary and Shoreline IBA, Rockabill IBA, Skerries Islands IBA, Rogerstown Estuary IBA, Lamabay Island IBA, Malahide/Broadmeadow Estuary IBA, Baldoyle Bay IBA, Irelands's Eye IBA, Howth Heath IBA, Dublin Bay. Seabird Colony Counts ▪ Seabird colonies are concentred in the south of the assessment area with the largest colony counts of the entire study area 30,000-70,000 off the Fingal Coast to the north of Dublin.
	Marine Mammals	▪ There are a number of populations of Harbour Seal (2003 estimate) within this assessment area the most significant of which is within Carlingford Lough. ▪ There are a number of breeding populations of Grey Seal (2005 estimate) within this assessment area the most significant population (101-500) located off the Fingal Coast. ▪ Significant number of sightings of Harbour Porpoise within this assessment area ▪ There have been sightings of Bottlenose Dolphin throughout this assessment area. ▪ A number of cetacean species (e.g. baleen whales) occur in both inshore and offshore waters in the Assessment Area	SACs designated for marine mammals: ▪ Lambay Island SAC designated for Grey Seals.
	Reptiles	Some sightings of leatherback turtles but less than other Assessment Areas.	
	MPSs	Ballyness Bay, Dundalk Bay and North Dublin Bay. All three are designated for Intertidal mudflats Malahide Estuary which is designated for Zostera beds.	

Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles

Assessment Area	SEA Subject	Sensitive Receptors	
Assessment Area 2	**Benthic and Intertidal Ecology**	Key benthic habitats: ▪ Intertidal mudflats (e.g. Dublin Bay, The Burrow, Rosslare Point), biogenic and rocky reef habitat (Wicklow Reef SAC), *Modiolus modiolus* communities (St David's Head), sea-pen and burrowing megafauna (Lambay Head), tidal rapid and reef habitat – throughout the area.	SACs designated for benthic habitats and species: ▪ Wicklow Reef SAC, Slaney River Valley SAC, Carnsore Point SAC. Sandbanks slightly covered by seawater at all times ▪ Bray, Codling, India, Arklow, Seven, Fathom Bank, Glassgorman, Rusk, Blackwater /Moneyweights, Lucifer, Long and Holdens Banks. Estuaries ▪ River Nore (Wexford)
	Fish and Shellfish	Fish species: ▪ Isolated (occasional) Basking Shark sightings within this assessment area ▪ Mackerel nursery areas area located throughout this assessment area, there are no spawning areas ▪ Cod nursery areas area located throughout this assessment area within the 60m contour, there are no spawning areas ▪ Horse Mackerel nursery areas are located throughout this assessment area, there are no spawning areas ▪ A small nursery and spawning area for Whiting is located in the far south of this assessment area ▪ Atlantic salmon, sea trout and eels are also present	Shellfish species: ▪ Edible crab, scallops, oysters, periwinkles, whelks
	Seabirds	Special Protection Areas (SPAs): ▪ Wicklow Head SPA, Kilcoole Marshes SPA, Lady's Island Lake SPA, Tacumshin Lake SPA, Wexford Harbour and Slobs SPA, The Raven SPA, Tacumshin Lake SPA, The Murrough. Ramsar Sites: ▪ The Raven	Important Bird Areas (IBAs): ▪ North Wicklow Coastal Marshes IBA, Wicklow Head IBA, Cahore Marshes IBA, Wexford Harbour and Slobs IBA, Lady's Island Lake IBA, Tacumshin Lake IBA. Seabird Colony Counts ▪ Isolated seabird colonies, fewer than any other assessment area, the most significant of these have colony counts of 500-2500 at Wicklow and Carnsore Point in the far south of this assessment area
	Marine Mammals	▪ One small (10-22 (2003 estimate)) isolated population of Harbour Seal within this assessment area at Wexford (Loch Garman) ▪ Two small populations (0-10 (2005 estimate) of Grey Seal in the south at Wexford (Loch Garman) and in the north Wicklow. ▪ There have been sightings of Harbour Porpoise throughout this assessment area, however less prevalent than other areas. ▪ Sightings of Bottlenose Dolphins within in this assessment area, however fewer and amore isolated than the other assessment areas.	▪ Slaney River Valley / Raven Point nature Reserve SAC is designated for Otter.
	Reptiles	Some sightings of leatherback turtles	
	MPAs	None present within this assessment area	

Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles			
Assessment Area	**SEA Subject**	**Sensitive Receptors**	
Assessment Area 3	**Benthic and Intertidal Ecology**	Key benthic habitats: ▪ Intertidal mudflats (e.g. Clonakilty Harbour outer, Inner Ballymacoda, Inner Dungarvan Harbour, Waterford Harbour, Wexford Harbour and Bannow Bay), Zostera beds (Kinsale Harbour), potential biogenic and rocky reef habitat. Estuaries: ▪ River Barrow (Waterford) and Blackwater (Cork).	SACs designated for benthic habitats and species: ▪ Carnsore Point SAC, Lady's Island Lake SAC, Saltee Islands SAC, Hook Head SAC, Bannow Bay SAC, River Barrow and River Nore SAC, Tramore Dunes and Backstrand, Ballymacoda (Clonpriest and Pillmore) SAC, Great Island Channel SAC, Courtmacsherry Estuary SAC, Clonakilty Bay SAC.
	Fish and Shellfish	Fish species: ▪ Significant number of Basking Shark sightings particularly in the west of this assessment area. ▪ Mackerel nursery areas are located throughout this assessment area with the exception of the far south west. Spawning areas located in the south and south west outside of the 12nm limit. ▪ Cod nursery areas are located along the length of the coast within this assessment area within the 60m contour. Spawning areas are located in the east within the 12nm limit. ▪ A Haddock nursery area is located along and just outside the 12nm limit with the exception of the far west. Spawning areas are generally throughout with the exception of within the 60m contour in the east. ▪ Hake nursery areas are located throughout this assessment area with the exception of near shore areas. There are no spawning areas ▪ Pockets of Herring nursery and spawning areas are located in near shore areas along this coastline within this assessment area ▪ Megrim nursery areas are located throughout this assessment area outside of the 60m contour. A spawning area is locate in the far west outside of the 12nm limit ▪ Whiting nursery and spawning areas throughout this assessment area within the 12nm limit. ▪ White Belly Angler Monk nursery area is located in the west of this assessment area ▪ Black Belly Angler Monk is located in the far south west of this area outside of the 12nm limit ▪ Other pelagic fish species, Atlantic salmon, sea trout and eels are also present	Shellfish species: ▪ Lobster, crayfish, edible crab, velvet crab, shrimp, *Nephrops,* scallops, Periwinkles
	Seabirds	Special Protection Areas (SPAs): ▪ Saltee Islands SPA, Helvick Head SPA, Sovereign Islands SPA, Old Head of Kinsale SPA, Ballyteigue Burrow SPA. Ramsar Sites: ▪ Bannow Bay, Tramore Backstrand, Dungarvan Harbour, Blackwater Estuary, Ballymacoda, Ballycotton Bay, Cork Harbour.	Important Bird Areas (IBAs): ▪ Saltee Islands IBA, The Cull/Killag IBA, Keeragh Islands IBA, Bannow Bay IBA, Tramore Backstrand IBA, Dungarvan Harbour IBA, Helvick Head IBA, Blackwater Estuary IBA, Ballymacoda IBA, Ballycotton, Ballynamona and Shanagarry IBA, Cork Harbour IBA, Sovereign Islands IBA, Old Head of Kinsale IBA, Inner Clonakilty Bay IBA. Seabird Colony Counts ▪ Seabird colonies are present along the majority of the assessment area with the most significant count 10,000 – 30,000 on Saltee Island.
	Marine Mammals	▪ Small, isolated populations of Harbour Seal within this assessment area 10-22 (2003 estimate) population within Kinsale Bay and a smaller population estimate of 1-9 in Dungarvan Harbour. ▪ Small breeding populations 0-10 (2005 estimate) of Grey Seal in the far west of this assessment area in Roscarbery Bay. A larger (501-1000) isolated breeding population is located to the far east of this assessment area at Ballyteige Bay. ▪ This assessment area has the highest number of Harbour Porpoise sightings of all six assessment areas in particular in the west. ▪ Bottlenose Dolphin sightings are prevalent throughout this assessment area. ▪ High number of cetacean species sightings (fin and humpback whales are seasonally abundant)	SACs designated for marine mammals: ▪ Saltee Islands SAC is designated for grey seals ▪ River Barrow and River Nore / Blackwater River (Cork/Waterford) SACs are designated for the presence of Otter.
	Reptiles	Important area for sightings of leatherback turtles	
	MPAs	Tramore Dunes and Mudflats, this site is designated for Intertidal mudflats and Zoster beds	
Assessment Area 4	**Benthic and Intertidal**	Key benthic habitats:	SACs designated for benthic habitats and species:

Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles			
Assessment Area	**SEA Subject**	**Sensitive Receptors**	
	Ecology	▪ Intertidal mudflats (Castlemaine Harbour), Maerl beds (Tralee Bay, Sneem Harbour, Ardgroom Harbour, Valentia Island, Roaringwater Bay, Bantry Bay, Castle Island Sound, and Kenmare River), Ostrea edulis beds (Tralee Bay), sea-pen and burrowing megafauna communities (Kenmare River, Sneem Harbour, Lough Hyne, Bantry Bay and Berehaven), Zostera beds (Tralee Bay, Castlemaine Harbour, Valentia Island, Roaringwater Bay, Castle Island Sound), potential biogenic and rocky reef habitat.	▪ Lough Hyne Nature Reserve and Enviros SAC, Roaringwater Bay and Islands SAC, Blackwater River (Kerry) SAC, Balliskelligs Bay and Estuary SAC, Valencia Harbour/Portmagee Channel SAC, Castlemaine Harbour SAC, Blasket Islands SAC, Kenmare River SAC. Estuaries ▪ Shannon
	Fish and Shellfish	▪ Significant number of Basking Shark sightings within this assessment area ▪ Mackerel nursery areas are located along the length of the coastline, within and just outside of the 12nm limit. Spawning areas located throughout area outside of the 12nm limit. ▪ Cod nursery areas are located along the coast largely within or just outside the 60m contour ▪ Small nursery area for Blue Whiting is located in the far west of this assessment area, spawning areas are located outside of the study area ▪ A small Haddock nursery area is located in the far north of this assessment area and a spawning ground in the far south. ▪ Hake nursery areas are located throughout this assessment area with the exception of near shore areas, spawning areas are located outside of the 12nm limit. ▪ Herring nursery and some spawning grounds are located within the 60m contour ▪ Horse Mackerel nursery areas are located throughout the whole of this assessment areas, spawning areas are also located throughout with the exception within the 60m contour. ▪ Megrim nursery and spawning areas are located throughout this assessment area partly inside and outside of the 12nm limit ▪ Whiting nursery areas are located throughout this assessment area within the 12nm limit. Spawning areas are located in the south of this assessment area within the 12nm limit ▪ White Belly Angler Monk nursery areas are located throughout this assessment area with the exception of near shore areas ▪ Black Belly Angler Monk nursery areas are located throughout this assessment area with the exception of near shore areas ▪ Other pelagic fish species, Atlantic salmon, sea trout and eels are also present	Shellfish species: ▪ Lobster, edible crab, crayfish, velvet crab, shrimp, *Nephrops*, scallops, oysters, periwinkles
	Seabirds	Special Protection Areas (SPAs): ▪ Bull & Cow Rocks SPA, Skelligs SPA, Puffin Island SPA, Deenish & Scariff Island SPA, Blasket Islands SPA, Iveragh Peninsula SPA, Beara Peninsula SPA, Sheep's Head Toe Head SPA, Castlemaine Harbour SPA. Ramsar Sites: ▪ Castlemaine Harbour.	Important Bird Areas (IBAs) ▪ Sheeps Head and Mizen Head Peninsulas IBA, Beara Peninsula IBA, Bull and Cow Rocks IBA, Iveragh Peninsula IBA, The Skelligs: Great Skellig and Little Skellig IBA, Puffin Island IBA, Castlemaine Harbour IBA, Blasket Islands IBA, Dingle Peninsula Seabird Colony Counts ▪ Seabird colonies are prevalent along the majority of this assessment area with significant populations of 10,000 – 30,000 at Skellig Rocks and Blasket Islands
	Marine Mammals	▪ Harbour Seal populations are prevalent in this assessment area with high concentrations in Kenmare Bay and Bantry Bay ▪ Breeding populations estimates of 500-1000 (in 2005) in the far south (Dunmanus Bay) and the far north (off the Dingle Peninsular) of this assessment area. ▪ Sightings of Harbour Porpoise are prevalent in this assessment area ▪ Sightings of Bottlenose Dolphins are common in this assessment area.	SACs designated for marine mammals: ▪ Roaringwater Bay and Islands SAC and Blasket Island SAC are designated for Grey Seals ▪ Roaringwater Bay and Islands SAC, Glengarriff Harbour and Woodland SAC, Kenmare River SAC and Castlemine Harbour SAC are designated for Otter ▪ Glengarriff Harbour and Woodland SAC and Kenmare River SAC are designated for Harbour Seal ▪ Roaringwater Bay and Islands SAC and Blasket Island SAC are designated for Harbour Porpoise
	Reptiles	Important area for sightings of leatherback turtles.	
	MPAs	▪ Blasket Island designated for Phoecena phoecena,	

Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles			
Assessment Area	**SEA Subject**	**Sensitive Receptors**	
		▪ Kenmare River designated for Maerl Beds, ▪ Roaringwater Bay and Islands designated for Maerl beds, Zostera beds and Phoecena phoecena. ▪ Belgica Mound Province designated for Lophelia pertusa reefs ▪ South West Porcupine Bank which is designated for Lophelia pertusa reefs	
Assessment Area 5	**Benthic and Intertidal Ecology**	Key benthic habitats: ▪ Intertidal mudflats (Inner Galway Bay), maerl beds (Mannin Bay Kilkieran Bay), sea-pen and burrowing megafauna communities (Manning Bay, Kilkieran Bay), Zostera beds (Poulnasherry Bay – Shannon, Mannin Bay, Kilkieran Bay, Blacksod Bay and Broadhaven), potential biogenic and rocky reef habitat Sandbanks slightly covered by seawater at all times ▪ Ballybunion and Turbot/Kilstiffin Banks	SACs designated for benthic habitats and species: ▪ Tralee Bay and Magharees Peninsula, West of Cloghane SAC, Magharee Islands SAC, Kerry Head Shoal SAC, Lower River Shannon SAC, Galway Bay Complex SAC, Clew Bay Complex SAC, Kilkieran Bay and Islands SAC, Kilkee Reefs SAC, Carrowmore Point to Spanish Point and Islands SAC, Carrowmore Dunes SAC, Black Head-Poulsallagh Complex SAC, Inishmore Island SAC, Slyne Head Peninsula SAC, Sylne Head Islands SAC, Kingstown Bay SAC, Bellacragher Saltmarsh SAC, Achill Head SAC, Mullet/Blacksod Bay Complex SAC, Duvillaun Islands SAC, Inishkea Islands SAC
	Fish and Shellfish	Fish species ▪ Occasional and isolated sightings of Basking Shark within this assessment area ▪ Mackerel nursery area is located along the length of the coastline of this assessment area, spawning grounds are also located on the edge of the study area. ▪ Cod nursery areas are located along the whole length of the coastline within the 12nm limit. ▪ Blue Whiting nursery areas are located outside of the 12nm limit within this assessment areas, there is also a small pocked of spawning area on the edge of the study area. ▪ A nursery and spawning area for Haddock is located off the coast at Galway within this assessment area ▪ Hake nursery area within and outside of the 12nm limit with the exception of the far north is located within this assessment area. Spawning areas are located on the edge of the study area along the whole length of this assessment area. ▪ A Herring nursery area is located within Galway Bay and spawning areas are located intermittently along the coast within the 12nm limit in this assessment area ▪ A Horse Mackerel nursery is located throughout this assessment area. Spawning areas are located throughout the majority of the assessment area with the exception of the near shore areas. ▪ Megrim spawning and nursery areas are located throughout the majority of this assessment area with the exception of the near shore areas and the outside of the 12nm limit in the far south of this assessment area ▪ A Whiting nursery and spawning area is located within Galway Bay. ▪ White Belly Angler Monk nursery area is located throughout the majority of this assessment area with the exception of small area in the far north west and some of the near shore areas ▪ Black Belly Angler nursery area is located in the south of this assessment area just outside and along the 12nm limit ▪ Pelagic fish species, Atlantic salmon, sea trout and eel are also present.	Shellfish species: ▪ Lobster, edible crab, crayfish, velvet crab, shrimp, *Nephrops,* scallops, oysters, periwinkles.
	Seabirds	Special Protection Areas (SPAs): ▪ Termoncarragh lake and Annagh Machair SPA, Inishglora and Inishkeeragh SPA, Inishkea Islands SPA, Duvillaun Island SPA, Bill Rocks SPA, Clare Island SPA, Cross Lough (Mullet) SPA, Cross Lough (Killadoon) SPA, High Island SPA, Cruagh Island SPA, Slyne Head Island SPA, Inner Galway Bay SPA, Cliffs of Moher SPA, Mid Clare Coast SPA, Illauninearaun SPA, Loop Head SPA, Kerry Head SPA, Akeragh, Banna and Barrow Harbour SPA, Tralee Bay SPA, Magharee Island SPA, Dingle Peninsula SPA, Lough Corrib SPA. Ramsar Sites:	Important Bird Areas (IBAs): ▪ Lough Gill IBA, Tralee Bay and Barrow Harbour IBA, Magharee Islands, Mucklaghmore and Illaunbarnagh IBA, Loop Head IBA, Illaunonearaun IBA, Mid Clare Coast including Mutton and Mittle Islands IBA, Cliffs of Moher IBA, Aran Islands (parts) IBA, Inner Galway Bay IBA, Roundstone Bog IBA, Connemara Islands IBA, High Island IBA, Inishbofin and Inishshark (including Davillaun) IBA, Cross Lough (Killadoon) IBA, Clare Island Cliffs IBA, Duvillaun Islands IBA, Inishkea Islands IBA, Inishglora and Inishkeeragh IBA. Seabird Colony Counts

Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles			
Assessment Area	**SEA Subject**	**Sensitive Receptors**	
		▪ Tralee Bay, Inner Galway Bay, Lough Corrib, Owenduff Catchment,	▪ Large number of seabird colonies throughout this assessment area, however there are no colonies with counts over 10,000
	Marine Mammals	▪ Large number of Harbour Seal populations (2003 estimate) within the north of this assessment area with significant populations (>60) in Galway Bay. Sparse populations within the south (off the coast of County Clare) ▪ Significant Breeding populations (2005 estimate) of Grey Seals off the Galway and Mayo Coasts with populations of >1000 identified around the islands of Inishshark and Inishbofin and within Blacksod Bay. ▪ Significant number of sightings of Harbour Porpoise within Galway Bay ▪ Sightings of Bottlenose Dolphins are prevalent along the whole of the coastline of this assessment area. ▪ Suggested migratory corridor for humpback whales	SACs designated for marine mammals: ▪ Slyne Head Island SAC, Inishbofin and Inishshark SAC, Duvillaun Islands SAC and Inishkea Islands SAC are designated for Grey Seal ▪ Lower River Shannon SAC is designated for the Bottlenose Dolphin ▪ Tralee Bay and Maghareers Peninsula West to Cloghane SAC, Lower River Shannon SAC, Galway Bay Complex SAC, Kilkieran Bay and Islands SAC, Clew Bay Complex SAC and Mullet / Blacksod Bay Complex SAC are designated for Otters. ▪ Galway Bay Complex SAC, Kilkieran Bay and Islands SAC and Clew Bay Complex SAC are designated for Harbour Seal
	Marine Mammals	▪ Large number of Harbour Seal populations (2003 estimate) within the north of this assessment area with significant populations (>60) in Galway Bay. Sparse populations within the south (off the coast of County Clare) ▪ Significant Breeding populations (2005 estimate) of Grey Seals off the Galway and Mayo Coasts with populations of >1000 identified around the islands of Inishshark and Inishbofin and within Blacksod Bay. ▪ Significant number of sightings of Harbour Porpoise within Galway Bay ▪ Sightings of Bottlenose Dolphins are prevalent along the whole of the coastline of this assessment area. ▪ Suggested migratory corridor for humpback whales	SACs designated for marine mammals: ▪ Slyne Head Island SAC, Inishbofin and Inishshark SAC, Duvillaun Islands SAC and Inishkea Islands SAC are designated for Grey Seal ▪ Lower River Shannon SAC is designated for the Bottlenose Dolphin ▪ Tralee Bay and Maghareers Peninsula West to Cloghane SAC, Lower River Shannon SAC, Galway Bay Complex SAC, Kilkieran Bay and Islands SAC, Clew Bay Complex SAC and Mullet / Blacksod Bay Complex SAC are designated for Otters. ▪ Galway Bay Complex SAC, Kilkieran Bay and Islands SAC and Clew Bay Complex SAC are designated for Harbour Seal
	Reptiles	Important area for sightings of leatherback turtles.	
	MPAs	Galway Bay Complex designated for intertidal mudflats and Maerl beds; Kilkieran Bay designated for Maerl beds and Zostera beds; Kingstown Bay is designated for Maerl beds and Zostera beds; and Mullet/Blacksod Bay designated for intertidal mudflats, Maerl beds and Zostera beds. Hovland Mound Province which is designated for Lophelia pertusa reefs North West Porcupine Bank which is also designated for Lophelia pertusa reefs	
Assessment Area 6	**Benthic and Intertidal Ecology**	Key benthic habitats: ▪ Intertidal mudflats (Ballysadare Bay – Sligo Bay, Gweebarra Estuary, Donegal Bay), maerl beds (St John's Point, Mulroy Bay), zostera beds (Inner Drumcliff Bay – Sligo Bay, Aranmore, S. Donegal Bay, Mulroy Bay, Lough Swilly and Lough Foyle), potential biogenic and rocky reef habitat.	SACs designated for benthic habitats and species: ▪ Broadheaven Bay SAC, Killala Bay/Moy Estuary SAC, Ballysadare Bay SAC, Ben Bulben, Geniff and Glenade Complex SAC, Streedagh Point Dunes SAC, Bunduff Lough and Machair/Trawalua/Mullaghmore SAC, Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC, Donegal Bay SAC, St John's Point SAC, Slieve League SAC, West of Ardara/Maas Road SAC, Rutland Island and Sound SAC, Ballyness Bay SAC, Sheephaven SAC, Tory Island Coast SAC, Horn Head and Rinclevan SAC, Tranarossan and Melmore Lough SAC, Lough Swilly SAC, North Inishowen SAC, Mulroy Bay SAC
	Fish and Shellfish	Fish species: ▪ Significant number of Basking Shark sightings in particular off the northern coast within this assessment area. ▪ Mackerel nursery areas through the entire assessment area with Mackerel spawning areas in the south and the west. ▪ Cod nursery areas along the entire coastline of this assessment area ▪ Blue Whiting spawning and nursery areas out to sea to the west and south of this assessment area outside of the study area ▪ Haddock nursery area is located off the north coast of this assessment area and a Haddock spawning areas is located off the west coast (The Rosses) of this assessment area.	Shellfish species: ▪ Lobster, edible crab, velvet crab, crayfish, shrimp, *Nephrops,* scallops, oysters, cockles, periwinkles, whelks

Biodiversity, Flora and Fauna: Fish, Shellfish, Marine Mammals, Seabirds and Marine Reptiles			
Assessment Area	**SEA Subject**	**Sensitive Receptors**	
		▪ A Hake nursery area is located off the north coast and spawning areas to the west of this assessment area. ▪ Herring nursery and spawning areas are located intermittently along the coastline of this assessment area ▪ Horse Mackerel nursery area is located throughout this assessment area, however there are no spawning areas ▪ Megrim nursery and spawning areas is located throughout this assessment area ▪ Whiting spawning areas are located throughout this assessment area out to the 12nm limit. There are no nursery areas within this assessment area ▪ A White Belly Angler Monk nursery area is located between the 12nm limit and the edge of the study areas within this assessment area ▪ A small Black Belly Angler Monk nursery area is located in the edge of the study area. ▪ Other pelagic fish species, Atlantic salmon, sea trout and eels are also present.	
	Seabirds	Special Protection Area (SPAs) ▪ Inishtrahull SPA, Trawbreaga Bay SPA, Lough Foyle SPA, Inch Lough and levels SPA, Lough Swilly SPA, Greers Isle SPA, Horn Head SPA, Tory Island SPA, Inishbofin SPA, Inishdooey and Inishbeg SPA, Sheskinmore Lough SPA, Cummeen Strand SPA, Killala Bay/Moy Estuary SPA, Illanmaster SPA, Stags of Broad Haven SPA, Blacksod Bay / Broadhaven SPA, West Donergal Coast SPA, Illancrone and Inishkeeragh SPA, Roaninish SPA, Inishsirrer and Inishmeane SPA, Inishkeel SPA, Rathlin O'Birne Island SPA, Inishduff SPA, Donergal Bay SPA, Inishmurray SPA, Ardboline Island and Horse Island SPA, Drumcliff Bay SPA, Ballysadare Bay IBA, Aughris Head SPA. Ramsar Sites: ▪ Blacksod Bay and Broadhaven, Killala Bay/Moy Estuary, Cummeen Strand, Trawbreaga Bay	Important Bird Areas (IBAs): ▪ Broadhaven, Blacksod and Tullaghan Bays and parts of the Mullet Peninsula IBA, Illaunmaistir (Oilean Maistir) IBA, Inishsirrer and Inishmeane IBA, Falcarragh to Min an Chladaigh IBA, Inishbofin, Inisdooey and Inisbeg IBA, Tory Island IBA, Horn Head Cliffs IBA, Dunfanaghy New Lake IBA, Fanad Head Peninsula IBA, Greer's Island (Massmount), Mulroy Bay IBA, Lough Swilly including Blanket Nook and Inch Lake IBA, Trawbreaga Bay IBA, Malin Head IBA, Inishtrahull. Seabird Colony Counts ▪ Seabird colonies are prevalent throughout this assessment area with large concentrations n the south west and north of the assessment area, however there are no counts greater than 10,000
	Marine Mammals	▪ Significant populations (2003 estimate) of Harbour Seal >60 at Killala Bay, Silgo Bay and Donegal Bay. Other smaller populations are present throughout this assessment area. ▪ Significant breeding population >1000 of Grey Seals (2005 estimate) within Gweebarra Bay. Smaller populations present along much of the coastline within this assessment area. ▪ Harbour Porpoise sightings along the majority of the coastline with the largest number within Donegal Bay. ▪ Bottlenose Dolphin sightings along the majority of the coastline.	SACs designated for marine mammals: ▪ Slieve Tooey/Tormore Island/Loughros Beg Bay SAC and Horn Head and Rinclevan SAC are designated for Grey Seals ▪ Slieve Tooey/Tormore Island/Loughros Beg Bay SAC, West of Ardara/Maas Road SAC, Gweedor bay and island SAC, Mulray Bay SAC, Lough Swilly SAC and North Inishowen Coast SAC are designated for Otters ▪ Killala Bay / Moy Estuary SAC, Ballysadare Bay SAC, Cummeen Strand / Drumcliff Bay (Silgo Bay) SAC, Donegal Bay SAC, West of Ardara / Maas Road SAC and Rutland Island SAC are designated for harbour Seals.
	Reptiles	▪ Leatherback sea turtles (historically Donegal has the third highest numbers of sightings in Ireland)	
	MPAs	▪ Cummeen strand / Drumcliff Bay (Silgo Bay) designated for intertidal mudflats. ▪ Mulroy Bay designated for Maerl beds and Zostera beds.	

Assessment Area	Sensitive Receptors	
Cultural Heritage Including Archaeological Heritage		
	Archaeological Remain	Wrecks and Other Features
All Assessment Areas	There are a number of archaeological remains and sites of local, regional and national importance are present along the entire coast of Ireland.	There are numerous recorded wreck sites, listed buildings and National Monuments (including those in State care) are present along the coastline in all areas including the wreck of RMS Lusitania in Area 3) There are also a number of areas with potential for early settlement sites and unrecorded wrecks
Assessment Area 1	Wold Heritage Sites ▪ The Archaeological Ensemble of the Bend of Boyne is situated on the north banks of the River Boyne 50km to the north of Dublin. Potential Prehistoric Sites ▪ Glacial lake shores extend along the length of this assessment area with the exception of the far north. These are likely to of been occupied during the late Palaeolithic and Mesolithic periods.	Wrecks ▪ There are 10 chartered wrecks within this assessment area ▪ There are a further 979 recorded wrecks off the coast of Dublin and 302 off Louth and Meath.
Assessment Area 2	Potential Prehistoric Sites ▪ Glacial lake shores extend along the length of this assessment area with the exception of the far south. These are likely to of been occupied during the late Palaeolithic and Mesolithic periods	Wrecks ▪ There are 5 chartered wrecks within this assessment area ▪ There are a further 1602 recorded wrecks off Wexford and 478 off Wicklow.
Assessment Area 3	Potential Prehistoric Sites ▪ An area of Drowned Estuaries and Inlets is located outside of the 12nm limit in the west of this assessment area and extends eastwards to the study area boundary. It is likely this site contains evidence of settlement sites inhabited by fishing communities.	Wrecks ▪ There are 61 chartered wrecks within this assessment area ▪ There are a further 1652 recorded wrecks off the coast of Cork, 652 off Waterford and 1602 off Wexford
Assessment Area 4	World Heritage Sites ▪ Skellig Michael is located within this assessment area, it is of outstanding universal value and an exceptional and unique example of an early religious settlement. Potential Prehistoric Sites ▪ Sheltered Bays are present along the majority of this assessment area within the 100m contour may have provided sheltered settlement sites.	Wrecks ▪ There is 1 chartered wrecks within this assessment area, this is within Dingle Bay ▪ There are a further 467 recorded wrecks off the coast of Kerry and 1652 off the coast of Cork.
Assessment Area 5	Potential Prehistoric Sites ▪ Sheltered Bays are present along the majority of this assessment area within the 100m contour may have provided sheltered settlement sites.	Wrecks ▪ There is 1 chartered wreck within this assessment area, this is off the coast of 'The Mullet' in the far north. ▪ There are also a further 279 recorded wreck sites off the coast of Mayo, 310 off Galway, 211 off Clare, 64 off Limerick and 467 off the coast of Kerry.
Assessment Area 6	Potential Prehistoric Sites ▪ No potential prehistoric sites are located within this assessment area.	Wrecks ▪ There are approximately 145 chartered wrecks within this assessment area, these are predominantly located in the north. ▪ There are a further 923 recorded wreck sites off the coast of Donegal, 89 off the coast of Silgo and 279 off the coast of Mayo

Assessment Area	Sensitive Receptors			
Commercial Fisheries, Shellfisheries and Aquaculture				
	Shell fisheries	**Fin fisheries**	**Spawning Grounds**	**Aquaculture**
Assessment Area 1	▪ *Nephrops,* cockles, razor clams, whelk.	▪ Whitefish, whiting, haddock, black sole, plaice	▪ Cod, within the 60m contour throughout this assessment area ▪ Haddock, within the 60m contour throughout this assessment area ▪ Whiting, generally within the 60m contour except in the north where these grounds extend past the study area boundary.	▪ Oyster sites in Carlingford Lough with a further couple of sites located in the south of Dundalk Bay ▪ Mussel Clam sites are concentrated in Carlingford Lough ▪ A Plant site is also located in Carlingford Lough ▪ Two Cockle sites are located in the north and south of Dundalk Bay.
Assessment Area 2	▪ Whelk, scallop.	▪ Cod, ray species, black sole, plaice	▪ Cod, a small area of spawning ground extends into the far south of this assessment area ▪ ,Whiting in the far south off the coast at Wexford from the coast to the study area boundary	▪ The only sites in this assessment area are for Mussels within the Rosslare harbour area
Assessment Area 3	▪ *Nephrops,* edible crab, lobster, shrimp, scallop, crayfish, whelk, oyster.	▪ Herring, cod, haddock, whiting, Angler fish, megrim, hake, black sole, plaice, ling	▪ Mackerel, throughout the west of the assessment area outside of the 60m contour. ▪ Cod, within the east of this assessment area within the 12nm limit ▪ Haddock, throughout the majority of this assessment area with the exception of near shore areas within the 60m contour in the east. ▪ Horse Mackerel, throughout the west of the assessment area outside of the 60m contour ▪ Megrim, within the far west of this assessment area outside of the 12nm limit ▪ Whiting, throughout the whole assessment area within the 12nm limit.	▪ There are Pacific oysters sites located within Ballyteige Bay, Dungavan Harbour, Younghal Bay and Kinsale Bay ▪ Mussel sites are concentrated in the River Barrow Estuary, Dungavan Harbour, Younhal Bay and Kinsale Bay with the largest concentration in the River barrow Estuary. ▪ Clam sites are located in Ballyteige Bay, Dungavan Harbour, Younghal Bay, Cork Harbour and Kinsale Bay ▪ A Plant site is located at Dungavan Harbour Aquaculture sites with development potential ▪ Dunmanus Bay
Assessment Area 4	▪ Edible crab, lobster, shrimp, spider crab, *Nephrops,* scallop, crayfish.	▪ Angler fish, megrim, black sole, plaice, hake, haddock	▪ Mackerel, throughout the whole of this assessment area outside of the 12nm limit ▪ Haddock, small area in the south east of this assessment area outside of the 12nm limit ▪ Hake, throughout this assessment area outside of the 12nm limit ▪ Horse Mackerel, throughout this assessment area with the exception of inside the 60m contour and near shore areas ▪ Megrim, throughout this assessment area outside and just inside the 12nm limit ▪ Whiting., through the southern half of this assessment area within the 12nm limit	▪ Scallop sites are located off the coast of Crookhaven, Bantry Bay, Kenmare River Estuary and the south and north of Dingle Bay ▪ Mussel sites are located in the far south of this assessment area, Dunmanus Bay, Bantry Bay, Kenmare River Estuary and Dingle Bay ▪ Salmon sites are located in Bantry Bay and Kenmare River Estuary ▪ A Saltwater Trout site is also located in Bantry Bay ▪ Scallop sites are located in the south of the assessment area, Bantry Bay, Kenmare River Estuary and the south and north of Dingle Bay ▪ Clam sites are located in the south of the assessment area, Dunmanus Bay, Bantry Bay, Kenmare River Estuary and the south of Dingle Bay ▪ Urchin sites are located in Dunmanus Bay, Bantry Bay ▪ Plant sites are located in the far south, Bantry Bay and the north of Dingle Bay

Assessment Area	Sensitive Receptors			
Commercial Fisheries, Shellfisheries and Aquaculture				
Assessment Area 5	▪ *Nephrops,* edible crab, spider crab, lobster, shrimp, oyster, crayfish	▪ Haddock, megrim, black sole, hake, Angler fish	▪ Mackerel within the far west of this assessment area just within the study area boundary ▪ Blue Whiting within the far west of this assessment area just within the study area boundary ▪ Haddock, small area either side of the 12nm limit adjacent to Galway Bay ▪ Hake within the far west of this assessment area just within the study area boundary ▪ Herring, within the 60m contour intermittently along the coast ▪ Horse Mackerel, throughout the majority of this assessment area outside of the 60m contour ▪ Megrim throughout the majority of this assessment area outside of the 60m contour ▪ Whiting, a small area within Galway Bay	▪ A Large number of Pacific Oyster sites are located within this assessment area, significant concentrations of sites are located in the Mouth of Shannon, Galway Bay, Clew Bay and Blacksod Bay ▪ Mussel sites are located in Mouth of Shannon, Galway Bay, Lough Corrib, Kilkeran Bay, Mannin Bay, Clew Bay and Blacksod Bay ▪ Salmon, Saltwater Trout, Cod and Turbot sites are located along the coast from Galway Bay to Clew Bay ▪ Scallop sites are located in Brandon Bay, Lough Corrib and Clew Bay. ▪ Clam sites are located in Galway Bay, Lough Corrib and Clew Bay ▪ Abalone, Urchin and Plant sites are also located in this assessment area. Aquaculture sites with development potential ▪ North east of Inisheer Island, north east of Skerd Rock and east of Inishturk Island.
Assessment Area 6	▪ *Nephrops*, crab, lobster, shrimp, oyster	▪ Cod, haddock, whiting, megrim, black sole, plaice, rays, ling	▪ Mackerel, within the west of this assessment area generally outside of the 12nm limit ▪ Haddock, a small area from Troy Island in the north to Rathlin O'Birne Island in the south either side of the 12nm limit ▪ Hake, in the far west of this assessment area just within the study area boundary. ▪ Herring, intermittently along the coast within the 12nm limit ▪ Megrim throughout this assessment area, generally outside of the 12nm limit ▪ Whiting, throughout this study area, generally within the 12nm limit	▪ Pacific Oyster sites are located in Killala Bay, Silgo Bay, Donegal Bay, Gweebarra Bay, Rosses Bay, Sheep Haven and Lough Swilly ▪ Mussel sites are located in Silgo Bay, Donegal Bay, Gweebarra Bay, Rosses Bay, Sheep Haven and Lough Swilly ▪ Salmon sites are located in Donegal Bay and Lough Swilly and a saltwater trout site is located in Donegal Bay. ▪ Scallop sites are located to the east of Sheep Haven ▪ Clam sites are located in Killala Bay, Silgo Bay, Donegal Bay, Gweebarra Bay, Rosses Bay and Sheep Haven. ▪ A Plant site is located in Silgo Bay, two Urchin sites are located in Donegal Bay and a number of Abalone sites are located to the east of Sheep Haven. Aquaculture sites with development potential ▪ North east of Gola Island

Population and Human Health: Ports, Shipping and Navigation		
	Shipping Intensity	**Ports and Harbours**
Assessment Area 1	▪ Shipping intensity is high with 5001-10,0000 vessels recorded at some locations in and out of the port of Dublin, in particular for passenger vessels. ▪ There are a number of indicative navigation channels into Carlingford Lough, Dundalk and two into Dublin.	▪ Main commercial ports include Dublin, Drogheda, Dun Laoghaire, Greenore. ▪ Main fishing ports include Balbriggan, Clogherhead, Dun Laoghaire, Howth, Skerries ▪ Dublin is a major ferry port ▪ There are near shore anchorage areas in Carlingford Lough, Dundalk Bay and the north and south of Dublin Bay.
Assessment Area 2	▪ Shipping intensity is high in particular for cargo vessels with high numbers of passenger vessels (5001 to 10,000) in and out of the port of Wexford. ▪ There is one indicative navigation channel within this assessment area to Rosslare. ▪ A traffic separation scheme (Tuskar Rocks) is located along the indicative navigation channel to Rosslare	▪ Rosslare is the only major commercial and ferry ports ▪ There are fishing ports and smaller commercial ports (Arklow, Wicklow and Courtown) ▪ Near shore anchorage areas are located at Bray and off the coast at Arklow and Courtown

Assessment Area	Sensitive Receptors	
Commercial Fisheries, Shellfisheries and Aquaculture		
Assessment Area 3	▪ Shipping density is moderate with high density close to the ports of Waterford and Cork ▪ Indicative navigation channels are located to Waterford and Cork	▪ Two major ports: Cork and Waterford and Youghal ▪ Fishing ports are located at Killmore Quay, Duncannon, Dunmore East, Ballycotton, Cobh, Crosshaven, Kinsale and Union Hall. ▪ Local Ferry ports are located at Duncannon and Cobh ▪ Near shore anchorage areas are located at Waterford, off the coast at Kinsale and Union Hall.
Assessment Area 4	▪ Shipping intensity is moderate to low with a moderate amount of tankers and cargo and a low amount of passenger vessels ▪ There is one indicative navigation channel into Bantry Bay ▪ Fastnet Rocks Traffic Separation Scheme is located off the south coast of the assessment area to the south of Crookhaven	▪ Two major ports: Bantry Bay and Castletownbere ▪ There are fishing ports at Skull, Bantry Bay, Castletownbere (this is the second busiest fishing port), Portmagee, Valentia, Cromane and An Daingean (Dingle) (this is the third busiest of the Irish Fishing Ports) ▪ There are local ferry ports at Baltimore, Skull, Castletownbere, Valentia and Cromane ▪ There are numerous off shore anchorage areas in Dunmanus Bay, Bantry Bay Kenmare River Mouth and in the north of Dingle Bay. ▪ Numerous fishing ports along the coast
Assessment Area 5	▪ Shipping intensity is moderate to low with a moderate amount of cargo vessels and Tankers to Galway. Passenger vessel intensity is low with the exception of Rossaveel to the Aran Islands. ▪ There is one main indicative navigation channel in the south of this assessment area. This separates into three spurs, one to Fenit a second to Kilrush and Shannon Foynes and a much smaller third spur to Galway. A second channel also enters Galway from the west.	▪ The main commercial ports are Shannon Foynes and Kilrush ▪ There are fishing ports at Castlegregory, Fenit, Carrigaholt, Galway, Inisheer, Inishmore, Inishmaan, Rossaveel, Carna, Achill and Belmullet ▪ Local ferry ports are located at Shannon Foynes, Kilrush, Galway, Inisheer, Inishmore, Inishmaan, Rossaveel and a number around Clew Bay. ▪ Near shore anchorage areas are generally located in the Mouth of Shannon, Kilkeran Bay and Blacksod Bay
Assessment Area 6	▪ Shipping intensity is moderate to low with a moderate amount of cargo vessels. ▪ There are two indicative navigation channels, one to Silgo with two spurs to Ballina and Killybegs and a second in the north to Greencastle	▪ Two major ports: Sligo and Killybegs ▪ Fishing ports are located at Killybegs which is the busiest fishing port in Ireland, Burton Point, Downings, Rathmullan, Malin Head and Greencastle ▪ Local ferry ports are located at Burton Point, Greencastle and a number along the coast of Rosses bay and Tory Sound ▪ There are a number of near shore anchorage areas located in Killala bay, Silgo Bay, Donegal Bay, Gweebarra Bay and Lough Swilly
Population and Human Health: Recreation and Tourism		
	Cruising Routes, Sailing	**Blue Flag Beaches, Wildlife Watching and Surfing, Coastal Walks**
Assessment Areas 1	▪ The following marinas are located within this assessment area, Malahide, Howth, Dublin City Moorings and Dun Laoghaire. ▪ There are a large number of sailing clubs along the coast within this assessment area with the highest concentration in Dublin Bay.	▪ There are 23 Blue Flag Beaches within the counties of Louth, Meath, Dublin Fingal, Dublin City Council, Dun Laoghaire- Rathdown and Wicklow. ▪ There are two coastal walks within this assessment area, Donabate and Portrane and Howth Head
Assessment Areas 2	▪ There is one Marina located within this assessment area at Arklow ▪ Greystones Sailing Club, Wicklow Sailing Club, Arklow Sailing Club, Courtown Sailing Club and Wexford Harbour Boat and Tennis Club are located within this assessment area	▪ East Coast Surf Club is located to the south of Bray within this assessment area ▪ There are 10 Blue Flag Beaches five located in Wicklow and five in Wexford ▪ There are three costal walks within this assessment area, Bray Head, Carnsore Point and Raven Point.
Assessment Areas 3	▪ There are nine marinas within this assessment area, these are, Kilmore Quay, Waterford City, East Ferry, Royal Cork Yacht Club Salve, Crosshaven Boatyard, Trident Hotel, Castlepark, Kinsale Yacht Club and Courtmacsherry Pontoon ▪ Moorings are located at Helvick, Ballycotton and Glandore ▪ There are a large number of sailing clubs concentrated around Waterford and Cork	▪ The following surf clubs are located within this assessment area, T-Bay and Cork ▪ Surf spots are located at Tramore, Tramore left, Ireland Perfect Wave, Annestown, Bunmahon, Ardmore, Ballycotton, Inch, Fennels Bay, Fennels Bay Reef, Oysterhaven, Garretstown, Inchydoney, Ownachincha, Long-strand and Red Strand. ▪ 17 Blue Flag beaches are located within this assessment area, one in Wexford, six in Waterford and ten in Cork. ▪ There are two coastal walks within this assessment area, Ardmore Head and Great Island.

Assessment Area	Sensitive Receptors	
Commercial Fisheries, Shellfisheries and Aquaculture		
Assessment Areas 4	▪ There are six marinas within this assessment area, these are, Baltimore Pntoon, Sea horse, Lawrance Cove, Dromquinna Pontoon, Cahersiveen and Dingle Marina. ▪ Moorings are located at Crookhaven, Schull, Castletownbere, Cork, Lawrence Cove, Adrigole, Glengarriff, Derrynane, Sneem, Portmagee, Knightstown, Kells, Ventry and Smerwick ▪ The fowling sailing clubs are located within this assessment area, Baltimore, Glenans, Crookhavan, Schull Harbour, Schull Community College, Bantry Bay, Valentia Island and Dingle Sailing Club.	▪ Kerry Surf Club is the only Surf Club located within this assessment area ▪ Surf spots are located at Barley Cove, Derrynane, Ballinskelligs, Saint Finan's Bay, Rossbeigh, Arnascaul Rivermouth, Coumeenole, Smerwick Harbour and Ballydavid ▪ Ten blue flag beaches are located within this assessment area, two in Cork and eight in Kerry. ▪ There are twelve coastal walks within this assessment area, Bere Island long and short walks, Cape Clear Island, Derrtnane Bay, Dursey Island, Great Blasket Island, Kerry Head, Mizen Head, Sheeps Head, Sherkin Island, Slea Head and Valentia Island.
Assessment Areas 5	▪ There are six marinas located within this assessment area located at Fenit Harbour, Kilrush, Glin Pontoon, Foynes Yacht Club Pontoon, Kildysart Pontoon and Galway City Marina. ▪ Moorings are located at labasheeda, Carrigaholt, Kilronan, Sruthan, Kiggaul, Maumeen, Kilkieran, Roundstone, Clifden, Fahy Bay, Leenane, Inishturk, Clare Island, Blacksod, Elly Bay and Ballyglass. ▪ The following sailing clubs are within this assessment area, Tralee Bay, Jeanie Johnston, STV, Irish Windsurfing Association, University of Limerick Sailing Club, Foynes Yacht Club, Royal Western Yacht Club, Univeristy of Limericjk Staff Sailing Club, Cullaun Sailing Club, Galway Bay Sailing Club, Galway, Corrib Rowing and Tachting Club, Badoiri Lurgan, Ballinduff bay Water Sports Club, Clifden Boat Club, Mayo Sailing Club, Ballacragher Bay Boast Club and Achill Powerboat Club	▪ Four surf clubs are located within this assessment area these are, Free Riders of Limerick, West Coast, Connemara and Achill Surf Clubs. ▪ Surf spots are located at Tralee Bay, Brandon Bay, Stoney Gap, Sandy Bay, Mossies, Banna Strand – Sandy Lane, Gary William point, Ballybunion, Doonbeg Castle, Doughmore, Killard, Spanish Point Reefs, Spanish Point Beach, Lahinch Beach, Cornish Reef, Lahinch, Doolin Point, Crab Island, Fanore, Doonloughin, Killadoon, Dooega, Dooagh Reef, Doogort. ▪ There are 39 Blue Flag Beaches within this assessment area across the counties of Kerry, Clare, Galway and Mayo. ▪ There are fourteen coastal walks within this assessment area, these are, Clare Island, Croaghaun and Achill Head, Inis Meain, Inis Mor, Inis Oirr, Inishbofin, Inishturk, Killary Harbour, Loop Head, Minaun Cliffs Achill Island, Omey Island, the Magharees and the Three Sisters.
Assessment Areas 6	▪ There are six marinas within this assessment area these are, Rthmullen Pntoonm, Fahan Creek, Lough Swilly, Foyle Pontoon, Coleraine and Seatons Marinas. ▪ Moorings are located at Kilcummin, Teelin, Portnoo / Inishkeel, Aranmore, Downings, Portsalon, Moville and Culdaff ▪ The following sailing clubs are located within this assessment area: Sligo Yacht Club, Mullaghmore Sailing Club, Donegal Bay Rib Club, Rosgoil Boat Club, LYIT, Lough Swilly Yacht Club, Inishtrahull Cruising Club and Moville Boat Club.	▪ Eight Surf Clubs and located within this assessment area, these are, West Sligo Surf Club, Co.Sligo Surf Club, North Sligo Surf Club, Bundoran Board Riders, irish Soul Surfers, Rossnowlagh, Causeway Coast and Christian Surfers Network surf clubs. ▪ Surf sports are located at Bunatrahir Bay, Pollacheeny Harbour, Inishcrone, Kilcummin Harbour, Lackan Bay, Easky, Dumnoran Strand, Strandhill, Lighthouse, Ballyconnel, Sueedagh Strands, Mullaghmore, Tullagh, Budoran, Rossnowlagh, Muckros, Lochross Point, Loughros Beg, Gweebarra, Dunfanaghy, Ballymastoker, Ballyhiernan Bay, Magillian Point, Portballintrae, Castlerock Down, White Rocks and Black Rocks. ▪ There are 24 blue flag beaches located within this assessment area within the counties of Mayo, Sligo, and Donegal. ▪ There are thirteen coastal walks within this assessment area, these are, Arranmore Island, Belderrig to Portacloy, Benwee Head, Bloody Foreland, Clonmany and Binnion, Downpatrick Head , Glencolumbcille, Horn Head, Inishowen Head, Malin Head, melmore Head, Slieve League and Tory Island.
Population and Human Health: Aviation and Military Exercise		
	Aerodromes and Radar	**Military Exercise**
Assessment Area 1	▪ Three aerodromes in the vicinity (two civil and one military) ▪ No 'Potential to Interfere' areas	▪ Gormanstown Department of Defence danger area ▪ Fishery protection and search and rescue operations.
Assessment Area 2	▪ There are no aerodromes in the vicinity ▪ No 'Potential to Interfere' areas	▪ There are no Department of Defence danger areas. ▪ Fishery protection and search and rescue operations.
Assessment Area 3	▪ Two aerodromes in the vicinity (both civil) ▪ No 'Potential to Interfere' areas	▪ Department of Defence danger area D13 off Clonakilty Bay. ▪ Area used for fleet exercises and submarine exercise and transit, although no ammunition firing is undertaken in this area. ▪ Fishery protection and search and rescue operations
Assessment Area 4	▪ Two aerodromes in the vicinity (both civil) ▪ No 'Potential to Interfere' areas	▪ Department of Defence danger area D14 off Dursey Island and Skelling Rocks ▪ Fishery protection and search and rescue operations.

Assessment Area	Sensitive Receptors	
Commercial Fisheries, Shellfisheries and Aquaculture		
Assessment Area 5	▪ Eight aerodromes in the vicinity (all civil) ▪ Two radar installations ▪ Valentia and Malin Head Search and Rescue ▪ “Low-fly” exclusion area covering the River Shannon for marine rescue helicopters operating out of Shannon Airport. ▪ No ‘Potential to Interfere’ areas	▪ There are no Department of Defence danger areas ▪ Area used for fleet exercises and submarine exercise and transit in the north of this assessment area, although no ammunition firing is undertaken in this area
Assessment Area 6	▪ Two aerodromes in the vicinity (civil) ▪ One radar installation ▪ No ‘Potential to Interfere’ areas	▪ There are no Department of Defence danger areas ▪ Much of the area is used for fleet exercises and submarine exercise and transit, although no ammunition firing is undertaken
Population and Human Health: Dredging and Disposal Areas		
	Aggregate Dredging and Extraction	**Dredge Disposal Areas**
Assessment Area 1	▪ No existing aggregate dredging areas. ▪ There is a sand aggregate resource potential in the south of this assessment area.	▪ Nine dredge disposal sites, these are concentrated around the north of Dundalk Bay, off the coast at Droghed Dublin. ▪ There is one sewage sludge disposal site located off the coast at Dublin.
Assessment Area 2	▪ No existing aggregate dredging areas. ▪ 11 potential aggregate extraction areas (sand and gravel). Potential sand extraction sites cover the majority of the assessment area, where those for gravel and mixed aggregates are in the north off the coast at Bray.	▪ Three dredge disposal sites at Bray, Wicklow and Arklow ▪ One fish waste disposal site in the south of the assessment area at Wexford ▪ One fish waste and dredge spoil disposal site within Wexford Bay.
Assessment Area 3	▪ No existing aggregate dredging areas. ▪ One potential aggregate extraction area for sand in the far east of this assessment area to the east of Wexford.	▪ Five dredge disposal sites located within this assessment area at Tomhaggard, port of Waterford, Kinsale, and Roasscarbery Bay. ▪ One methanol disposal site which is located outside of the 12nm limit off the coast at Cork. ▪ One industrial waste disposal site, just inside the 60m contour at Cork ▪ One rock dredge disposal site in the east of this assessment area at Kilmore Quay
Assessment Area 4	▪ There is one Maerl extraction site in Bantry Bay to the east of Bare Island. ▪ No potential aggregate extraction areas identified.	▪ One dredge disposal sites in Bantry Bay ▪ Two fish waste disposal sites located off Cape Clear and south of Dursey Island. ▪ One rock dredge disposal site in the north of Dingle Bay
Assessment Area 5	▪ No existing aggregate dredging areas. ▪ No potential aggregate extraction areas identified.	▪ Sixteen dredge disposal sites located at Ballyheige Bay, and large concentration in the River Shannon, Galway Bay and off the coast of Inishshark and Inishbofin ▪ One fish waste disposal site in Clew Bay ▪ One rock and dredge spoil disposal site in the River Shannon
Assessment Area 6	▪ No existing aggregate dredging areas. ▪ No potential aggregate extraction areas identified.	▪ Two dredge disposal sites one in Donegal Bay and a second in Rosses Bay ▪ Two rock dredge disposal sites in Gweebarra Bay and to the west of Troy Island.

Assessment Area	Sensitive Receptors	
Seascape		
	Landscape/Seascape Designations	**Seascape Character Types**
Assessment Area 1	Wold Heritage Sites ▪ The Archaeological Ensemble of the Bend of Boyne is situated on the north banks of the River Boyne 50km to the north of Dublin. Potential nominees to the World Heritage List (2009) ▪ Dublin – A Georgian City and its Literary Tradition National Parks ▪ Wicklow Mountains National Park County Landscape Designations ▪ Outstanding Natural Beauty areas and Special Amenity Areas in Wicklow ▪ Protected Views and Prospects (Dun Loachaire) ▪ Areas of High Landscape Amenity (Fingal) ▪ Sensitive and Exceptional Landscape Value areas (Meath) ▪ Landscape Value and Sensitivity (Lough) National level designations in transboundary areas of Northern Ireland ▪ Lecale Coast AONB ▪ Mourne AONB	Large open or partially open Sea Lough with raised hinterland ▪ Carlingford Lough Low lying coastal plain and coastal estuarine landscape, low lying islands and peninsulas ▪ Portmarnock to Dunany Point ▪ Greencastle to Kilough Narrow coastal strip with raised hinterland ▪ Lambay Plateaus and high cliffs ▪ Bray Head Large Bay ▪ Dublin Bay ▪ Dundalk Bay
Assessment Area 2	Potential nominees to the World Heritage List (2009) ▪ Early Medieval Monastic Sites (Glendalough) National Parks: ▪ Wicklow Mountains National Park County Landscape Designations: ▪ Outstanding Natural Beauty areas and Special Amenity Areas (Wicklow) ▪ Sensitive and Vulnerable Landscapes (Wexford)	Low lying plateau landscape ▪ Hook Head to Rosslare Harbour ▪ Courtown to Loughlinstown ▪ Arklow Head/Clogga to Rathdown Low lying coastal plain and coastal estuarine landscape, low lying islands and peninsulas ▪ Hook Head to Loch Garman ▪ Loch Garman to Kilmicheal Point
Assessment Area 3	County Landscape Designations ▪ Sensitive and Vulnerable Landscapes (Wexford) ▪ Vulnerable, Normal and Robust Landscapes and Scenic Routes (Waterford) ▪ Areas of Very High Landscape Value, Areas of Very High Sensitivity and Scenic Areas and Scenic Routes (Cork)	Low lying plateau landscape ▪ Hook Head to Rosslare Harbour Low lying coastal plain and coastal estuarine landscape, low lying islands and peninsulas ▪ Toe Head to Cross Haven ▪ Hook Head to Loch Garman Large Bay ▪ Cork harbour to Loop Head

Assessment Area	Sensitive Receptors	
Seascape		
Assessment Area 4	World Heritage Sites ▪ Skelling Michael is located within this assessment area, it is of outstanding universal value and an exceptional and unique example of an early religious settlement. National Parks ▪ Killarney National Park County Landscape Designations ▪ Rural Prime Special Amenity Areas, Rural Secondary Special Amenity, Identified Views and prospects (Kerry) ▪ Areas of Very High Landscape Value, Areas of Very High Sensitivity and Scenic Areas and Scenic Routes (Cork)	Rugged peninsulas with drowned valleys ▪ Brandon Head to Mizen Head Large Bay ▪ Brandon Bay
Assessment Area 5	Potential nominees to the World Heritage List (2009) ▪ The Burren ▪ Ceide Fields and NW Mayo Boglands ▪ Western Stone Forts National Parks ▪ Ballycroy National Park ▪ Connemara National Park ▪ Burren Uplands National Park County Landscape Designations ▪ Vulnerable Landscapes, Scenic Routes and Areas of High Amenity (Clare) ▪ Scenic Views and Prospects (Limerick) ▪ Rural Secondary Special Amenity and Identified views and prospects (Kerry) ▪ Highly Sensitive, Sensitive and Less Sensitive Landscapes, Protected Views, Highly Scenic and Scenic Routes (Mayo) ▪ Unique, Special Sensitivity, and High Sensitivity Landscapes (Galway) ▪ Rural Prime Special Amenity Areas, Rural Secondary Special Amenity, Identified Views and prospects (Kerry)	Large open or partially open Sea Lough with raised hinterland ▪ Clew Bay ▪ Galway Bay ▪ Mouth of Shannon Low lying coastal plain and coastal estuarine landscape, low lying islands and peninsulas ▪ Benwee Head to Blacksod Bay ▪ Kilkieran Bay Complex intended coastline with small bays and offshore islands ▪ Blacksod Bay to Kilkieran Bay ▪ Arran Islands Plateaus and high cliffs ▪ Loop Head Peninsula Large Bay ▪ Ballyheigue Bay ▪ Tralee Bay Large River Estuary ▪ Shannon

<table>
<tr><th>Assessment Area</th><th colspan="2">Sensitive Receptors</th></tr>
<tr><td colspan="3">Seascape</td></tr>
<tr><td>Assessment Area 6</td><td>National Parks
▪ Glenvaeagh National Park

County Landscape Designations
▪ Highly Sensitive, Sensitive and Less Sensitive Landscapes, Protected Views, Highly Scenic and Scenic Routes (Mayo)
▪ Normal Rural Landscape, Sensitive Rural Landscape with intrinsic scenic quality, Visually Vulnerable Landscape with distinctive natural features and Scenic Routes (Silgo)
▪ Outstanding Natural Beauty areas and High Visual Amenity areas (Leitrim)
▪ Areas of Especially High Scenic Amenity and Views and Prospects (Donegal)

World level designations in transboundary areas of Northern Ireland
▪ The Giant’s Causeway

National level designations in transboundary areas of Northern Ireland
▪ The Causeway Coast AONB
▪ The Antrim Coast and Glens Antrim Coast AONB</td><td>Large open or partially open Sea Lough with raised hinterland
▪ Lough Foyle
▪ Lough Swilly

Low lying coastal plain and coastal estuarine landscape, low lying islands and peninsulas
▪ Benwee Head to Blacksod Bay

Narrow coastal strip with raised hinterland
▪ Maghera to Killybegs

Complex intended coastline with small bays and offshore islands
▪ Malin Head to Dunaff Head
▪ Fanad Head to Maghera

Plateaus and high cliffs
▪ Inishowan Head to Malin Head
▪ Downpatrick Head to Benwee Head

Large Bay
▪ Donegal Bay</td></tr>
<tr><td colspan="3">Material Assets: Oil and Gas Infrastructure and Cables and Pipelines</td></tr>
<tr><td></td><td>Oil and Gas Infrastructure</td><td>Cables and Pipelines</td></tr>
<tr><td>Assessment Area 1</td><td>▪ No areas of active oil and gas development in the Assessment Area.
▪ A “Licensing Option” area in the south of this assessment area exists which contains three exploration wells. These were drilled then abandoned.
▪ Two gas interconnector pipelines run through this Assessment Area from the Skerries and Drogheda.</td><td>▪ There are numerous telecommunications cables within the Assessment Area the majority of which converge to the north of Dublin.
▪ Two gas pipelines from the Skerries and Drogheda link the gas networks of Ireland and the UK.
▪ The East West Interconnector cable is within this assessment area and heads east from the Skerries.</td></tr>
<tr><td>Assessment Area 2</td><td>▪ There no areas of active oil and gas development in the Assessment Area.
▪ A small “Licensing Option” area is within the far north and an “Exploration Licence” area exists in the far south of this assessment area.
▪ Eight exploration wells were drilled and then abandoned.</td><td>▪ Two telecoms cables are located from Arklow and the north of Wexford. A third cable from Dublin Bay parallels the shore through this assessment area
▪ Windfarm electricity export cable.</td></tr>
<tr><td>Assessment Area 3</td><td>▪ There are three Gas Fields at Ballycotten, Kinsale Head and Southwest Kinsale and Seven Head.
▪ Two areas of “Petroleum Lease” around the Severn Heads, Ballycotton and Kinsale Head gas fields.
▪ There are eight “exploration licence” areas and three “licensing option” areas
▪ Two offshore platforms are located at Kinsale Head and Southwest KInsale
▪ Large number of wells located throughout this assessment area
▪ Oil and gas pipeline is present from the coast at Gyleen to Seven Head Gas Field.</td><td>▪ There are numerous telecommunications cables within the Assessment Area which meet the shore at Kilmore Quay in the east of the study area.
▪ A large number of cables pass through the south of this assessment area outside of the 12nm limit.
▪ Small network of pipelines involved in exporting gas from the Seven Heads, Ballycotton and Kinsale Head gas fields.</td></tr>
<tr><td>Assessment Area 4</td><td>▪ There are no areas of active oil and gas development in the Assessment Area.
▪ There are no areas that have been marked as being a “Licensing Option”, “Exploration Licence” or “Petroleum Licence” area.</td><td>▪ Hibernia Atlantic “D” telecoms cable passes through the Assessment Area.</td></tr>
<tr><td>Assessment Area 5</td><td>▪ There are no areas of active oil and gas development in the Assessment Area.
▪ Small “Exploration Licence” area which contains one exploration well that was drilled and then abandoned
▪ There is one pipeline on the northern extent of this assessment area out to Corrib Gas Field. This Gas Field is located outside of the study area.</td><td>▪ There are subsea power and telecoms cables connecting from the mainland to Inis Bo Finne and the Aran Islands.
▪ There is one pipeline on the northern extent of this assessment area out to Corrib Gas Field. This Gas Field is located outside of the study area.</td></tr>
</table>

Assessment Area	Sensitive Receptors	
Seascape		
Assessment Area 6	▪ There are currently no areas of active oil and gas development. ▪ Areas of "Exploration Licence" in the south west and north east of this assessment area ▪ Four exploration wells that were drilled and then abandoned.	▪ Hibernia Atlantic "A" telecoms cable passes through this Assessment Area.
Climate: Renewable Energy Developments and Gas Storage		
	Renewable Energy Developments	**Gas Storage Areas**
Assessment Area 1	▪ No existing offshore renewable infrastructure in this Assessment Area ▪ Wind farm lease areas which are under application are Oriel Windfarm which is located off Dundalk Bay and Dublin Array to the south of Dublin Bay.	▪ No sites are currently under consideration for natural gas or CO_2 storage
Assessment Area 2	▪ Arklow Bank offshore wind farm which is currently in operation is located off shore at Arklow. A larger windfarm lease area also exists around this site. ▪ Two potential wind farm areas: the southern section of Dublin Array application area and Codling Bank lease area which is located just within the 12nm limit off shore at Bray. ▪ No existing wave and tidal infrastructure	▪ No sites are currently under consideration for natural gas or CO_2 storage
Assessment Area 3	▪ No existing offshore renewable infrastructure	▪ No sites are currently under consideration for natural gas or CO_2 storage
Assessment Area 4	▪ No existing offshore renewable infrastructure	▪ No sites are currently under consideration for natural gas or CO_2 storage
Assessment Area 5	▪ Galway Bay wave energy test centre ▪ Sceirde wind farm application area is located to the south of Kilkieran Bay ▪ Proposed Belmullet wave energy test centre located between the 60m contour and the 12nm limit off the coast of The Mullet ▪ No existing or proposed tidal energy infrastructure	▪ No sites are currently under consideration for natural gas or CO_2 storage
Assessment Area 6	▪ No existing offshore renewable infrastructure	▪ No sites are currently under consideration for natural gas or CO_2 storage

11.5 Confidence Levels

As discussed in the approach and method (Chapter 6), as part of the assessment process it is necessary to determine the level of confidence in the results of the assessment. The level of confidence assigned to an assessment result gives a good reflection of the certainty by which conclusions can be drawn from the results. Confidence levels are of particular importance in terms of this SEA as they are necessary to reflect where known data and knowledge gaps have influenced various results of the assessment.

The confidence levels assigned to the results of the assessment of the Assessment Area are presented in Table 11.6 below. These confidence levels are based on the criteria presented in Table 11.5.

Table 11.5: Criteria to Define Confidence Levels

Confidence Level	Description
High	High levels of confidence occur where: ▪ There are no gaps or very limited gaps in baseline data. ▪ Interactions between the environment and marine devices are well understood (e.g. there is recognised guidance or well documented and peer reviewed evidence of potential effects that could occur (e.g. offshore wind developments).
Medium	Medium levels of confidence are likely to occur where: ▪ There are gaps in baseline data but knowledge and experience from related projects or fields of work leads to a greater level of confidence in the assessment of potential effects that could occur. ▪ There are limitations in understanding in how devices interact with the environment but greater certainty in available baseline data and supplementary evidence from related areas of work/similar projects.
Low	Low levels of confidence are likely to occur where: ▪ There are known gaps in baseline data and no available supplementary information to support assessment of effects. ▪ There are known gaps in understanding how devices interact with the environment and no available supplementary information to support assessment of effects.

Table 11.6: Confidence Levels

SEA Directive Topics	DETI SEA Topics	Level of Confidence						
		Assessment Area						
		Assessment Area 1	Assessment Area 2	Assessment Area 3	Assessment Area 4	Assessment Area 5	Assessment Area 5a	Assessment Area 6
Water, Soil (Sediment)	Geology, geomorphological and sediment processes	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	Sediment contamination and water quality	High	High	High	High	High	High	High
Biodiversity, Flora and Fauna	Protected sites and species	High	High	High	High	High	High	High
	Benthic and intertidal ecology	Low	Low	Low	Low	Low	Low	Low
	Fish and shellfish	Medium	Medium	Low	Low	Low	Low	Low
	Birds	Medium	Medium	Low	Low	Low	Low	Low
	Marine mammals	Medium	Medium	Low	Low	Low	Low	Low
	Marine reptiles	Low	Low	Low	Low	Low	Low	Low
	Noise and vibration	Low	Low	Low	Low	Low	Low	Low
	EMF (Electric and Magnetic Fields)	Low	Low	Low	Low	Low	Low	Low
Cultural Heritage including Archaeological Heritage	Marine and coastal archaeology and wrecks	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Population and Human Health	Commercial fisheries	Medium	Medium	Low	Low	Low	Low	Low
	Mariculture	High	High	High	High	High	High	High

SEA Directive Topics	DETI SEA Topics	Level of Confidence						
		Assessment Area						
		Assessment Area 1	Assessment Area 2	Assessment Area 3	Assessment Area 4	Assessment Area 5	Assessment Area 5a	Assessment Area 6
	Radar Interference	High	High	High	High	High	High	High
	Military practice areas	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	Dumping areas	High	High	High	High	High	High	High
	Shipping and navigation (including ports and harbours)	High	High	Medium	Medium	Medium	Medium	Medium
	Recreation and tourism	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Material Assets	Cables and pipelines	High	High	High	High	High	High	High
	Mineral resources/aggregate extraction	High	High	High	High	High	High	High
	Renewable energy developments	High	High	Low	Low	Medium	Low	Low
Landscape	Landscape, seascape and visual receptors	Low	Low	Low	Low	Low	Low	Low
Climatic Factors	Carbon impacts of offshore wind and marine renewables	High	High	High	High	High	High	High
	Carbon and gas storage	High	High	High	High	High	High	High

Section 12: Cumulative Effects Testing OREDP Development Scenarios

12 Cumulative Effects: Testing OREDP Development Scenarios

12.1 Introduction

This chapter presents the key findings from the assessment of the cumulative environmental effects of various levels of development (commercial scale) across the main Assessment Areas and Irish waters as a whole. Chapter 13 presents the results from the assessment of potential cumulative effects associated with other marine plans, programmes and offshore developments.

12.2 Focus of the Cumulative Assessment

The main aim for this part of the cumulative assessment is to assess the extent to which varying levels of development (MW) (offshore wind, wave and tidal) can be accommodated within the main Assessment Areas without likely significant adverse effects on the environment, and other marine activities/users, and how these different levels of development are likely to contribute towards overarching targets for the development of offshore renewables in Irish waters as set out in the OREDP.

As identified in Chapter 8: Resource Assessment, the waters around Ireland contains a huge resource of offshore wind and wave energy. However, the majority of this resource is purely theoretical, in that whilst it exists, a large proportion of it cannot be exploited for a number of reasons, mainly relating to the technical feasibility and economic viability of harnessing energy from such extreme, harsh and challenging environments. However, there a number of locations off the coast of Ireland where there are potential opportunities for exploiting the available offshore wind, wave and tidal resources.

This SEA therefore focuses on examining the areas where there are potential opportunities for developing the available offshore wind, wave and tidal resource and the potential environmental effects associated with development in those areas. However, it should be noted that it is acknowledged there are a number of other factors that influence the ability for the different areas of resource to be exploited e.g. availability of grid connections and onshore grid capacity, provision of other supporting infrastructure and availability of manufacturing/supply services. However, these factors are not assessed/considered as part of this SEA, the focus of which, in accordance with the SEA Directive, is purely to assess the potential effects of Ireland's long term strategy for the development of offshore renewable on the environment.

12.3 Theoretical and Technical Resource Areas

Chapter 8: Resource Areas identified the main theoretical and technical resource for offshore wind, wave and tidal within Irish waters. A definition of these different resource types is provided below:

- Theoretical Resource: This is defined as the gross energy content within the Study Area.
- Technical Resource: This is the theoretical resource limited by existing technical limitations such as water depth and other parameters.

12.3.1 Overview of Theoretical and Technical Offshore Wind, Wave and Tidal Resources

Table 12.1 below provides a summary of the main areas of Offshore Wind, Wave and Tidal Resource in the study area based on the information presented Chapter 8. This summary focuses purely on theoretical and technical resource. It does not include any consideration of environmental constraints.

Table 12.1: Summary of Theoretical and Technical Resource

Resource Type	Theoretical Resource	Technical Resource
Offshore Wind	Majority of the Irish offshore area where data is available is predicted to have a mean annual wind speed of between 7.0 and 11 m/s at 100m height above mean sea level (MSL). Wind speed generally increases with distance from the coast in all directions around Ireland with greatest resource to the south and west of Ireland which faces westerly prevailing winds.	Main technical parameter determining extent of potential offshore wind resource is water depth. - Fixed foundation turbines generally constrained to between 10m and 60m depth. - Resource for floating devices (turbines) extends out to 200m depth (edge of study area/continental shelf).
Wave	Based on mean annual wave power in kilowatts per meter of wave crest (kW/mWC) the greatest area of resource is located to the west and south west of the study area with the nearshore resource reaching 40-50kW/mWC in these areas. The nearshore resource off the east coast is lower, generally between 0 – 10kW/m. As with wind the wave resource increases with distance from shore, reaching levels of 60-70kW/mWC along the western and southern boundaries of the study area.	The main constraining thresholds for wave energy include water depth and average kW/mWC. - Main wave resource occurs in areas between 10m and 100m depth. - Main resource identified where wave power is greater than 20 kW/mWC.
Tidal	Focus for this SEA is on Tidal Stream energy. Tidal barrage projects are not included. Main areas of tidal resource are located off the coast of Co. Wexford and Co. Wicklow, the Irish Sea through St Georges Channel, and Co. Donegal in the Inishtrahull Sound. A number of sea loughs and tidal inlets and estuaries also have good tidal stream currents.	The main constraining thresholds for tidal stream resource include water depth and Peak Spring Current Flow. - Main constraining threshold in terms of water depth is 20m to 80m. - Main constraining threshold in terms of Peak Spring Current Flow is >1.2m/s Based on these constraining thresholds two main areas of resource have been identified these include the southern Irish Sea coast through the St Georges Channel, including Codling and Arklow Banks and Tuskar Rock and Carnsore Point and Inishtrahull Sound. A number of smaller, more discrete areas of resource have been identified within a number of narrow complex tidal straits and estuaries.

12.4 Development Scenarios

As identified above the overall potential technical resource for offshore wind, wave and tidal in Irish waters is very large, and offers significant potential in terms of the levels of electricity that could be generated from this resource. However, it is recognised that due to a range of factors, including potential effects on the environment, it is unlikely that all of the potential technical resource that has been identified will be harnessed/developed. It is also recognised that, as with most emerging industries and technologies, the timescale for realising the potential of the offshore renewable energy resource around Ireland is expected to be long term, with most large scale commercial developments starting to come on line around between 2015 and 2020, leading to further growth and expansion of the industry towards 2030 and even beyond that.

Therefore in order to develop a strategy for the long term development of this offshore renewable energy resource, SEAI and DCENR has explored a range of development scenarios that take into account both current and longer term levels of interest in the development of offshore renewable energy, as well as Ireland's commitments to combating climate change and reducing carbon emissions. The focus for this part of the SEA (Part 3: Cumulative Assessment) is examine the potential environment effects of each of the scenarios.

The scenarios range from low to high.

- **Low**: This scenario consists of the 800MW of offshore wind to receive a grid connection offer under Gate 3. It also includes 75MW of wave and tidal development, which is included in the Table 10 modelled scenario in the National Renewable Energy Plan (NREAP).
- **Medium**: This scenario consists of 2,300MW of offshore wind, which comes from the Table 10 non-modelled scenario of the NREAP (broadly based on the combination of offshore wind projects with either foreshore lease or grid connection) and the 500MW of wave and tidal energy in the same table (the Government's 2020 ocean energy target).
- **High**: This scenario consists of 4,500MW of offshore wind and 1,500MW of wave and tidal current. These figures come from the SEA Scoping Report.

Table 12.2: Development Scenarios

Development Scenarios to 2030			
	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)
Wind	800	2,300	4,500
Wave and Tidal	75	500	1,500

12.5 Assessment Areas

Given that the main focus for this part of the assessment (Part 3: Cumulative Assessment – Testing OREDP Scenarios) is to assesses the potential environmental effects that varying levels of development e.g. numbers of commercial scale developments and total Megawatts (MW) produced, would have on the environment within each of the Assessment Areas, and ultimately across all Assessment Areas within Irish waters. To assist with this assessment the study area has been split into a number of Assessment Areas. The main reasons for this are to:

- Improve the manageability of the assessment by breaking the study area into smaller sections – assists with discussion of potential effects and presentation of results
- Focus the assessment areas around the main areas of offshore energy resource as these are the areas where development is most likely to occur.
- Assist with the cumulative assessment by examining potential effects in smaller areas and then across the entire study area.

12.5.1 Identification of the Assessment Areas

Based on the review of available resources (offshore wind, wave and tidal) presented in Chapter 7, it was identified that both offshore wind and wave resources are present within the majority of Irish waters. Tidal resources, by comparison, tend to occur in smaller, more discrete areas, mainly off the east coast and along the north coast where tidal currents are generally strongest. Given the large extent of both offshore wind and wave resources within the wider study area it was determined necessary to break the study area up into smaller areas or parts in order to make the study area and the assessment of the main areas of resource more manageable.

The study area (defined in Chapter 1: Introduction) and illustrated in Figure 1.1 was therefore divided into a total of seven separate assessment areas. These are listed in Table 12.3 below and illustrated in Figure 11.4. The key factors used to identify these Assessment Areas include:

- The extent of the available resource (theoretical and technical) for offshore wind, wave and tidal based on the information presented in Chapter 8 and illustrated in Figures 8.1 to 8.3.
- Development/operating parameters and constraints associated with each of the technologies as discussed in Chapter 7 and summarised below.
- Feedback from consultation with statutory authorities and individual developers on current and possible future areas of interest for developments.
- Review of current development patterns taking into account technical feasibility of where development is likely to occur.

The assessment areas identified in Table 12.3 below extend out from the coast (mean high water mark) to a distance of 100km. Consequnelty the Assessment Areas do not cover entire study area which extends out to the 200m depth contour (which is further than 100km from the coast in some areas off the west and south coast) and to the territorial limit on the east coast (12nm). The 100km limit for the Assessment Areas reflects the current upper length limit of AC export cable technology (i.e. for greater distances DC cables will be required, with converter stations on land to convert to AC).

Table 12.3: Assessment Areas

Assessment Area	Technology	Location
1	Wind	East Coast - North
2	Wind & Tidal	East Coast - South
3	Wind[1]	South Coast
4	Wind & Wave	West Coast - South
5	Wind & Wave	West Coast
5a	Tidal[2]	Shannon Estuary
6	Wind & Wave & Tidal	West Coast - North

Note 1: Wave is not considered in Assessment Area 3, as although there is some offshore technical resource here it was considered to be too far offshore for development within the timeframe of the SEA. It was decided to only consider wave in the more accessible near shore wave resource areas on the southwest, west and northwest coast where developer interest is predicted to be initially focussed (Assessment Areas 4, 5, 6).

Note 2: Only those areas of significant tidal resource suitable for the development of commercial tidal arrays were considered in the assessment. It is recognised that there are a number of smaller discrete areas of tidal resource around the Irish coast. However, due to their scale these areas were only considered to be more suitable for demonstration or test projects rather than full scale commercial developments. The exception to this is the Shannon Estuary where both developers and environmental authorities have indicated that there is interest in the development of a commercial scale tidal array in this area.

12.6 Development Outside the Assessment Areas

Although the main focus for this part of the assessment (Part 3) is to assess the potential environmental effects of a number of commercial scale projects within the main Assessment Areas, it should be noted that **the SEA does not preclude any development (demonstration/test, pre-commercial or commercial) occurring outside of these assessment areas**. It is recognised that development could occur in the areas outside the main assessment areas. However, the main Assessment Areas identified are those that have been identified through ongoing consultation with wave, wind and tidal developers and environmental authorities as being the areas where development is most likely to occur in the timeframe of the OREDP e.g. up to 2020 and possibly 2030. It is therefore assumed that development outside these assessment areas up to 2020 and to 2030 would be unlikely.

However, it should be noted that baseline data has been collated for the entire study area. Therefore where data exists (e.g. there are no gaps) this will be available for any development irrespective of its location. Additionally, although developments outside the assessment areas have not been included in the cumulative assessment, they would, as with any development in the study area, still be subject to project level assessments (e.g. EIA) and consenting.

12.7 Operating Parameters

The operating/development parameters used to assist the identification of the potential resource within the study area are presented in Table 12.4 below. This is based on information presented in Chapter 8.

Table 12.4: Operating Parameters

Development/Operating Parameters		Fixed Wind	Floating Wind	Tidal	Wave
Water Depth		10m to 60m	60m to 200m	20m to 80m	10m to 100m
Constraining Threshold		> 7.0 m/s mean annual wind speed at 100 m height	> 7.0 m/s mean annual wind speed at 100 m height	Peak Spring Current Flow >1.2 m/s	Mean annual wave power (kilowatts) per metre of wave crest (WC) >20 kW/mWC
Approximate MW/km^2		10	10	50	10
Average Turbine/Device Generating Capacity		5 MW	2.3 - 5 MW	1 MW	0.5 MW to 5 MW
Average Scale of Commercial Development	MW	300 MW	300 MW	50 MW	30 MW
	Km^2	30km^2	30km^2	1km^2	3km^2

12.8 Dealing with Existing and Proposed Developments

Although it is recognised that existing and proposed developments have to be taken into account in the assessment of cumulative effects, it is not the focus of the SEA to examine individual sites for development. In identifying the levels of development that could be accommodated in each Assessment Area (with and without environmental effects) areas that already have foreshore leases have been included in the overall total (MW) that could be accommodated in a specific area. For example, in Assessment Area 1, taking into account technical and environmental constraints, the assessment identifies that there is potential to develop between 1200MW and 1500MW from offshore wind without likely significant adverse effects on the environment. However, the assessment also recognises that of that 1200MW to 1500MW, 480MW have already been granted a foreshore lease or are due to receive an offer of grid connection, therefore also taking into account existing projects the remaining resource in that Assessment Area is between 720MW and 1020MW.

There are a large number of applications for offshore wind developments in Irish Waters at various stages of the foreshore consenting process, however, of those, only two have been consented, and a further three, as of autumn 2010, are due to receive a grid connection offer in the Gate 3 process. The developments include:

- Consented: Arklow Bank (520 MW) – Phase 1 (25 MW) operational in June 2004.
- Consented: Codling Bank Wind Farm (1100 MW)
- Awaiting approval: Dublin Array (Kish and Bray Bank) (364 MW)
- Awaiting approval: Oriel Wind Farm (330 MW)
- Awaiting approval: Sceirde Wind Farm (Fuinneamh Sceirde Teo (FST)) (100 MW)

Of the offshore wind developments listed above, all except Sceirde Wind Farm, are located off the east coast of Ireland. Scierde Wind Farm is located off the West Coast, just to the north of Galway Bay.

12.9 Testing the Development Scenarios

The focus of this part of the assessment is to test the development scenarios discussed above. The assessment is split into two parts:

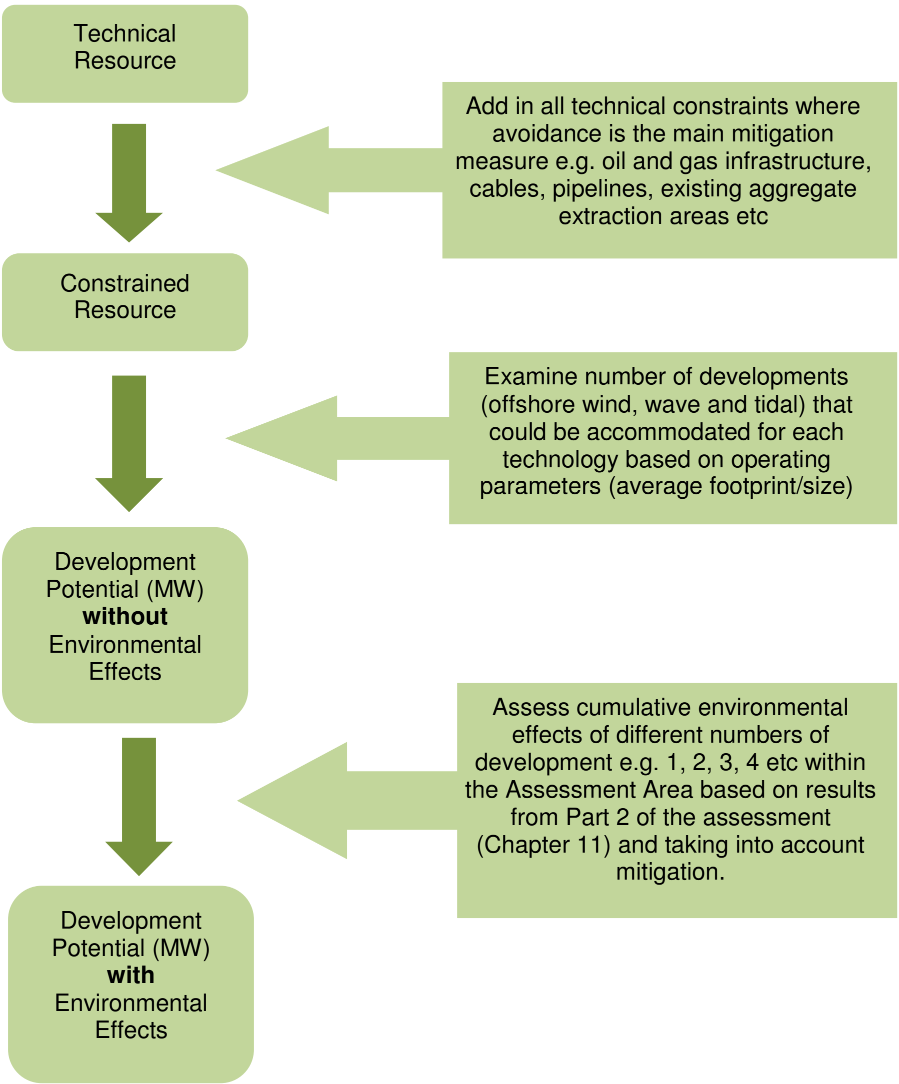
- **Part 1:** Assessment of the cumulative effects of different levels of development (MW) within each of the assessment areas.
- **Part 2:** Assessment of the cumulative effects of different levels of development across the whole study area and testing the ‘development scenarios’.

The approach to identifying and assessing the different amounts (MW) of development that could be accommodated in each of the assessment areas is illustrated below. Further information on the approach taken to assessing each of the different SEA subjects in terms of potential cumulative effects are provide in Section 12.9.1.

12.9.1 Approach to the Cumulative Assessment within each Assessment Area

Figure 12.1 below illustrates the approach taken to assessing each of the six Assessment Areas.

Figure 12.1: Approach to Identifying Development Potential in each Assessment Area



12.10 Approach to Assessing Effects in Relation to Specific SEA Receptors

In terms of the cumulative assessment the SEA subjects have been split into technical and environmental constraints. All technical constraints have been taken into account as part of the cumulative assessment. These constraints are summarised below.

In terms of the environmental constraints, each of the sensitive receptors e.g. protected sites, birds, benthic habitats, archaeological remains etc, have all been dealt with in a certain way. This is based on the nature and character of the potential interactions of each receptor with offshore renewable energy developments the likely significance of any potential effects based on the findings from the Generic Assessment (Chapter 10) and the Assessment of the Assessment Areas presented in Chapter 11. Details of how each of the SEA environmental constraints have been dealt with the in cumulative assessment is provided below.

12.10.1 Technical Constraints

The following SEA issues/subjects have been identified as technical constraints and as such have been taken into account when identifying potential areas where development could occur:

- Aquaculture sites
- Disposal and dredging areas (based on 1000m buffer around point data)
- Cables and pipelines (all buffered by 1000m)
- Areas where shipping intensity is more than 100 vessels per month
- All defence danger areas
- All oil and gas lease areas
- Existing oil and gas infrastructure (other than pipelines)

12.10.2 Environmental Constraints

The following provides an overview of how each of the SEA subjects/environmental constraints has been dealt with in the cumulative assessment.

- **Water and Soil (Sediment):**
  - Coastal modelling would be carried out at project stage to inform site selection to minimise adverse effects on coastal processes.
  - Appropriate good practice measures would be integrated into project designs to minimise the risk of contamination from devices.
- **Biodiversity, Flora and Fauna**: (Further detail on the approach to addressing constraints in relation to Biodiversity, Flora and Fauna is provided below)
  - All protected sites (MPAs, Ramsar, SPAs, SACs, IBA etc) have been avoided when identifying potential areas for development.
  - Seal breeding and haul out sites have been avoided.
  - Potential marine mammal migratory routes and feeding hotspots (where known) have been avoided where possible.
  - Consideration has been given to ensuring sufficient spacing between commercial developments to minimise the potential for the creation of barriers to movement and large scale habitat disturbance and exclusion.

- **Cultural Heritage including Archaeological Heritage:**
  - Known areas of archaeological importance are avoided.
  - Where there is potential for archaeological remains it is assumed appropriate surveys would be carried out at the project level to inform site selection, the siting of individual devices and routeing of export cables.
- **Ports, Shipping and Navigation:**
  - Areas with high intensity of vessel movements (e.g. 100 per month) and main routes in and out of ports have been avoided.
- **Commercial Fisheries**:
  - Consideration has been given to maximising space between commercial developments to minimise displacement from traditional fishing grounds.
- **Recreation and Tourism:**
  - Key recreational sites are avoided where possible. Effects on other recreational activities are considered under other subjects e.g. seascape.
- **Seascape:**
  - Due to the complexity of the seascape character around Ireland, a separate methodology was developed to assess potential effects on seascape. Further detail on this is provided in Chapter 6 of the Environmental Report.

12.10.2.1 Biodiversity, Flora and Fauna: Protected Sites

For the purpose of this assessment, in terms of identifying areas with potential for future development without any likely significant adverse effects on the environment or other marine activities/users, all protected sites (Biosphere Reserves, Natura 2000 (SACs and SPAs), Ramsar, MPAs and the range of national sites) have been avoided when identifying areas where development could occur. Consideration has also been given to the likely effects of installing arrays in proximity to sites designated for mobile species, for example potential effects of offshore wind farms on birds accessing adjacent SPAs. This does not necessarily restrict development from occurring within, or close to a protected site in the future, it simply aims to identify whether the developments scenarios set out in the OREDP could be achieved without development having to occur within any of Ireland’s protected sites.

This approach has been taken due to the high level nature of this assessment as it is recognised that, in order to conclude that development could occur within a particular protected sites there would be a requirement to provide all the necessary evidence to demonstrate that the development (offshore wind, wave or tidal) would not have a significant adverse effect on the integrity of a given site. This acquisition of this evidence would be based on detailed site specific surveying and monitoring which is outside the scope of this SEA. It therefore is assumed that there would be potential for an offshore renewable energy development to have a likely significant adverse effect on a protected site, therefore these sites have been avoided.

12.10.2.2 Biodiversity, Flora and Fauna: Benthic Ecology

As noted in Chapter 9: Baseline Environment, the current listing for Natura 2000 sites with qualifying interest features for marine Annex I or II (habitats or species) is 80 (of which four are in offshore areas that lie outside the boundaries of the study area). As discussed above, as part of the cumulative assessment, these sites have been avoided in considering potential opportunities within a given area for the development of offshore renewable energy developments. However, it is acknowledged that, although a large proportion of the sensitive benthic communities are protected there are still areas outside these protected sites where sensitive benthic habitats and species could be present.

Given that the distribution and abundance of benthic communities outside the protected sites is unknown (except where surveys and research have been carried out to inform the designation of additional SAC sites e.g. as part of the NPWS National Programme 2008 and 2009, or as part of other SEAs such as the Irish Offshore Strategic Environmental Assessments (IOSEA 1-3)), the potential for likely significant adverse effects on benthic communities is also unknown. In terms of addressing this as part of the cumulative assessment the following judgements have been made as part of the identification of possible areas for development:

- Where the potential for benthic communities to be present is unknown, the assessment has made a judgement as to the number of developments (or generating capacity (MW)) that could be accommodated within an area based on the type of development that would occur in that area and the likely effects of that development on benthic communities e.g. substratum loss (resulting in habitat loss and disturbance), sediment re-suspension, increased turbidity etc. For example, in terms of offshore wind where devices are installed on either piled foundations or gravity bases, the cumulative assessment takes into account the following:
  - Opportunities for distributing developments over a wider area to maximise space between developments in order to prevent large areas of substratum loss and therefore minimise potential effects on the benthic environment.
  - Where development is confined to a specific location, assessment of the number of developments (for offshore wind based on 300MW) that could be accommodated in that specific location allowing for sufficient space between developments to prevent substratum loss (and therefore effects on any potential benthic communities) over a wider area.

- Where data/information suggests that an area has potential for Annex I habitats to be presented but the precise location/distribution of these habitats is unknown, then a judgement has also been made on the number of developments that could be accommodated in an area whilst allowing for sufficient flexibility for alternative development sites to be identified should any Annex I habitats be identified as part of detailed surveys carried out at the project stage.

12.10.2.3 Biodiversity, Flora and Fauna: Marine Mammals, Fish, Birds and Reptiles

It is recognised that even if a development is only undertaken outside protected sites, the development could still have an affect the qualifying features for which the site is designated, particularly mobile species such as marine mammals or birds. Where available data relating to the distribution of certain species has been taken into account in the assessment of cumulative effects and, as with the protected sites, those areas where certain key species are known to be present have been avoided. However, there are a number of gaps in the data on species distribution and abundance, therefore in some locations the presence or absence of a certain species is unknown. Similarly there are gaps in data on behavioural activities such as migratory routes.

In terms of the cumulative assessment and potential effects on mobile species (birds, marine mammals, reptiles and fish), the following judgements have been made regarding the number of offshore renewable energy developments that could potentially be accommodated in a certain area:

- Known feeding, breeding and loafing (bird) hotspots have been avoided.
- Known migratory routes have been avoided.
- Where data/information suggests that certain sensitive species could be present in an area, but the precise location of these species and their abundance is unknown, a judgement has been made on the number of developments (or total amount of MW) that could be developed in certain locations without giving rise to likely significant adverse effects on a certain species should it be present e.g. information available may indicate that a certain area is used by marine mammals e.g. common seals for feeding, although the exact locations of these activities are unknown. Based on the characteristics of that area the assessment takes into account the following:
  - The number of developments that could occur within that area without causing disruption or disturbance to feeding activities. For example, there could be sufficient space in a certain location for a couple of developments to be spaced at sufficient distances that they would not impinge significantly on the movement of seals to and from an area or within that area.

- The total number of developments that could occur in an area before the spacing and distances between developments starts to decrease to a point that would potentially start to restrict the movement of seals to and from and within the area (barriers to movement), would reduce the overall area available for foraging, and possibly reduce the availability of food (fish due to habitat displacement) and increase the risk of collision.

- Where data/information suggests that certain sensitive species could be present in an area, but the precise location of these species and their abundance is unknown, then a judgement has also been made on the number of developments that could be accommodated in an area whilst allowing for sufficient flexibility for alternative development sites to be identified should certain key/sensitive species be identified as part of detailed surveys carried out at the project stage.

12.11 Results from Testing the OREDP Development Scenarios

This section presents the results of the assessment of each of the assessment areas. These results are based on the development of commercial scale offshore wind, wave and tidal developments only. Although test sites, demonstration projects and pre-commercial developments are not excluded from this SEA, they are not included specifically in the cumulative assessment as the main focus for this part of the assessment is to assist with the development of Ireland's long term strategy as set out in the OREDP for the development of offshore renewable energy. The focus of the strategy and OREDP is on full scale commercial developments rather than test, demonstration or pre-commercial projects, although it is acknowledged that these projects are essential to the ongoing development of the industry and could also generate electricity that could be fed into Ireland's grid network.

12.11.1 Assessment Results Assessment Area 1: East Coast (North) - Offshore Wind

Table 12.5 below provides an overview of the main findings from the cumulative assessment for Assessment Area 1.

Table 12.5 Assessment Area 1: East Coast (North) – Offshore Wind

Technology	Wind
Development Potential (MW) prior to assessment of Environmental Effects	>10000MW
Development Potential (MW) with Environmental Effects (including mitigation)	1200MW to 1500MW
Existing and proposed development	480MW (Oriel Windfarm (330MW) and northern section of Dublin Array Windfarm (150MW).
Remaining potential for development	720MW to 1020MW
Summary of Main Constraints	Potential effects on protected sites, benthic communities, birds, marine mammals, commercial fisheries and seascape.

Based on the results from the cumulative assessment it was identified that within Assessment Area 1 there would be potential to develop between 1200MW and 15000MW from offshore wind (based on four to five developments with an average size of 300MW) without any likely significant adverse effects on the environment. However, of that 1200MW to 1500MW, 480MW is already taken up by existing developments and applications (330MW from Oriel and approximately 150MW from the northern section of Dublin Array (Kish Bank)) (overall total generating capacity for Dublin Array is 364MW). Consequently the remaining offshore wind development potential within this Assessment Area ranges between 720MW to 1020MW (two to three 300MW developments).

Opportunities for development beyond 1500MW become increasingly constrained by environmental factors and other marine activities/users so consequently the likelihood for significant adverse effects to occur also increases. The main environmental and other marine activities potentially limiting the amount of offshore wind development in Assessment Area 1 to between 1200MW and 1500MW include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Shipping and Navigation
- Commercial fisheries
- Seascape

In order to avoid any likely significant adverse effects on protected sites such as Howth Head Coast SPA, Lambay Island SPA and SAC, Dundalk Bay SPA and the Bull Island UNESCO Biosphere Reserve consideration has been given to placing developments outside of these sites. The assessment identifies, that taking other constraints into account such as shipping channels and other technical constraints, there would be potential for up to 1500MW without any direct overlap with any protected sites in the area. The assessment also identified that based on information available at the time of the assessment there would be potential to develop up to 1500MW in this area without likely significant adverse effects on marine mammals, birds and benthic communities although further surveys would still be required for individual projects to ensure that significant adverse effects do not occur. In particular it is likely that surveys would be required for any project in this area in order to assess the potential significance of any development on the areas that the NPWS have identified as supporting potential Annex I habitat. Surveys are also likely to be required to assess the potential effects of offshore wind developments on bird movement to and from key protected sites such as Dundalk Bay SPA, South Dublin and River Tolka Estuary SPA and the Bull Island UNESCO Biosphere Reserve.

One of the other main constraints on offshore wind development in Assessment Area 1 relates to the shipping lanes entering and leaving Dundalk, Greenore and Dun Laoghaire. The intensity of vessel movements within these channels has been identified as high, therefore any development within or adjacent to these main shipping channels could place a significant risk on navigational safety in terms of collision risk and vessel displacement and restricted port access. However, it is acknowledged that in certain locations for example on Kish Bank to the south of the Assessment Area, development could have positive effects by excluding vessels from areas known to be dangerous for shipping and increasing navigation aids in these areas.

In order to avoid any likely significant adverse effects on shipping and navigation, the assessment has considered placing developments in areas where vessel movements are generally lower such as areas offshore from Dundalk Bay and Bray to the south of the area.

In terms of commercial fisheries, this area has been identified as being fished extensively for *Nephrops* and there are extensive spawning grounds for cod, haddock, plaice and whiting and associated seasonal fisheries. It is likely that any development above 1500MW in this area could have a likely significant effect on commercial fisheries in this area as a result of permanent displacement from traditional fishing grounds. However, further surveys and consultation with the fishing industry would be required as part of the development of individual projects to fully determine the significance of any potential effect as this may vary from site to site and could also be dependent on whether fishing activities can occur within a development area.

In terms of seascape, the potential for significant cumulative effects to occur are reduced with increased distance offshore and increased spacing between individual developments. In terms of Assessment Area 1, the assessment has identified that a large proportion of the coastline of the east coast (north) comprises seascape types 3 (low plateau) and 4 (low lying coastal plain) which are generally considered to be the least sensitive to offshore wind developments. It is likely therefore that a number of offshore wind farm developments could be accommodated in this area without significant effects on seascape character, depending on the siting of developments, their distance from shore and siting away from more sensitive areas such as Dublin Bay Cliffs, Dundalk Bay and other large bays. In some locations there is potential for transboundary cumulative effects in Northern Ireland in relation to the Mourne Mountains AONB. In general it is likely that between 0 and 15km from shore potential effects would be of moderate significance. Any development between 15km and 35km would be slight, with negligible effects beyond 35km.

12.11.2 Assessment Results Assessment Area 2: East Coast (South) – Offshore Wind and Tidal

Table 12.6 below provides an overview of the main findings from the cumulative assessment for Assessment Area 2.

Table 12.6 Assessment Area 2: East Coast (South) – Wind and Tidal

Technology	Wind	Tidal
Development Potential (MW) prior to assessment of Environmental Effects	>10000MW	>5000MW
Development Potential (MW) with Environmental Effects (including mitigation)	3000MW to 3300MW	750MW to 1500MW
Existing and proposed development	**1834MW** (southern section of Dublin Array (214MW, Codling Bank (1100MW), Arklow Bank (520MW)	0MW although includes the area identified as an 'initial development area' by MRIA.
Remaining potential for development	1166MW to 1466MW	750MW to 1500MW
Summary of Main Constraints	Potential effects on protected sites, benthic communities, birds, commercial fisheries, shipping and navigation.	Marine mammals, birds, benthic communities, commercial fisheries and navigation.

12.11.2.1 Offshore Wind Development Potential

The results from the cumulative assessment of Assessment Area 2 indicate that although there is a significant potential resource of offshore wind off the east coast (south) of Ireland (e.g. more than 10000MW), there are also a number of areas of environmental sensitivity and other marine activities/users that could constrain the amount of development that could be accommodated in this area. Taking these constraints into account the assessment concludes that there may be potential to develop between 3000MW and 3300MW from offshore wind in this area without any likely significant adverse effects on the environment and other marine activities/users.

However, in terms of this assessment, based on existing information, a large proportion of this potential resource is already taken up by the existing and proposed offshore wind developments in this area. In total, the overall installed capacity of the existing and proposed offshore wind developments within this Assessment Area is 1834MW. Therefore based on the results from this assessment, the remaining development potential within this area ranges from 1166MW to 1466MW. It is likely that any additional development in this Assessment Area over and above this would potentially have significant adverse effects on the environment.

The main factors limiting development within this Assessment Area to between 3000MW and 3300MW include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Shipping and Navigation
- Commercial fisheries
- Seascape

As with Assessment Area 1, when identifying the potential for offshore wind (fixed) development in this Assessment Area, consideration has been given to avoiding all existing protected sites. The main aim of this is to avoid the potential for any likely significant effects on these sensitive areas. However, as discussed in section 12.9.2.2 this does not necessarily preclude development within these areas, it just enables a judgement to be made as to the level of development that could be achieved in a particular assessment area and therefore across the study area by avoiding these sites.

However, although the assessment avoids all protected sites, offshore wind developments in this area could still have likely significant adverse effects on species and habitats that are not contained within the protected sites. For example, it is acknowledged that the NPWS has identified a number of broad areas within this Assessment Area has having potential to support Annex I habitat (benthic). Most of these broad areas overlap with the main areas of offshore wind (fixed) resource and are therefore very difficult to avoid completely. It is not currently known whether these habitats are actually present in this area, therefore, these areas have still been considered as having potential for development on the basis that necessary surveys would still be required at the project stage, or as part of ongoing surveys of this area, to establish whether the areas does contain potential Annex I habitat and what the likely significance of any potential effects from offshore wind farm development would be.

In addition to the area containing potential Annex I habitat, there are a number of other sensitive receptors present in the area. Of particular importance are the breeding seabird colonies located around Wexford Harbour and Wicklow Head. Although these areas are designated as SPAs and therefore have been avoided in terms of identifying areas for offshore wind development, it is likely that a number of the birds breeding in that area will feed and loaf in the adjacent coastal and nearshore waters. The areas surrounding these areas of particular interest have also been avoided as part of this assessment as alternative locations are available. However, due to the presence of these sites and the fact that there are a number of bird breeding colonies located outside these sites elsewhere along the coastline in Assessment Area 2, it is likely that specific surveys will be required for any development in this area to determine whether there will be an effects on birds, in particular migratory species, and assess the likely significance of those effects.

Relative to Assessment Areas 3, 4, 5 and 6, Area 2 generally contains fewer populations of grey and harbour seal and there are fewer sightings of harbour porpoise, bottlenose dolphin, leatherback turtle and basking shark. However, these species of conservation importance have been sighted in this area, and therefore could potentially be affected by offshore wind farm developments in terms of habitat loss and exclusion due to the physical presence of a development and noise during installation. Surveys are likely to be required to determine the presence of certain species and assess the likely significance of any effects from offshore wind developments on these species

The main commercial shell fisheries in this area that could be potentially affected by offshore wind developments is whelk which is mainly concentrated in the southern part of the assessment areas. The main effects on commercial shellfishery include substratum loss, direct disturbance and suspended sediment created during the installation of piled foundations. The potential significance of these effects depends in the importance of the fishing ground.

Assessment Area 2 also contains important spawning and associated fishing grounds for cod (to the north of the area) and ray species (within the central and southern part of the area. There is potential for these areas to be disturbed during the installation of piled foundations and exclusion from more traditional fishing grounds. Again the overall likely significance of these effects depends on the importance of the fishing grounds and whether fishing can continue within the boundaries of development.

The main constraint on offshore wind development in Assessment Area 2 is shipping and navigation. One of the main shipping routes that run from the Atlantic along the south coast of Ireland before heading north into the Irish Sea and the North Channel passes through this assessment area. This route has a high intensity of vessel movements and is used by a wide range of vessels including oil tankers and cargo ships. Therefore, in order to avoid any potential significant adverse effects on navigational safety due to increased collision risk and vessel displacement, this main channel has been avoided when identifying possible areas for the development of offshore wind. Consideration has also been given to avoiding the main shipping routes entering and leaving the main ports of Dublin and Rosslare.

In terms of seascape, the potential for significant cumulative effects to occur are reduced with increased distance offshore and increased spacing between individual developments. As with Assessment Area 1, a large proportion of the coastline in this assessment area comprises seascape types 3 (low plateau) and 4 (low lying coastal plain) which are generally considered to be the least sensitive to offshore wind developments. It is therefore likely that a number of offshore wind farm developments could be accommodated in this area without significant effects on seascape character, depending on the siting of developments, their distance from shore and siting away from more sensitive areas such as some of the sensitive landscapes around Wicklow. In general it is likely that between 0 and 15km from shore potential effects would be of moderate significance. Any development between 15km and 35km would be slight, with negligible effects beyond 35km.

12.11.2.2 Tidal Energy Potential

In terms of tidal energy, the assessment identifies that, from the potential resource that is available in this area (more than 5000MW) there could be potential to develop between 750MW and 1500MW without significant adverse effects on the environment and other marine activities/users. Unlike offshore wind, tidal technology generally has a much higher generating capacity per square km. This is mainly due to the general characteristics of tidal stream energy which tends to be more consistent and concentrated than wind or wave energy and the fact that, based on current operating designs, most tidal devices can be closely packed within an array e.g. 50 turbines per km compared to 10 offshore wind farms per km. Consequently much less space is required to achieve fairly high levels of installed capacity. However, in comparison to offshore wind, which is generally present across the whole of Assessment Area 2, the optimal tidal resources in this area (which has also been identified as an ‘initial development area’ by the Marine Renewables Industry Association (MRIA)) is generally concentrated in a much smaller, more discrete area, around East Wicklow.

The main environmental constraints and other marine activities/users that potential limits development of tidal resource in this area above 1500MW include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Shipping and Navigation
- Commercial fisheries

As with offshore wind and discussed in section 12.9.2.2 when identifying possible areas of tidal resource for development, consideration has been given to the avoidance of protected sites in the area in particular Wexford Harbour and Slobs SPA and Ramsar and Wicklow Head SPA which have been identified as being most sensitive for birds, and other sites such as Carnsore Point SAC and Wicklow Reef SAC, in order to minimise any likely significant adverse effects on the integrity and conservation objectives of those sites.

However, there is still potential for tidal developments to have likely significant adverse effects on species and habitats that are located outside the main protected sites, for example, a large proportion of the tidal resource area overlaps with the area identified by the NPWS as having potential for Annex I habitat (benthic). However, the areas identified by the NPWS are fairly broad and it is acknowledge that further work/project level surveys would be required to determine the presence of sensitive benthic communities in certain locations and the likely significance of any tidal developments on these communities.

There is also potential that, although the main sensitive areas for birds have been avoided (around Wexford Harbour and Wicklow Head which are to the south of the main area of tidal resource), tidal developments could still potentially have likely significant adverse effects on birds that feed or loaf outside these protected areas in particular diving birds and pursuit feeders. Again surveys would be required for individual protects to identify the importance of particular areas outside protected sites of feeding or loafing for certain bird species.

In terms of marine mammals, there are a few breeding populations of harbour and grey seal in this Assessment Area although there are no designated SACs for marine mammals. Sitings of bottlenose dolphin or harbour porpoise are also fairly limited in comparison to other areas. However, there are still high levels of uncertainty in relation to how marine mammals interact with tidal developments and the potential effects of these developments in terms of increased collision risk and creating barriers to movement along key migratory or feeding routes. Given that, based on the findings from the baseline study, there is limited marine mammal activity in this area; the assessment concludes that, although there is still uncertainty surrounding potential effects, any potential effects are likely to be less significant than in other areas. Similarly sitings of marine reptiles in this area are also fairly limited although the assessment has identified that there are some jellyfish feeding hotspots, exclusion from which could have a likely significant effect on marine reptiles.

The other main constraints on tidal development in Assessment Area 2 include commercial fisheries and shipping and navigation. In terms of commercial fisheries the main area of concern is a lack of information relating to the location of inshore fisheries due to there being a lack of data on inshore fishing vessels that are less than 15m in length. Further work and conclusion with representatives from the fishing industry would be required to establish the character of these fishing activities in this area.

In terms of shipping and navigation, in order to minimise likely significant adverse effects on navigational safety from increased risk of collision and vessel displacement and reduced access to major ports, consideration has been given to placing developments in the areas of lowest shipping intensity, in particular avoiding the main shipping lanes into and out of Rosslare and Dublin and the main north-south coast shipping lane. It is likely that developing more than 1800MW from tidal energy in this area could lead to developments encroaching into these shipping lanes, which could potentially have likely significant adverse effects on navigational safety.

As with Assessment Area 1, the most dominant seascape type in Assessment Area 2 is type 3: low plateau and type 4: low lying coastal plain, both of which are the least sensitive to offshore developments. In terms of tidal developments, it is likely that a large proportion of the development (if not all depending on the device type) will be submerged beneath the water, significantly reducing potential effects on seascape. However, where there are a number of developments it is likely that some parts of a development will protrude above the surface of the water, where this occurs close to shore e.g. between 0 to 5km from the coast which would be characteristic with the main area of tidal resource, there could be a moderate significant effect on seascape character.

12.11.3 Assessment Results Assessment Area 3: South Coast – Offshore Wind

Table 12.7 below provides an overview of the main findings from the cumulative assessment for Assessment Area 3.

Table 12.7 Assessment Area 3: South Coast –Offshore Wind	
Technology	Wind
Development Potential (MW) prior to assessment of Environmental Effects	>10000MW
Development Potential (MW) with Environmental Effects (including mitigation)	1500MW to 1800MW
Existing and proposed development	0MW
Remaining potential for development	1500MW to 1800MW
Summary of Main Constraints	Water depth (technical) Shipping and navigation Potential effects on protected sites, benthic communities, birds, reptiles and migratory routes for marine mammals. Potential effects on commercial fisheries. Seascape effects

Although the results from the cumulative assessment have identified that there is potential for development of between 1500MW and 1800MW from offshore wind in Assessment Area 3, the overall development potential of off the south coast is significantly constrained by water depth which in some locations drops to below the optimal operational depth for fixed offshore wind farm developments (60m depth) at a distance of only (5km to 25km) from the coast. However the coastline in Assessment Area 3 is fairly long, therefore, although in some locations water depth increases significant from the shoreline, there are some areas where offshore wind farm developments could be sited, although these areas are all still fairly closer to the coast e.g. within 0 to 5km.

In addition to water depth, the main environmental factors limiting development within this Assessment Area to between 1500MW and 1800MW include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Shipping and Navigation
- Commercial fisheries
- Seascape

The main consequence of developments being located closer to the coast is that they are also in closer proximity to the main environmentally sensitive areas, in particular coastal and marine protected sites. Based on the potential areas that are available for development, the assessment identifies that, by avoiding all protected sites, the area could potentially accommodate up to 1800MW (six 300MW offshore wind farms). However, any development above this is likely to result in developments overlapping key protected sites in the area, in particular the marine SACs at Hooks Head and Saltee Island both of which are protected for their reef habitat and therefore are likely to be significantly adversely affected by offshore wind developments.

Large sections of the coastline in Assessment Area 3 are also recognised as being of importance for seabird populations and breeding colonies. This is recognised through the large number of SPA, Ramsar and IBA designations that are present along the length of the coast. Although the assessment concludes that these sites could be avoided with up to 1800MW of development in the area, there is still potential, due to the close proximity of any development in this area to the coastline, that this level of development could have a likely significant adverse effect on seabird populations, in particular migratory species and species that feed and loaf in nearshore areas.

The nearshore areas around the south coast are also recognised as being of potential importance for marine mammals, turtles and basking sharks. There are a small isolated populations of harbour seals within Kinsale Bay and Dungarvan Harbour and a small breeding population of grey seals in the far west of the area. Saltee Island is also designated as an SAC for grey seal. In addition to seals, there are also regular sitings of harbour porpoise and bottlenose dolphin in the area and high numbers of cetacean species (fin and humpback whales are seasonally abundant in the area). The area is also important for turtles with high numbers of sightings of leatherback turtles. There are also high numbers of basking shark sightings in the area.

The potential effects of offshore wind developments on feeding, breeding and migratory patterns of marine mammals, turtles, basking sharks and other fish species are still not well understood, particularly the effects of noise from piling of turbine foundations and the longer term effects of operational developments on habitat exclusion and creating barriers to the movements of mammals, reptiles and fish along migratory routes to between feeding and breeding areas. Further surveys would be required at the project stage to inform the assessment of the likely significance of any potential cumulative effects of a number of offshore wind farm developments in this area, in particular given the fact that future development in this area in likely to be located close inshore.

In addition to potential effects on nature conservation, any development above 1800MW of offshore wind development in this area is also likely to be constrained by existing commercial fishing activities, particularly inshore fisheries, for which there is currently limited understanding due to a lack of data relating to the movement of small fishing vessels that are less than 15m in length. There are a number of important shellfisheries areas along the south coast, including *Nephrops*, edible crab, lobster, shrimp, scallop, crayfish and whelk, as well as extensive spawning grounds for herring, cod, haddock and whiting. It is likely that some of these shellfisheries areas could be subject to direct disturbance from offshore wind developments, the likely significance of these potential effects would increase as the level of development increases. In terms of the spawning areas, there is potential for these areas to be disturbed during the construction of the offshore wind farms. However, the likely significance of these effects can be reduced by avoiding the key spawning seasons. Additionally, in the long term, the presence of the offshore wind farms could provide further refuge for key species during spawning.

The main area where there is potential for development off the south coast also overlaps with the main shipping channel that runs along the south coast of Ireland. Vessel densities in this shipping lane are generally very high. Due to the constrained nature of the resource for fixed offshore wind developments in this area, it is likely that any development above 1500MW to 1800MW would overlap this main area of shipping. This could potentially have significant adverse effects on navigational safety by increasing the risk of collision and increased vessel displacement in the area.

One of the other main constraints on development in this area is the potential for likely significant effects on seascape. In general, potential effects on seascape increase with distance offshore. However, given that the main area of offshore wind resource (for fixed devices) is located within the nearshore areas, it is likely that, even in the areas where the main seascape type is type 4, low lying coastal plain, which generally has a lower sensitivity to offshore wind development, the potential effects on seascape will be of moderate significance. Due to the nearshore nature of any offshore wind development in this area, it is likely that any effect on the more sensitive seascape areas such as the large bays, which are prominent along the south coast, will be substantial to moderate, depending on the siting of individual developments.

12.11.4 Assessment Results Assessment Area 4: West Coast (South) – Offshore Wind and Wave

Table 12.8 below provides an overview of the main findings from the cumulative assessment for Assessment Area 4.

Table 12.8 Assessment Area 4: West Coast (South) – Wind and Wave

Technology	Wind	Wave (10m to 100m depth)	Wave (100m to 200m depth)
Development Potential (MW) prior to assessment of Environmental Effects	>10000MW	>5000MW	>5000MW
Development Potential (MW) with Environmental Effects (including mitigation)	600MW to 900MW	500MW to 600MW	3000MW to 3500MW
Existing and proposed development	0MW	0MW	0MW
Remaining potential for development	600MW to 900MW	500MW to 600MW	3000MW to 3500MW
Summary of Main Constraints	Water depth, geology and coastal processes, seascape, protected sites, benthic communities, birds, marine mammals and recreation and tourism.	Protected sites, birds and marine mammals, seascape and commercial fisheries.	Birds and marine mammals, commercial fisheries.

12.11.4.1 Offshore Wind (Fixed) Potential

As with Assessment Area 3, there is a significant offshore wind resource located off the southwest coast of Ireland. However, opportunities for the development of this resource with fixed foundation devices are significantly constrained across the majority of this assessment area due to water depth, which in many places increases to more than 60m depth very close to the shore (e.g. within one to 15km of the coast). Overall the assessment has identified that there is potential for the development of between 500MW and 600MW of offshore wind (fixed) in this assessment area. Other than water depth the main constraints on development include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Shipping and Navigation
- Seascape
- Commercial fisheries

In addition to water depth development opportunities in this assessment area are further constrained by the diverse and rich natural environment along this coastline and the surrounding marine area. Where potential opportunities for development do exist these are generally very close to the coast, and consequently are further constrained by the presence of a number of protected sites (e.g. Castlemaine Harbour SAC, SPA and Ramsar site, Ballinskelligs Bay SAC, Blasket Islands SPA, SAC and MPA and Roaringwater Bay and Islands SAC and MPA) that are present in the area.

However, due to the high ecological and biodiversity value of this part of the Ireland coast and marine environment, the assessment has identified that, even though there could be potential to develop up to 1800MW (e.g. six 300MW developments) in areas outside these protected sites, development to this level (1800MW) is likely to have a significant adverse effect on the surrounding sections of coastline and nearshore areas which have been identified by the NPWS as having significant potential to support Annex I habitats (benthic) and which also support a large number of breeding colonies for birds and both harbour and grey seals. The surroundings waters have also been identified as being of importance for leatherback turtles with the Counties of Cork and Kerry having the highest and second highest number of turtle records respectively.

The assessment concludes that, overall, any development above 600MW (two 300MW offshore wind farms) is likely to have negative effects on the overall intrinsic nature conservation and biodiversity importance of this area, with likely significant effects occurring for anything above 900MW (three 300MW offshore wind farms).

Characteristically the south western coast of Ireland is a very exposed, rugged, remote and generally undisturbed area. This is reflected in its rich and diverse nature conservation and biodiversity value, and its complex and distinct seascape character which is made up of exposed and rugged peninsulas and headlands with expansive elevated views combined with sheltered inner sounds with small scale views framed by the surrounding wild, rural landmass. The wild, rugged and dramatic seascape character of this part of the coast is an integral part of the character and atmosphere of the Skellig Michael World Heritage Site (WHS) which is designated for its outstanding cultural value as an early monastic site and remote hermitage site.

The seascape character of this area and the Skellig Michael WHS are both considered to be highly sensitive to potential offshore wind developments in this area. The seascape assessment concludes that any development within 0 to 24km of the coast is likely to have a moderate to substantial significant effect on seascape character and, depending on where a development is sited, the setting of the WHS. Given that, due to technical constraints associated with water depths, any fixed offshore wind development located in this assessment area is likely to be located within very close proximity to the coastline e.g. within a couple of km from the coast, these potential effects are most likely to be of substantial significance. With site specific seascape assessments it may be possible to identify some locations where potential effects could be reduced to moderate or slight. However, it is unlikely due to the overall character of this area that more than one or two 300MW offshore wind farms (e.g. 600MW) could be developed without substantial significant effects.

One of the areas that, from a technical perspective, has been identified as having potential for development is Dingle Bay which is one of the few areas where shallower waters extend far enough to accommodate commercial offshore wind farm developments in areas outside the main shipping channels that run in and out of this area. However, due to the character and ecological value of this area, it is likely that any development in this bay would potentially have likely significant adverse effects on nature conservation and seascape. There may also be indirect effects on recreation and tourism, which is key feature of this area.

Elsewhere, the main shipping channels that pass through this assessment area run very close to the adjacent coastline. Therefore in order to avoid these channels, development would need to be sited very close to the coast, where as noted above it is likely to have significant adverse effects on nature conservation and biodiversity, seascape and the Skellig Michael WHS and recreation and tourism.

In addition to the effects mentioned above, it should also be noted that this area is important for commercial fisheries, and although the main edible crab and *Nephrops* areas generally extend further offshore, and are therefore unlikely to overlap with any of the fixed offshore wind development, there are still a number of nearshore shellfishery areas which would be sensitive to direct disturbance from offshore wind development. These include lobster, shrimp, spider crab, scallops and crayfish. There are also important spawning areas for herring, whiting, megrim and haddock located throughout this assessment area. As with the other assessment areas, there is still limited understanding on inshore fishing activities in these areas due to a lack of data on the movement of small fishing vessels (less than 15m). It is likely that further studies and consultation with inshore fisheries groups would be required at the project stage in order to determine the significance of any potential effects on inshore fishing activities in these areas.

12.11.4.2 Wave Potential

The results from the assessment have concluded that in Assessment Area 4 there is potential to develop between 500MW and 600MW from wave energy in areas with water depths between 10m and 100m and 3000MW to 3500MW in water depths of 100m to 200m. Wave energy is generally much less constrained by water depth than fixed offshore wind developments and therefore can be development in areas that are located much further offshore. This not only increases potential opportunities for avoiding key environmental constraints such as protected sites, and other marine activities, it also increases the overall total resource that could be available for development.

However, there is an exception to this, which are the oscillating wave surge converter devices, some of which operate in shallow water of around 10m depth and therefore is located in very nearshore areas (e.g. up to half a kilometre offshore). However, it is unlikely that oscillating wave surge converter devices that operate in shallow waters would be installed in this Assessment Area due to the limited availability of shallow nearshore sites (in most locations water depths increase to more than 60m within 20m to 25m of the shore).

It should be noted that although the generating capacity for wave devices is similar to offshore wind technologies e.g. average generating capacity of 10MW per square km, the technology for extracting energy from the waves is much less advanced than wind technology. Therefore based on current progress, the scale of the wave arrays that have been considered for this SEA are much smaller than offshore wind farm developments with the average commercial scale of a wave array being approximately 30MW compared to 300MW for wind. However, due to the scale of the wave resource available in Irish waters, and the fact that in most areas, due to the ability to develop wave further offshore, there are less environmental constraints on development, the approach to identifying the potential wave capacity in each area was based on identifying broad areas where wave development could occur and applying the principal that the average generating capacity is 10MW per square km, irrespective of the actual size of individual arrays.

It is acknowledged that this is likely to change in the future as technologies for extracting energy from waves continue to develop and evolve. This potential for change in terms of the overall scale of commercial wave developments has been taken into account in the assessment of potential environment effects.

Based on the results from the assessment, the main factors that influence the amount of wave development that could be accommodated in this Assessment Area include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Seascape

Opportunities for developing wave energy in Assessment Area 4 are generally much less constrained than for offshore wind as the majority of the developments can be located in offshore locations where they would avoid most protected sites (although there are some offshore SACs designated for benthic communities e.g. Belgica Mound and Porcupine Bank SW which, although they are located outside the study area would need to be taken into account in the future siting of any wave arrays in this area. The main potential areas for wave development also overlap the NPWS broad areas for potential Annex I habitat (benthic). Again, further studies and surveys would be required at the project stage to determine the presence of sensitive benthic communities in certain locations and assess the likely significance of any effects from wave arrays on these communities.

Again, in terms of birds, marine mammals, marine reptiles and fish, the assessment has identified that the majority of potential areas for the development of commercial wave arrays are in offshore areas, away from the main breeding colonies for birds and seal and the adjacent nearshore feeding areas. However, although there is limited data on the distribution, abundance and behaviour of birds, marine mammals, marine reptiles and fish in offshore waters, this does not imply that these receptors are not present in these areas. Therefore although the wave arrays may be located in offshore areas, these developments could still have adverse effects on birds, marine mammals, marine reptiles and fish in terms of direct habitat exclusion due to the presence of the arrays or from noise during the installation and operation of the arrays, and possible creation of barriers to movement where there are a number of commercial arrays sited close together.

When identifying potential opportunities for the development of wave arrays in this area consideration was given to the amount of development that could be accommodated across the area whilst maintaining reasonable distances between individual arrays in order to avoid any likely significant effects in terms of habitat exclusion and barriers to movement from developments being located to close together.

Other potential constraints on wave developments in Assessment Area 4 include potential effects on seascape and the Skellig Michael WHS. It is recognised that, in general seascapes are less sensitive to wave developments than offshore wind developments, mainly due to the fact that wave devices tend to lie on the surface of the water whereas as wind devices protrude, in some cases up to 40m or 60m above the surface of the water and therefore are more visually and physically intrusive.

As noted above, the seascape character of Assessment Area 4 is complex and distinctive, comprising rugged and exposed peninsulas and headlands with sheltered bays, with a general feeling of being very wild and remote. It is therefore likely that, although seascape types are generally less sensitive to wave arrays than offshore wind developments, the introduction of new, manmade structures into a very natural, wild and remote seascape is still likely to have substantial to moderate effects on seascape character within 0 to 10km from the coast and moderate to slight moderate effect between 10km and 15km. Beyond 15km most effects on seascape character will reduce to slight or neutral due to reduced visibility of the arrays at this distance. It is therefore also likely that, depending on their location, wave arrays in this area could also have adverse effects on the setting of the WHS, although further assessments would be required at the project stage to confirm the likely significance of these effects.

By developing further offshore, there are a number of opportunities for locating arrays in areas that avoid main areas for shipping and navigation, reducing any potential for significant adverse effects on navigational safety. Similarly, there are also options for reducing potential effects on commercial fisheries and other marine activities in the area.

12.11.5 Assessment Results Assessment Area 5: West Coast – Offshore Wind and Wave

Table 12.9a below provides an overview of the main findings from the cumulative assessment for Assessment Area 5.

Table 12.9a Assessment Area 5: West Coast – Wind and Wave

Technology	Wind	Wave (10m to 100m depth)	Wave (100m to 200m depth)
Development Potential (MW) prior to assessment of Environmental Effects	>10000MW	>10000MW	>10000MW
Development Potential (MW) with Environmental Effects (including mitigation)	600MW	5000MW	6000MW to 7000MW
Existing and proposed development	100MW (Sceirde Rocks Wind Farm)	0MW although area includes MRIA 'initial developments areas' for North Kerry, West Clare and southern section of North Mayo area. Area also includes Belmullet wave test site.	0MW
Remaining potential for development	500MW	5000MW	6000MW to 7000MW
Summary of Main Constraints	Water depth, seascape, protected sites, birds, marine mammals and recreation and tourism.	Protected sites, birds and marine mammals, seascape, navigation and commercial fisheries.	Birds, marine mammals and commercial fisheries.

12.11.5.1 Offshore Wind (Fixed) Potential

As with Assessment Areas 3 and 4, potential opportunities for offshore wind (fixed) are constrained in this assessment area due to the water depths which drop to below the optimal depth for fixed wind structures of 60m within a very short distance from the shoreline e.g. 5km to 25km. The cumulative assessment concludes that there could be potential to develop between 300MW and 600MW from offshore wind (one to two 300MW wind farms). Of this, the Sceirde Rocks Wind Farm is due to receive a grid connection offer in the Gate 3 process and are currently awaiting a decision on their foreshore lease application, reducing the remaining potential for development in this area from offshore wind (fixed) to 500MW.

In addition to water depth, the main environmental factors limiting development within this Assessment Area to between 300MW and 600MW include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Shipping and Navigation
- Commercial fisheries
- Seascape

Any development above 600MW is likely to have a significant adverse effect on protected sites, benthic communities, birds, marine mammals, marine reptiles, fish, seascape, shipping and navigation, and commercial fisheries. This is mainly because the offshore wind resource is so restricted in this assessment area that it would be very difficult to avoid these main environmental receptors and other marine users that also occupy areas close to the shore.

As with Assessment Area 4, the majority of the coastline in this assessment area is protected by international and national designations e.g. MPAs, SACs, SPAs and Ramsar sites and there are a large number of breeding colonies for birds and both harbour and grey seals. The area is also important for leatherback turtles, which have been sighted offshore and in nearshore areas. The potential offshore wind (fixed structure) areas also overlap with the broad areas identified by the NPWS as having potential to support Annex I habitats (benthic communities). Further studies would be required at the project stage to confirm the presence of sensitive habitats and the likely significance of any potential effects on these habitats and wider benthic communities.

In terms of the potential effects on seascape, the coastline of Assessment Area 5 is varied and complex, comprising a number of different seascape types from large bays and sea loughs including the mouth of the Shannon, Galway and Clew; numerous offshore islands including the Achill and Aran Islands; dramatic high cliffs, peninsula's and headlands such as the Cliffs of Moher and the Dingle Peninsula along with sandy flats and flat or very low lying complex islands and peninsulas such as Blacksod Bay. The landscape character is generally rural with some remote and undeveloped areas of natural grassland and bog and some dense urban areas such as Galway. All of these different seascape types have different levels of sensitivity to offshore wind farm developments, although due to the general undeveloped nature of this section of the coast, most areas are of moderate to high sensitivity. Due to the complex and indented nature of the coast in certain locations effects on one seascape type are likely to overlap with effects on adjacent seascapes of lower sensitivity, increasing local sensitivity to development of this type.

The assessment concludes that overall, the significance of potential effects of offshore wind farm developments on seascape decrease with distance from the shore. However, given that in this assessment area, development of offshore wind farms would be constrained to the coastal and nearshore areas due to water depth, it is likely that, at a strategic level offshore wind farm developments in such close proximity to the coast would have at least moderate to substantial, if not mainly substantial significant effects on seascape. However, more detailed seascape assessments would be required at the project stage to determine the exact nature of the effects on seascape and the likely significance of those effects.

Assessment Area 5 also includes a number of shellfish areas which could potentially be affected by offshore wind (fixed) developments in nearshore areas. These include spider crab, lobster, shrimp, oyster and crayfish. The areas for edible crab and *Nephrops* extend further offshore and are therefore less likely to be effected by developments in the nearshore areas. The area may also be used for inshore fin fishing although the characteristics of these activities are unknown due to limited data available on the movement of the smaller vessels (less than 15m in length) which are used to fish the more inshore areas. Further information on inshore fishing activities will need to be obtained from additional studies and extensive consultation with inshore fisheries groups.

In order to avoid any significant adverse effects on shipping and navigation the main shipping route into Galway Bay has been avoided.

12.11.5.2 Wave Potential

The assessment concludes that there is potential in this area for the development of up to 12000MW from wave energy without likely significant adverse effects on the environment (based on 5000MW in 10m to 100m water depth and between 6000MW and 7000MW in water of 100m to 200m depth. This is based on existing available information and could potentially be higher (or indeed lower) subject to additional studies and surveys being carried out either at the project or strategic level to fill known data and information gaps in the area and based on the acquisition of additional knowledge on the potential interactions between wave devices and the certain key receptors from the monitoring of wave developments deployed elsewhere.

This Assessment Area also includes some of the 'initial development areas' which have been identified by the MRIA as having potential for wave developments (North Kerry, West Clare and the southern section of the North Mayo area) and contains the proposed Belmullet test site which can accommodate up to three full scale prototype devices.

As with Assessment Area 4, the constraints on wave development in this area are generally limited due to the fact that the main areas for development are generally located further offshore than fixed offshore wind or tidal developments. Therefore, there are more options and greater flexibility for identifying development sites that avoid the most sensitive receptors that are present in the area. Based on the results from the assessment, the main factors that influence the amount of wave development that could be accommodated in this Assessment Area include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Seascape
- Commercial fisheries

As noted in section 12.9.2.2 above, the majority of the coastline in this assessment area is protected under International, European and national designations which include a large number of MPAs, SPAs, SACs, Ramsar Sites and IBAs. Whilst it is possible to avoid these protected sites by siting developments further offshore, wave developments could still potentially affect key receptors that are present in the areas outside these sites, such as birds, marine mammals, marine reptiles and fish in terms of habitat exclusion from the physical presence of developments in an area or noise generated during the installation and operation of a development or by creating barriers to movement along migratory routes or between feeding and breeding areas (mainly marine mammals and fish).

Much of the coastline supports large breeding colonies of seabirds and both harbour and grey seals. There have also been a significant number of sightings of harbour porpoise within Galway Bay and bottlenose dolphins are known to be prevalent in the area. It is suggested that the area is a migratory corridor for humpback whales and is also known to be important for leatherback turtles and basking sharks. It is therefore likely that a number of specific surveys would be required at the project level to determine the likely significance of any potential effects on these species. Surveys also likely to be required to determine whether there are any sensitive Annex I habitats (benthic) in this area and assess the likely significance of wave developments on these habitats and wider benthic communities.

In identifying the overall potential for the development of wave energy in this area, consideration was given to identifying areas where there would be options for developments to be sited sufficient distances apart to minimise the potential for a number of development in a location to create barriers to movements or lead to the exclusion of certain receptors from large areas of the sea.

This approach would also help to reduce potential effects on seascape by reducing the clustering of developments in certain areas. As discussed above the seascape assessment has identified that the coastline in Assessment Area 5 is varied and complex and comprises a range of seascape types, each of which has a varying level of sensitivity to the different types of offshore renewable energy developments that could occur in the area.

Overall, most of the seascape types in this area will have a lower sensitivity to wave developments than offshore wind developments. However, developments in nearshore and coastal areas e.g. 0km to 5km from the coast are likely to have more significant effects on seascape e.g. moderate to substantial depending on seascape type and location, than developments located further offshore. Given that the main area of wave resource has been identified in the offshore areas, it is likely that the associated potential effects on seascape will range in significance from slight to moderate. However, more detailed seascape assessments would be required for individual projects to determine the actual likely significance of any potential effects, particularly for wave projects where there is still a high level of variation between the different types of devices that could be deployed in certain areas.

It should also be noted that, whilst most of the potential areas of wave resource that could be suitable for development is located in offshore areas, there could be potential for nearshore and coastal sites to be developed by oscillating wave surge devices that operate in shallower water. Specific seascape assessments would be required to determine the potential effects of this device type on seascape character, both in terms of the offshore elements (device) and the onshore elements of this development (turbines are located on shore).

There are limited constraints in this area in terms of shipping and navigation. However, any future wave developments will need to take account of potential effects on commercial shell fisheries and fin fisheries including offshore areas for edible crab and *Nephrops*. The main commercial fishing grounds for fin fish are generally widespread across most of this Assessment Area and include haddock, megrim, black sole, hake and Angler fish. The potential effects of wave developments on these fishing grounds and the significance of these effects is dependent upon the importance of the fishing area and whether there would be options to continue fishing within the development area. It is therefore likely that, for all developments in this area, further studies would be required combined with extensive consultation with commercial fisheries groups and representatives to identify key fishing grounds and understand the likely significance of wave developments on commercial fishing activities.

12.11.6 Assessment Results Assessment Area 5a: Shannon Estuary - Tidal

Table 12.9b below provides an overview of the main findings from the cumulative assessment for Assessment Area 5a.

Table 12.9b Assessment Area 5a: Shannon Estuary – Tidal	
Technology	Tidal
Development Potential (MW) prior to assessment of Environmental Effects	1000MW
Development Potential (MW) with Environmental Effects (including mitigation)	0MW
Existing and proposed development	0MW
Remaining potential for development	0MW
Summary of Main Constraints	Protected sites, benthic ecology, birds, marine mammals, fish, and navigation

In addition to the potential offshore wind and wave resource in Assessment Area 2, the Shannon Estuary was also identified as having containing a significant tidal stream resource. However, further investigation of the area identified that, although there is significant potential tidal resource within the area there are very limited opportunities for the development of this resource at a commercial scale. However, there may be opportunities for the area to be used as a location to test tidal devices or for the deployment of a full size demonstration projects, although the potential effects of these developments have not been assessed as part of this SEA and therefore would need to be looked at as part of a separate study or specific project proposals.

The main environmental factors restricting any tidal development within the Shannon Estuary include:

- Potential effects on protected sites, benthic ecology, birds and marine mammals
- Shipping and Navigation
- Commercial fisheries

There are a number of factors that limit any opportunity for commercial scale tidal development in the Shannon Estuary. These include in particular the likely significant adverse effects on the Lower River Shannon SAC which is designated for its population of bottlenose dolphins (which is the only resident population in Ireland) and Annex I habitats (benthic). Given that the SAC occupies the entire estuary in this area, it would not be possible to avoid this site. It is therefore likely that any commercial scale development within the estuary could potentially have a significant adverse effect on these qualifying features, particularly as, due to the restricted space within the estuary, there is potential for an increased risk of collision between the development and the dolphins and limited options for avoiding any of the areas of Annex I habitat that is presented in the area. In addition to the SAC, there are also a number of SPAs in the estuary which are also likely to affected by a commercial scale tidal development either directly or due to habitat loss, disturbance and noise in the immediate surrounding area.

In addition to effects on nature conservation and biodiversity there are also likely to be significant adverse effects on shipping and navigation as the entire section of the estuary that contains the main tidal resource is recorded as having a high intensity of shipping movements. Although there could be opportunities for coexistence in this area, it is likely that the water depths within the estuary are insufficient to provide sufficient clearance between fully submerged devices and vessels. It is therefore likely that any commercial scale development in the estuary would result in devices being placed in the main shipping channel which potentially would have likely significant adverse effects on navigational safety due to increased collision risk and vessel displacement in an already constrained area and reduced port access.

The Seascape of the Shannon river estuary is made up of low flat or rolling coastlines and estuarine seascape with mudflats and islands forming a broad horizontal vista. The potential effects on seascape of tidal devices that protrude above the water surface are likely to be of moderate significance. Local sensitivity may increase in proximity to areas recognised as of local scenic or amenity value or may decrease in proximity to existing commercial or industrial infrastructure.

There are also likely to be effects on commercial fisheries within the estuary.

Overall, due to the constraints associated with the SAC and potential for likely significant adverse effects on the resident population of bottlenose dolphins and the Annex I habitats, and potential effects on the SPA and associated seabird populations, and the intensity of shipping in the main channel, it was concluded that there would be no opportunity for the development of a commercial scale tidal development within the Shannon Estuary.

12.11.7 Assessment Results Assessment Area 6: West Coast (North) – Offshore Wind, Wave and Tidal

Table 12.10 below provides an overview of the main findings from the cumulative assessment for Assessment Area 6.

Table 12.10 Assessment Area 6: West Coast (North) – Wind, Wave and Tidal

Technology	Wind	Wave (10m to 100m depth)	Wave (100m to 200m depth)	Tidal
Development Potential (MW) prior to assessment of Environmental Effects	>10000MW	>10000MW	>10000MW	>5000MW
Development Potential (MW) with Environmental Effects (including mitigation)	3000MW to 4500MW	7000MW to 8000MW	6000MW to 7000MW	750MW to 1500MW
Existing and proposed development	0MW	0MW	0MW	0MW
Remaining potential for development	3000MW to 4500MW	7000MW to 8000MW	6000MW to 7000MW	750MW to 1500MW
Summary of Main Constraints	Slight effects on protected sites, benthic communities, birds, marine mammals, reptiles and fish.	Protected sites, marine mammals, birds and benthic communities.	Birds, marine mammal and commercial fisheries.	Marine mammals, birds, benthic communities, commercial fisheries and navigation.

12.11.7.1 Offshore Wind Potential (Fixed)

Assessment Area 6 has been identified as having the greatest development potential in terms of fixed offshore wind of all of the Assessment Areas. This is mainly due to water depths in this area generally being shallower than elsewhere on the west or south coast, therefore increasing the total potential resource that is available for development and there being, in comparison to the other Assessment Areas, low levels of shipping/vessel movements across the area. The removal of these main constraints from this areas means that there are more opportunities for locating developments in offshore areas, therefore avoiding protected sites and reducing potential effects on other sensitive receptors e.g. birds, and marine mammals that breed along the coast. Developing areas further offshore also reduces the likely significance of potential effects on seascape and potential effects on shellfisheries and inshore fin fisheries.

Overall the assessment concluded that there is potential to develop between 3000MW and 4500MW from offshore wind in Assessment Area 6. This figure reflects the overall size of the assessment area and scale of the offshore wind resource that it contains. However, although there is potential to avoid the protected sites that are present in the area including a large number of MPAs, SPAs, SACs, Ramsar Sites and IBAs, there will still be a requirement for a range of project specific studies to be carried out in order to confirm the presence of key sensitive receptors in both nearshore and offshore areas and the likely significance of any potential effects on those receptors e.g. habitat loss and barriers to movement.

This is of particular importance in terms of benthic ecology as some of the potential areas for offshore wind development overlap with the broad areas identified by the NPWS as having potential to support sensitive Annex I habitat. There have also been a large number of sightings of harbour porpoise, bottlenose dolphin, leatherback sea turtles (historically Donegal has the third highest numbers of sightings in Ireland) and basking sharks in the area. There is also potential for a number of birds to use the nearshore and offshore areas for feeding and loafing.

One of the main limitations on the total amount of development that could be accommodated in this area is the potential cumulative effects on seascape including transboundary effects in respect to Northern Ireland and the south west coast of Scotland. These transboundary effects include potential effects on the Giant's Causeway World Heritage Site located off the north coast of Northern Ireland. Specific assessments would be required for individual projects to determine how offshore wind developments in Irish waters would affect neighbouring seascape areas and important areas e.g. WHSs and the potential significance of those effects.

The coastline of this Assessment Area which extend north from Glendorragh Point in County Mayo to Inishowen Head in Donegal is complex and varied and comprises and number of different seascape character types from large bays and sea loughs, numerous offshore islands, dramatic high cliffs, peninsulas, headlands, to sandy flats and flat/low lying complex islands and peninsulas. The landscape character is mainly rural with small scattered coastal towns. The main area of dense urban development is located around Donegal. Each of the different seascape types has varying levels of sensitivity to offshore wind farms and, due to the complex and indented nature of the coast, in certain locations effects on one seascape type are likely to overlap with effects on adjacent seascapes, potentially increasing local sensitivity. Consequently the potential significant of an offshore windfarm development on the seascape within this Assessment Area varies from location to location.

For most of the seascape types in this area, any offshore wind (fixed) development located between 0km and 24km from the coast is likely to have a substantial to moderate significant effect on seascape. The significance of any effect will reduce with distance from the shore; therefore it is likely that for any development beyond 24km the significance of the potential effect on seascape would reduce from moderate to slight. The overall significance of a development is also dependent on its location. For example, where the seascape character type is low lying coastal plain, which is the least sensitive type of seascape, the likely significance of any potential effects from offshore wind developments located within 0km to 24km of the coast may only range from moderate to slight.

In terms of cumulative effects, the overall significance of potential effects is likely to increase as development increases. Therefore, in determining the overall potential for offshore wind developments in this area consideration has been given to siting developments at reasonable distances to reduce the potential for creating visual barriers. This approach has also been used when considering potential effects on benthic ecology, birds, marine mammals, marine reptiles and fish in terms of habitat loss and exclusion and creating barrier to movement.

12.11.7.2 Wave Potential

The assessment concludes that there is potential in this area for the development of between 13000MW and 15000MW from wave energy with minimal adverse effects on the environment. This is based on existing available information and could potentially be higher subject to additional studies and surveys being carried out either at the project or strategic level to fill known data and information gaps in the area and based on the acquisition of additional knowledge on the potential interactions between wave devices and the certain key receptors from the monitoring of wave developments deployed elsewhere.

In addition to potential effects on benthic ecology and mobile species such as birds, marine mammals, marine reptiles and fish relating to habitat loss/exclusion and creation of barriers to movement, the other main factor that is likely to limit how many wave developments can be accommodated in this area will be the potential effects on seascape, particularly when considered in combination with high levels of offshore wind development in this area. As discussed previously, most of the seascape types found within Assessment Area 6 are generally less sensitivity to wave developments than offshore wind development. It is also likely that a large proportion of the wave developments would occupy offshore areas, further reducing the significance of any potential effects from moderate to slight.

12.11.7.3 Tidal Potential

Overall, there could be potential to develop between 750MW to 1500MW from tidal energy in this Assessment Area. As with offshore wind (fixed) and wave this, in comparison to the other Assessment Areas, indicates that there is significant potential for the development of offshore renewables off the northwest coast of Ireland.

Although the main area of tidal resource is located closer inshore than the potential offshore wind and wave resource, the assessment still concludes that, due to the overall scale of the tidal resource that is present in this assessment area, and limited constraints in terms of water depth and restrictions associated with shipping and navigation routes, that the indicated levels of development can still be achieved whilst avoided all protected sites and other sensitive areas.

However, as with offshore wind and wave in this area there will still be a requirement at the project stage to carry out surveys to determine whether key sensitive receptors e.g. Annex I habitat, birds (particularly diving and pursuit feeders), marine mammals, marine reptiles and fish are present in the area and to assess the likely significance of any potential effects on these receptors from tidal developments. The main potential effects that are likely to be of significant in terms of tidal developments include habitat loss and exclusion due to the physical presence of devices and noise generated during installation (piling) and operation, the risk of collision with operation devices (mainly affecting diving and pursuit feeding birds, marine mammals, marine reptiles and large fish species) and associated barriers to movement between feeding and breeding areas and along migratory routes.

This will be particularly important where tidal developments are located close to the coast where there are a significant number of bird and seal (harbour and grey) breeding colonies. There have also been a large number of sightings of harbour porpoise and bottlenose dolphin along the Donegal coast and the area is recognised as having the third highest recorded sightings of leatherback sea turtle. There have also been a significant number of basking shark sightings in this area.

In order to minimise the potential for any significant adverse effects on marine wildlife, consideration has been given to identifying areas where there are a range of possible locations for development and therefore options for identifying alternative sites if necessary should the surveys identify that the development in a certain location could have a significant adverse effect on a particular receptors. Consideration was also given to ensuring that within certain areas, certain amounts of development could be accommodated whilst maintaining reasonable separation distances between different developments to minimise the risk of creating barriers to movement and the extent of habitat loss/exclusion.

In terms of potential effects on seascape, most seascape types are generally less sensitive to tidal developments than either wave or offshore wind developments, as the devices are usually either fully or partially submerged beneath the water, therefore minimising the potential level of intrusion from this type of development. However, given that the main area of tidal resource is closer inshore than the wave or offshore wind resource, it is likely that, within 0km to 5km of the shore, where devices do protrude out of the water there would still be a substantial to moderate effect on seascape. As with the other technologies, the potential significance of any effect on seascape reduces with distance from the coast. In terms of tidal developments it is likely that from between 5km and 15km offshore most effects will be moderate to slight significance. The specific location of a development will also have a considerable influence over the likely significance of any effect on seascape. This would be determined at the project stage with a site and project specific assessment.

12.11.8 Assessment Results Floating Wind (Assessment Areas 3, 4, 5 and 6)

Table 12.11 provides an overview of the main findings from the cumulative assessment for floating wind in Assessment Areas 3, 4, 5 and 6.

Table 12.11: Floating Wind

Area	Area 3	Area 4	Area 5	Area 6
Technology	Floating Wind	Floating Wind	Floating Wind	Floating Wind
Development Potential (MW) prior to assessment of Environmental Effects	>20000MW	>20000MW	>20000MW	>20000MW
Development Potential (MW) with Environmental Effects (including mitigation)	6000MW	5000MW to 6000MW	7000MW	7000MW to 8000MW
Existing and proposed development	0MW	0MW	0MW	0MW
Remaining potential for development	6000MW	5000MW to 6000MW	7000MW	7000MW to 8000MW
Summary of Main Constraints	Birds, marine mammals, reptiles, fish and commercial fisheries.	Birds, marine mammals, reptiles, fish and commercial fisheries.	Birds, marine mammals, reptiles, fish and commercial fisheries.	Birds, marine mammals, reptiles, fish and commercial fisheries.

Due to the constrained nature of Assessment Areas 1 and 2, particularly in respect of shipping intensity, no resource potential for floating wind devices have been identified within these areas.

Overall, the assessment has concluded that there a significant potential for the development of floating offshore wind off both the south and west coast of Ireland. In total, taking into account potential environmental constraints there could be potential to development between 25000MW and 27000MW across Assessment Areas 3, 4, 5 and 6. This amount is based on existing available information and could potentially be higher (or indeed maybe lower) subject to additional studies and surveys being carried out either at the project or strategic level to fill known data and information gaps in the area, and based on the acquisition of additional knowledge on the potential interactions between wave devices and the certain key receptors from the monitoring of wave developments deployed elsewhere.

In terms of identifying the potential resource available for developing floating offshore wind off the coast of Ireland, the assessment has focused primarily on the offshore areas, most of which lie outside the main areas of resource identified for the other three technologies discussed previously. As there are no specific limits in terms of optimal water depth for floating wind devices, the main technical limiting factor in terms of the available resource that can be developed is the distance from the shore which for the purpose of this SEA has been set at 100km which is the upper limit of AC export cable technology.

Consequently the potential resource that is available is vast. As stated in the OREDP, Ireland's ocean territory extends over 89 million hectares. Taking this into account, the 27000MW of floating offshore wind would occupy approximately 270,000ha (based on the average size of a single commercial scale development of 300MW covering 30km^2). This equates to less than 1 percent of Ireland's total ocean territory.

However, although there is a substantial floating offshore wind resource available, there are a number of challenges facing development in these offshore areas, mainly relating to the extremely harsh conditions that these developments would have to withstand and the difficulties with installing and maintaining developments in these locations. In terms of environmental constraints, the majority of potential effects associated with these developments are unknown. This is also due to the harshness of the conditions offshore making it very difficult to obtain data and information relating to the character of the marine environment in these offshore areas.

All of the potential areas of identified as part of this SEA for the development of floating offshore wind across all four of the Assessment Areas avoid all known protected sites. However, it is acknowledged that there are four offshore SACs (Belgica Mound, Hovland Mound, NW Porcupine Bank and SW Porcupine Bank), that although located outside of the study areas of this SEA (beyond 200m) illustrate that there is potential for sensitive Annex I habitats (benthic) to be present in these offshore areas. There is potential that these four offshore SACs could in due course also be declared as OSPAR MPAs. Further to that, the NPWS has identified a number of broad areas, in coastal, nearshore and offshore locations, where there is potential for further Annex I habitats to be present. Therefore, although the areas identified for development currently avoid all existing protected sites, there would still be a requirement at the project level to carry out necessary surveys to confirm whether sensitive Annex I habitats are present in the area and to assess the potential effect of floating offshore wind developments on those habitats and determine the likely significance of those effects.

In addition to benthic habitats, very little is known about the distribution, abundance and behaviour of certain mobile species in offshore areas. The assessment has identified that the waters around Ireland support significant populations of seabird and marine mammals as illustrated by the significant number of large breeding colonies (for birds and grey and harbour seals) that are located along the entire west coast coastline. There have also been significant sightings of harbour porpoise and bottlenose dolphin as well as sightings of fin (off the south coast) and humpback (Area 4) whale. There have also been significant sightings of leatherback turtles. Basking sharks have also been sighted in significant numbers along the entire west and south coast. Based on the number of sighting of certain key species throughout the assessment areas it is likely that they could also be present in the offshore areas. Further surveys would therefore be required at the project stage to confirm the presence of these species and to assess the likely significance of any potential effects from these developments on these species.

Commercial fisheries, both shellfisheries and fin fisheries are widespread throughout Assessment Areas 3 to 6 and therefore could potentially be affected by floating offshore wind developments. The main shellfish species fished in offshore area are edible crab and *Nephrops*, with other shellfish species fished occupying areas nearer to shore. The main fin fish species that are fished commercially in the offshore areas include herring, cod, haddock, whiting, Angler fish, megrim, hake, black sole, plaice and ling. There are also a number of important spawning areas for mackerel, cod, haddock, hake, megrim, horse mackerel and whiting distributed throughout these Assessment Areas.

The main potential effect on commercial fisheries will be permanent displacement from traditional fishing grounds. It is recognised that the potential effects of this are likely to be more significant for inshore fisheries where there is greater pressure on available resource and available fishing areas, with displacement likely to lead to increased competition for fishing areas. However, there could also be significant effects offshore depending on the extent of the displacement and the importance of the ground for key species. Further studies would be required, supported by extensive consultation with commercial fisheries groups and representatives to understand the potential effect on commercial fisheries in offshore areas and the significance of those effects. Opportunities for fishing to continue within developments would also need to be looked at. It should also be noted that in some areas, the presence of an offshore renewable energy development could assist with stock recovery where existing fishing activities are excluded.

In order to minimise any likely significant adverse effects on shipping and navigation, the areas that have been identified as having potential for floating offshore wind development are located in areas of low shipping intensity which is located to the west of the main shipping route that runs north south along the west coast and to the south of the shipping lane that runs east west along the south coast. All developments would be required to include the necessary navigational aids in order to prevent accidental collision between devices and vessels offshore, in particular large commercial fishing vessels that do not necessarily follow recognised shipping lanes.

As noted previously, the significance of any potential effects on seascape reduces with distance from shore. It has been identified, that, in general it is very difficult to see anything beyond 35km from the coast. Therefore, it is likely that the majority of floating offshore wind developments that could occur in the Assessment Areas would be developed beyond 35km from shore and therefore would be out of view. Any potential effects on seascape would be negligible. However, for any development within 35km from the coast, it is likely that a project specific seascape assessment would still be required in order to assess the potential effects on seascape and the likely significance of those effects.

12.12 Conclusions from Testing the OREDP Development Scenarios

12.12.1 Summary of Assessment Results

Table 12.12 provides a summary of the development potential (taking into account potential environmental constraints and other marine activities/users) for each of the different offshore renewable energy technologies within Assessment Areas 1 to 6.

Table 12.12: Development Potential in each Assessment Area

Assessment Area	Total amount of development (MW) that could potentially occur within each assessment area without likely significant adverse effects on the environment (taking into account mitigation).				
	Fixed Wind (MW)	Wave (MW) 10 to 100m Water Depth	Wave (MW) 100m to 200m Water Depth	Tidal* (MW)	Floating Wind (MW)
1: East Coast (North)	1200 to 1500***	-	-	-	-
2: East Coast (South)	3000 to 3300****	-	-	750 to 1500	-
3: South Coast	1500 to 1800	-	-	-	6000
4: West Coast (South)	600 to 900	500 to 600	3000 to 3500	-	5000 to 6000
5: West Coast	500	5000	6000 to 7000	-	7000
5a: Shannon Estuary	-	-	-	0	-
6: West Coast (North)	3000 to 4500	7000 to 8000	6000 to 7000	750 to 1500	7000 to 8000
Total Development Potential (MW) without likely significant adverse effects	**9800 to 12500**	**12500 to 13600**	**15000 to 17500**	**1500 to 3000**	**25000 to 27000**

Notes on Table 12.12 above:

- * = the tidal resource is based on tidal stream technologies only and does not include tidal barrages.
- ** = although there is a large potential resource that could be developed with floating wind technologies, it should be noted that this technology is still very much an emerging technology. It is therefore unlikely that this technology would be developed at a commercial scale by 2020, or even possibly 2030.
- *** = The development potential in Assessment Area 1 takes into account the proposed Oriel Windfarm (330MW) and the northern section of Dublin Array (approx 150MW).
- **** = The development potential in Assessment Area 2 takes into account the approved Arklow Bank Windfarm (520MW) and Codling Bank (1,100MW), and the southern part of the proposed Dublin Array windfarm (approx 214MW) which is due to receive a grid connection offer in the Gate 3 process.
- (-) = Limited technical resource available. These areas may contain potential resource for each of the technologies. However, the resource assessment has concluded that for technical reasons e.g. water depths/distances from shore etc, the resource that is available is unlikely to be developed in the timescale of the OREDP (e.g. by 2030) or over a longer term timescale.

- Wave energy was split between the shallower (10m to 100m depth) and deeper water resource (100m to 200m depth). It is likely that initial wave development which would occur in the main timeframe of the OREDP e.g. 2015 to 2025 is likely to occur in the shallower areas which tend to be located closer, with deeper waters being exploited in the longer term e.g. 2025 to 2030 and beyond.
- The figures (MW) included in the table indicate the amounts of development that could potentially be accommodated within an area without likely significant adverse effects on the environment. These figures are not 'caps' on the total level of development that could occur. They simply reflect the results from the assessment of cumulative effects. There are still a number of uncertainties/unknowns. Consequently there is potential that with increased certainty e.g. filling of data and information gaps that these levels of development (MW) in an area could increase or decrease.

12.12.1.1 Addressing Natura Sites and Marine Protected Areas

The Assessment of the Assessment Areas (Chapter 11) identifies that development within Natura sites is likely to have significant adverse effects on the integrity and conservation objectives of those sites. These conclusions reflect the fact that at the strategic level the type and nature of development that could occur in a certain area is unknown and that there are still a number of data and knowledge gaps relating to the potential effects of offshore renewable energy developments on marine wildlife in general.

The objective of Chapter 12 was to test whether it is possible, based on a number of assumptions, to achieve the development scenarios set out in the OREDP without likely significant adverse effects on the environment. One of these assumptions was that development would not occur within Natura sites. This reflects the findings of Chapter 11 and the necessity of avoiding likely significant effects. This was not to scope out Natura sites from the assessment, but to identify if and how development could occur without resulting in adverse effects. If this approach had not been applied then the assessment would have inevitably concluded that unacceptable adverse effects would result from Plan.

However, given that there are a number of uncertainties surrounding potential development within Natura sites (relating to data and knowledge gaps) it should be recognised that whilst it is possible to achieve the scenarios in the OREDP without developing in these sites, individual developers may still seek to develop within these protected sites. Where this is the case it would be the responsibility of the individual developer as part of the Foreshore Lease Consenting Process and in accordance with the Habitats Directive to provide the necessary evidence for the regulatory authorities to demonstrate that a specific project or number of projects in a certain location would not have a significant adverse effect on the integrity or conservation objectives of a given site.

In conclusion, development should not take place within Natura sites unless it can be comprehensively demonstrated at the project level that no significant adverse effects on the integrity and conservation objectives of the site would occur.

12.12.2 Discussion on the Results from the Assessment

12.12.2.1 Fixed Wind Development Potential

Overall, the results from the assessment indicate that the areas with the greatest potential for fixed offshore wind developments are the east coast (Assessment Areas 1 and 2) and Assessment Area 6.

Although there is also a significant offshore wind resource located off the west coast of Ireland, potential opportunities for developing this resource are significantly constrained by water depth along the entire south and west coast which drops to below the optimal depth for fixed offshore wind devices of up to 60m within only a few kilometres of the shore. Where technically suitable areas for development do exist these are either very small and in close proximity to the coast or are further constrained by the main shipping and navigation channels that run north south along the west coast and east west through Assessment Area 3 on the south coast.

Consequently there is very limited opportunity in any of these areas (Assessment Areas 3, 4 and 5) to avoid protected sites or located developments in areas away from other sensitive receptors, particularly as the majority of the coastline along the south and west coast supports a rich and varied range of marine wildlife and habitats including a number of known and potential areas of Annex I habitat and extensive large colonies of breeding birds and large populations of both grey and harbour seals. There have also been significant sightings of bottlenose dolphins, harbour porpoise, leatherback turtles and basking sharks throughout these areas, as well as sightings of fin and humpback whale. By constraining developments to coastal and nearshore areas, the potential for likely significant adverse effects on these species increases, particularly in terms of creating barriers to movement as there is less opportunity to avoid these development areas, especially where they occupy constrained areas between the shore and busy shipping lanes.

Opportunities for fixed offshore wind developments off the south and west coast is also significantly constrained by the potential effects on seascape, especially in Assessment Area 4, where coastal or nearshore developments could have substantial significant effects on the remote, wild and rugged character of this part of Ireland and the setting of the Skellig Michael World Heritage Site. Any fixed offshore wind development in coastal and nearshore locations elsewhere along the west coast are also likely to have substantial to moderate significant effects on seascape character of this area.

In comparison to the west coast, the east coast is generally much shallower and technically offers a significant potential resource for development. However, this area is also extensively used by shipping and navigation and other marine activities, as well as supporting a range of habitats and species of conservation importance. When potential environmental constraints and other marine activities/users are taken into account, the overall potential for development reduces slightly. Additionally of the available resource identified in Assessment Areas 1 and 2 for fixed offshore wind, approximately half is already taken up by existing and proposed developments (480MW in Assessment Areas 1 and 1,834MW in Assessment Area 2). Consequently the opportunity for further development in these areas is slightly more limited.

Assessment Area 6 offers the greatest potential in terms of developing new areas for fixed offshore wind. The area is still rich in marine wildlife and habitats with very large numbers of protected sites located along the coast, large numbers of breeding colonies for birds and seal (grey and harbour) populations and a significant number of sightings for harbour porpoise, bottlenose dolphin, leatherback turtles and basking sharks. There is also potential for Annex I habitat to be present throughout the area. However, the area is generally much shallower and there are much less constraints in terms of having to avoid busy shipping and navigation routes therefore there is more potential for avoiding protected sites and for locating developments further offshore to reduce the likely significance of potential effects on other sensitive receptors and seascape. There is also more opportunity for identifying alternative development sites should project or site specific surveys identify that key sensitive receptors are present in the area.

However, there are potential significant limitations with developing in Assessment Area 6 in term of the availability of grid connections in this area. This could potentially place a significant constraint on future development in this area. Transboundary effects with Northern Ireland and southwest Scotland also need to be considered for Assessment Area 6.

12.12.2.2 Tidal Potential

Potential opportunities for tidal energy are, in comparison to wind and wave, fairly limited. The results from the assessment have concluded that overall, there would be potential to develop tidal energy in both Assessment Areas 2 and 6.

Opportunities for developing tidal energy in Assessment Area 5a: Shannon Estuary is significantly constrained by nature conservation interests (protected sites, marine wildlife and habitats) and shipping and navigation. The assessment has therefore concluded that this area would not be suitable for commercial scale tidal developments. However, this does not preclude smaller test or demonstration projects being developed in this area although these would need to demonstrate at the project stage that they would not have significant adverse effects on the integrity and conservation objectives of the Lower Shannon River SAC or the surrounding SPAs in the area.

In terms of the opportunities in Assessment Area 2, the assessment has concluded that there are a number of potential locations where tidal developments could be accommodated. The main constraints in these areas relate to birds around Wexford Harbour and Wicklow Head to the south of the area. Project level studies and surveys would also be required to determine any potential effects on marine mammals and reptiles in the area. However, the level of potential development identified is based on avoiding the main shipping channels. Also more information is required on commercial fishing activities in this area, in particular relating to inshore fisheries where there is limited understanding of the characteristics of these fishing activities due to a lack of date on the movement and distribution of smaller inshore vessels that are less than 15m in length.

As with fixed offshore wind, Assessment Area 6 offers significant potential in terms of tidal developments, although it is likely that further studies and surveys would be required in this area to determine the potential effects on the marine wildlife in the area in particular sea birds (diving and pursuit feeders) associated with the extensive number of SPAs and breeding colonies located along the coast. Surveys would also be required to determine the potential significance of any potential effects on marine mammals known to the present in the area (e.g. grey and harbour seals, harbour porpoise and bottlenose dolphin), marine reptiles (in particular leatherback turtles) and basking sharks. This will be of particular importance in these tidal areas, as although due to the size of the resource available there are significant potential opportunities for development, and a number of opportunities for identifying alternative sites if necessary, the developments are still likely to be in coastal or nearshore areas, where the potential for likely significant adverse effects (e.g. habitat exclusion, collision risk and barriers to movement) is much higher due to the more constrained nature of these areas.

Overall, although both areas offer potential for tidal developments, there are still areas where due to a lack of knowledge, potential effects are still unknown. This is mainly in relation to collision risk and the potential for tidal developments to create barriers to movement along migratory routes and between feeding areas due to noise generated during the operation of tidal devices.

12.12.2.3 Wave Potential

Assessment Areas 4, 5 and 6 offer the greatest potential in terms of wave development. Overall, opportunities for the development of the wave resource in these areas are generally unconstrained, particularly in offshore areas where there are more options for avoiding protected sites and locating developments away from sensitive receptors. As with offshore wind, potential effects on seascape also reduce with distance from the coast. However, as with tidal developments there are still unknowns in terms of how certain species interact with wave devices and the likely significance of any potential effect on these receptors. The main effects identified for wave developments relate to habitat exclusion and barriers to movement where commercial arrays occupy large areas of the water surface. Similarly potential effects on commercial fisheries are also unknown due to limited information relating to the locations of key fishing grounds, in both offshore and inshore waters.

12.12.2.4 Floating Wind

As with wave energy, the Assessment Areas 3, 4, 5 and 6 offer the greatest potential for the development of offshore floating wind. Generally due to the fact that floating offshore wind developments are less constrained by water depth, this technology offers the greatest potential for avoiding protected sites and other key sensitive receptors. The main constraints that have been identified with regard to the development of floating wind in offshore areas include potential effects on seabirds, marine mammals (mainly grey and harbour seals, bottlenose dolphin and harbour porpoise), marine reptiles (leatherback turtles) and basking sharks all of which are either known to breed in the area or have been sighted in significant numbers throughout Assessment Areas 3, 4, 5 and 6. Although the distribution, abundance and behaviour of a number of these species in the offshore areas of the study area are unknown, there is potential that the presence of floating offshore wind developments could lead to habitat loss or exclusion from key offshore feeding areas. Further studies would be required to determine the significant of these potential effects.

The assessment has also identified that there could be adverse effects on offshore commercial fisheries in terms of exclusion from traditional fishing grounds. It is likely that the significance of any effects on commercial fisheries will depend on the importance of the fishing ground and whether fishing could continue within the boundary of the development. However, given that this technology can be deployed in deeper water there is greater potential to avoid key shipping lanes and there is potential for siting developments in areas that are more than 35km from the coast, avoiding any significant effects on the seascape character of the south and west coast of Ireland.

12.12.3 *Achieving OREDP Development Scenarios*

The following considers the results of the assessment in regard to achieving the developments scenarios set out in the OREDP.

12.12.3.1 Wind (Fixed and Floating)

Overall, the scenario for offshore wind set out in the OREDP is to develop up to 4,500MW by 2030. This includes both fixed and floating wind. Based on the results from the assessment of the assessment areas and the cumulative assessment it has been identified that in total there is potential to develop between 9,200MW and 12,000MW from fixed offshore wind across the study area and up at least 2,7000MW from floating wind.

However, it is recognised that floating wind is still an emerging technology, and at present (October 2010) there are currently no commercial floating offshore wind developments in operation. Should the tests on this technology prove that it is an economically viable option it is still unlikely that there would be any significant commercial development of this technology before 2020, and possibly even 2030. Therefore, whilst there is significant potential for the development of this technology in the waters around Ireland, its overall contribution towards achieving the scenario set out in the OREDP may be limited.

It is therefore necessary to assess whether the scenario set out in the OREDP for wind can be achieved from purely fixed wind developments. The overall findings from the cumulative assessment suggest that it would be possible to develop between 9,200MW and 12,000MW from fixed wind. However, these potential amounts of development include the potential areas identified in Assessment Areas 3, 4 and 5. Whilst the assessment concludes that, based on existing information that the amounts of development identified in these assessment areas could be achieved without likely significant adverse effects on the environment, it is likely that due to the highly technical constrained nature of the seabed in these areas that, it may not be technically possible to achieving these levels development.

Furthermore, these areas have been identified as being highly sensitive in terms of environmental receptors, seascape and other marine users. Therefore although the assessment indicates that some offshore wind development could potentially occur in these areas, due to the technical constraints and constraints relating to shipping and navigation, there are significant limitations in terms of being able to identify alternative areas for development should a significant adverse effects on marine wildlife, habitats or seascape be identified at the project stage.

Taking this into consideration, it is likely that the 4,500MW identified in the OREDP scenario would most likely have to be achieved through fixed wind developments in Assessment Areas 1, 2 and 6. However, it should be noted that there could be constraints on the overall level of development that could in achieved in Assessment Area 6 due to limitations on the availability of grid connections in this area. Taking the worst case scenario, this could potentially reduce the development potential of this area to 0MW. However, based on information from the Grid 25 Implementation Programme it would appear that there are plans to strengthen/reinforce the existing transmission network in the northeast of Ireland to accommodate an increase in generation from renewable energy developments in this area. Although at present the main focus for these reinforcements is in relation to onshore renewable energy developments.

In the event that opportunities to develop any fixed offshore wind in Assessment Area 6 are limited by grid availability, it would be necessary to look at whether the 4,500MW scenario could be achieved simply with development in Assessment Areas 1 and 2. Based on the results from the cumulative assessment, the overall potential for development in these two areas was identified as being between 4,200MW and 4,800MW. On the basis that no significant adverse effects are identified at the project stage, it may be possible to achieve the upper amount of 4,800MW across these two areas. However, both areas are important in terms of marine wildlife and habitats and are also constrained with shipping and navigation activities and commercial fisheries. These constraints could limit the overall potential for achieving 4,500MW from fixed offshore wind in these two areas.

12.12.3.2 Wave and Tidal

Overall, the scenario for wave and tidal energy set out in the OREDP is to develop up to 1,500MW by 2030. Based on the results from the assessment of the assessment areas and the cumulative assessment it has been identified that in total there is potential to develop between 29,000MW and 34,000MW from wave and tidal across the study area. This includes between 27,500MW and 31,100MW from wave and 1,500MW and 3,000MW from tidal.

Based on the findings from the assessment it would appear that there would be more than enough potential to achieve the scenario for wave and tidal set out in the OREDP with wave alone as well as a combination of both technologies. Overall, the west coast has been identified as offering the greatest potential for the development of wave energy, both in shallower waters with between 12,500MW and 13,600MW from developments in 10m to 100m depth, and deeper waters with up to 17,500 MW from development in water of 100m to 200m depth. Due to the overall scale of the available resource in these areas there are a number of opportunities for developments to be sited in offshore locations where they can avoid protected sites and key shipping lanes and there is greater flexibly for identifying alternative sites for development if significant adverse effects are identified at the project stage.

In terms of tidal developments, the main areas with potential for development are Assessment Areas 2 and 6. The results from the assessment conclude that overall tidal developments are more constrained by environmental factors than wave developments. This is mainly due to the fact that the main area of resource for tidal tends to occur in specific locations where land and/or marine topography focuses the tidal stream energy such as around headlands and between islands.

Therefore tidal energy developments are generally located closer to coastal areas which are spatially more constrained in terms of available space for development and also tends to contain more environmental receptors in terms of protected sites and associated marine wildlife, other breeding colonies and adjacent feeding areas, shipping lanes, inshore fisheries (shellfish and fin fish) and other marine infrastructure and developments. Potential effects on seascape are also likely to be of greater significance for developments located in coastal and nearshore locations.

However, the assessment still concludes that there is potential to development between 750MW to 1,500MW from tidal energy in both Assessment Areas 2 and 6. Overall, the resource that is available in Assessment Area 6 is less constrained than the resource in Assessment Area 2 due to limited shipping movements in this area. This increases the potential for avoiding protected sites and identifying alternative sites for development should significant adverse effects be identified at the project stage. However, there could be potential constraints on development in Assessment Area 6 relating to limited grid connections in this area.

In Assessment Area 2, there is also a need to consider potential cumulative effects in relation to the development of offshore wind (fixed) in this area. Based on the findings from the assessment it has been identified that the majority of the development potential for offshore wind development in Assessment Area 2, has already been taken up by existing and proposed developments in this area. Therefore in order to avoid likely significant adverse effects in this areas resulting from both offshore wind and tidal developments, it may be necessary to limit tidal development in this area to 750MW rather than the upper amount of 1,500MW if significant adverse effects are to be avoided.

However, even with only 750MW of tidal development in Assessment Area 2, it would still be possible to achieve the high scenario for the development of wave and tidal energy of 1,500MW set out in the OREDP, on the basis that the total potential for wave off the west coast is between 27,500MW and 31,100MW.

12.12.4 Overall Conclusions

Based on the result of the assessment the following key points have been identified.

- There is potential resource for offshore wind off east coast but approximately half of this has been taken up by existing and proposed developments.
- There is also significant opportunity for developing offshore wind off the west coast (north) (Assessment Area 6), subject to grid availability. This is on the basis that there is generally greater flexibility in this area to avoid the protected sites and other sensitive receptors and marine activities.
- Opportunities for offshore wind off the west (Assessment Areas 4 and 5) and south (Assessment Area 3) coast are significantly constrained by water depth, shipping and navigation, seascape and environmental constraints close to the shore. Although the assessment has identified some development potential these areas generally appear unsuitable for fixed wind.
- There is significant potential for the development of wave and floating wind energy off the west coast. This is on the basis of the size of the available resource and opportunities for siting developments away from protected sites and other sensitive receptors including marine wildlife and habitats, commercial fisheries and sensitive seascape areas.
- There is potential for tidal energy to be developed off the south east and north west coast (Assessment Areas 2 and 6) although potential environmental constraints associated with this technology are greater due to its proximity to the coast. Assessment Area 6 is generally less constrained that Assessment Area 2 due to lower levels of shipping in this area, increasing potential for avoiding protected sites and other sensitive receptors. However, grid availability could limit development in this area. There is also potential for cumulative effects between tidal and offshore wind (fixed) in Assessment Area 2.
- The Shannon Estuary has been identified as being unsuitable for commercial scale tidal development due to nature conversation interests and shipping and navigation constraints.
- There is no exploitable floating wind or wave resource off the east coast.

Table 12.13: Summary of Cumulative Effects for Each Assessment Area

Assessment Area	Technology Type and Amounts (MW)			Summary of Cumulative Effects (Including Mitigation)
Assessment Area 1: East Coast (North)	Number of Commercial Fixed Wind Developments			Cumulative effects across all receptors for the development of 1200MW arrays are generally negligible to negative. Installation of five or more arrays in this area may cause significant adverse effects primarily associated with the potential presence of wind farm constraints either side of a very busy shipping channel and commercial fisheries. Effects associated with collision risk and habitat exclusion on birds, and possible barrier effects to birds, marine mammals and reptiles moving along the coast could also be of likely adverse significance. Further information is needed to fully understand and quantify the potential impacts on marine mammals, fish, birds, turtles and benthic ecology. Based on the general seascape character in this area it is likely developments within 0 to 15km from the coast would have moderate cumulative effects on seascape, these effects reducing to slight with increased distance from shore.
	600 MW	1200 MW	1800 MW	
	Negligible	Negative	**Unknown/ Significant adverse**	
Assessment Area 2: East Coast (South)	Number of Commercial Fixed Wind Developments			Cumulative effects across receptors for development of up to 1800MW are generally negligible to negative. Installation of seven or more arrays in this area may cause significant adverse effects primarily in relation to effects on protected sites and birds located on the adjacent coastline, and commercial fisheries. Effects relating to collision risk and habitat exclusion on birds could also be of adverse significance. Possible barrier effects to birds, marine mammals and reptiles moving along the coast could also be of likely adverse significance. Further information is needed to fully understand and quantify the potential impacts on marine mammals, fish, birds, turtles and benthic ecology. Potential effects on seascape are likely to be of moderate significance within 15km of the coast, reducing to slight further offshore.
	900 MW	1800 MW	2700 MW	
	Negligible	Negative	**Unknown/ Significant adverse**	
	Number of Commercial Tidal Developments			Cumulative effects across receptors for development of up to 750MW are generally negligible to negative. Installation of more than 1500MW in this area may cause negative effects primarily associated with the potential impacts on marine mammals, commercial fisheries and navigation. Further information is needed to fully understand and quantify the potential impacts on marine mammals, fish, birds, turtles and benthic ecology. Potential effects on seascape are likely to be of moderate significance within 5km of the coast, reducing to slight within increased distance offshore.
	100 MW	750 MW	1500 MW	
	Negligible	Negative	**Unknown/ Significant adverse**	

<table>
<tr><th>Assessment Area</th><th colspan="3">Technology Type and Amounts (MW)</th><th>Summary of Cumulative Effects (Including Mitigation)</th></tr>
<tr><td rowspan="6">Assessment Area 3: South Coast</td><td colspan="3">Number of Commercial Fixed Wind Developments</td><td rowspan="3">Potential cumulative effects across receptors for development of between 300MW and 900MW are generally negligible to negative. Further development of up to 1800MW is generally negative to significant adverse. The area where water depths are suitable for deployment of fixed wind structures in this area is very narrow, extending out to a maximum of up to 20 – 25m from the coastline. This area overlaps with the area of highest shipping intensity running adjacent to the coastline, and some of it also overlaps with marine SACs at Hook Head, and Saltee Islands, therefore limiting the available area for offshore wind deployment without significant environmental effects.

Installation of between 2100MW and 2700MW in this area is likely to have significant adverse effects on protected sites and birds located on the adjacent coastline, and commercial fisheries. Potential effects in relation to collision risk and habitat exclusion on birds and possible barrier effects to birds, marine mammals and reptiles moving along the coast are also likely to be of adverse significance. Further information is needed to fully understand and quantify the potential impacts on marine mammals, fish, birds, turtles and benthic ecology. Given that most developments would be located very close to the coast, potential cumulative effects on seascape are likely to range from moderate to substantial, particularly where developments affect sensitive seascape types such as large bays which are prominent along the eastern section of the coast in this area.</td></tr>
<tr><td>900 MW</td><td>1800 MW</td><td>2700 MW</td></tr>
<tr><td>Negligible to Negative</td><td>Unknown/ Significant adverse</td><td>Unknown/ Significant adverse</td></tr>
<tr><td colspan="3">Number of Commercial Floating Wind Developments</td><td rowspan="3">Cumulative effects across receptors for development of 6000 MW are generally negligible - negative. The potential for adverse effects increases as the size of the area exploited increases. The most significant potential effects are associated with commercial fisheries in terms of exclusion from traditional fishing grounds and marine wildlife due to habitat exclusion and possible barriers to movement, many of which require further work and site specific survey in order to better understand the level of potential effect. In terms of seascape, potential effects reduce from moderate to slight between 24km and 35km from the coast and are generally considered to be negligible beyond 35km as it is difficult to see anything beyond this distance. Providing that the floating wind developments are located in offshore areas (more than 24km from the coast and ideally 35km) potential cumulative effects on seascape character will be slight to negligible.</td></tr>
<tr><td>3000 MW</td><td>6000 MW</td><td>9000 MW</td></tr>
<tr><td>Negligible</td><td>Negative</td><td>Unknown/ Significant adverse</td></tr>
</table>

<table>
<tr><th>Assessment Area</th><th colspan="3">Technology Type and Amounts (MW)</th><th>Summary of Cumulative Effects (Including Mitigation)</th></tr>
<tr><td rowspan="6">Assessment Area 4: West Coast (South)</td><td colspan="3">Number of Commercial Fixed Wind Developments</td><td rowspan="3">The area where water depths are suitable for deployment of fixed wind structures in this area is very narrow, extending out to a maximum of up to 15m from the coastline, and there is therefore very limited potential to site devices away from sensitive receptors. Potential effects in relation to collision and habitat exclusion on birds and possible barrier effects to birds, marine mammals and reptiles moving along the coast could also be of adverse significance. Further information is needed to fully understand and quantify the potential impacts on marine mammals, fish, birds, turtles and benthic ecology.

Seascape character throughout in this area is highly sensitive to offshore wind developments. Any development within 15km of the coast is likely to have a substantial effect on seascape, in particular the Skellig Michael WHS. These effects are also likely to be of substantial to moderate significance up to 24km from the shore, reducing to slight/moderate further offshore e.g. more than 24km and slight/negligible at 35km. There are also likely to be significant adverse impacts on tourism and recreation where devices are sited within Dingle Bay, which is one of the few areas where shallow waters extend far enough to accommodate commercial scale arrays outside of the main shipping lanes.</td></tr>
<tr><td>600 MW</td><td>1200 MW</td><td>1800 MW</td></tr>
<tr><td>Negative</td><td>Unknown/ Significant adverse</td><td>Unknown/ Significant adverse</td></tr>
<tr><td colspan="3">Number of Commercial Wave Developments</td><td rowspan="3">Cumulative impacts across receptors for development of up to 3000 MW is generally negligible – negative (although potential adverse affects are greater in the inshore areas). Potential effects in relation to wave arrays relate mainly to potential effects on protected sites and mammals located on the adjacent coastline, navigation and commercial fisheries. Potential effects in terms of collision risk and habitat exclusion impacts on birds, marine mammals, fish and reptiles further offshore, and possible barrier effects to marine mammals and reptiles moving along the coast could also be of adverse significance. Further information is needed to fully understand and quantify the potential impacts on marine mammals, fish, birds, turtles and benthic ecology.

Wave developments are likely to have less of an effect on seascape character than fixed offshore wind developments. However, the seascape character along the south west coast is considered to be highly sensitive to all forms of development, particularly in regard to potential effects on the Skellig Michael WHS. Although potential effects on seascape can be reduced by increasing the distance of development from the shore, it is likely that even at a distance of up to 15km from the coast a large number of wave developments could have a moderate effect on seascape.</td></tr>
<tr><td>300 to 600 MW</td><td>3000 MW</td><td>4500MW</td></tr>
<tr><td>Negligible</td><td>Negative</td><td>Negative/ Significant Adverse</td></tr>
</table>

Assessment Area	Technology Type and Amounts (MW)			Summary of Cumulative Effects (Including Mitigation)
Assessment Area 4: West Coast (South)	Number of Commercial Floating Wind Developments			Potential cumulative effects across receptors for development of 5400 MW are generally negligible - negative. Potential adverse effects are likely to increase with larger areas exploited and the most significant potential impacts are associated with commercial fisheries and marine wildlife, many of which require further work and site specific survey in order to better understand the likely significance of any potential effect. Potential seascape effects can be minimised by developing beyond 24km from shore.
	2700 MW	5400 MW	8400 MW	
	Negligible	Negative	**Unknown/ Significant adverse**	
Assessment Area 5: West Coast (Centre)	Number of Commercial Fixed Wind Developments			Potential cumulative effects across receptors for development of up to 300MW are generally negligible. Further development of between 600MW and 900MW is generally negative to significant adverse. The area where water depths are suitable for deployment of fixed wind structures in this area is very narrow, extending out to a maximum of up to 15 - 25 km from the coastline. Installation of up to three arrays in this area could potentially have significant adverse effects on protected sites and birds located on the adjacent coastline. Potential effects on terms of collision risk and habitat exclusion impacts on birds, and possible barrier effects to birds, marine mammals and reptiles moving along the coast could also be of adverse significance. Further information is needed to fully understand and quantify the likely significance of any potential effects on marine mammals, fish, birds, turtles and benthic ecology. Seascape character throughout in this area is generally highly sensitive to offshore wind developments. Any development within 15km of the coast is likely to have a substantial effect on seascape. Any potential effects are also likely to be of substantial to moderate significance up to 24km from the shore. These effects would reduce to slight further offshore e.g. more than 24km, with effects becoming negligible at 35km.
	300 MW	600 MW	900 MW	
	Negligible	**Negative/ Significant adverse**	**Unknown/ Significant adverse**	
	Number of Commercial Wave Developments			Potential cumulative effects across receptors for development of between 1000MW to 3000 MW are generally negligible - negative. Potential effects up to 6000MW are generally negative although effects are likely to be more significant in the inshore areas. Potential effects are primarily associated with protected sites and mammals located on the adjacent coastline, navigation and commercial fisheries. Potential effects in terms of collision risk and habitat exclusion on birds, marine mammals, reptiles and fish, and possible barrier effects to marine mammals moving along the coast could also be of adverse significance. Further information is needed to fully understand and quantify the likely significance of any potential effects on marine mammals, fish, birds, turtles and benthic ecology.
	1000 to 3000 MW	3000 to 6000 MW	More than 7000 MW	
	Negligible	Negative	**Negative/ Significant adverse**	

Assessment Area	Technology Type and Amounts (MW)			Summary of Cumulative Effects (Including Mitigation)
Assessment Area 5: West Coast (Centre)	Number of Commercial Wave Developments (Continued)			In terms of seascape effects, there are a number of sections of the coastline in this assessment area where seascape character is considered to be sensitive to wave developments. It is therefore likely that, a large number of developments located within 0km to 5km of the coast could potentially have moderate to substantial effects on seascape character. However, these potential effects could be avoided or reduced to slight/negligible by siting developments more than 15km from the coast.
	1000 to 3000 MW	3000 to 6000 MW	More than 7000 MW	
	Negligible	Negative	**Negative/ Significant adverse**	
	Number of Commercial Floating Wind Developments			Potential cumulative effects across receptors for development of 7200 MW are generally negligible - negative. The likely significance of potential effects increase with larger areas exploited and the most significant potential effects are associated with commercial fisheries and marine wildlife, many of which require further work and site specific survey in order to better understand the likely significant of any effect. Potential moderate to substantial effect on seascape can be reduced by siting developments more than 24km from the coast. However, it is likely that moderate to substantial effects could occur at this distance where the overall number of developments increases. Where there are large numbers of developments any moderate to substantial effects can be further reduced/avoided by siting developments more than 35km from the coast.
	3600 MW	7200 MW	10,800 MW	
	Negligible	Negative	**Unknown/ Significant adverse**	
Assessment Area 5a: Shannon Estuary	Number of Commercial Tidal Developments			It is likely that any commercial scale tidal development in the Shannon Estuary is likely to have a significant adverse effect on the Lower Shannon Estuary SAC and a number of SPA sites that are also associated with the estuary. There are also likely to be significant adverse effects on shipping and navigation due to the high intensity of vessels within the estuary. Potential effects on seascape are likely to moderate to slight, particularly for tidal devices that can be fully submerged. There are also likely to be adverse effects on commercial fisheries within the estuary.
	50 MW	100 MW	150 MW	
	Unknown/ Significant adverse	**Unknown/ Significant adverse**	**Unknown/ Significant adverse**	

Assessment Area	Technology Type and Amounts (MW)			Summary of Cumulative Effects (Including Mitigation)
Assessment Area 6: West Coast (North)	Number of Commercial Fixed Wind Developments			Water depths within this area allow more potential for development further offshore away from the most sensitive areas, particularly to the north of the area. Potential cumulative effects across receptors for development of 3000MW are generally negligible to negative. Installation of 4500MW in this area may cause negative effects primarily associated with the potential impacts on shipping, commercial fishing and nature conservation. Potential effects associated with collision risk and habitat exclusion on birds, and possible barrier effects to birds, marine mammals and reptiles moving along the coast could also be of adverse significance. Further information is needed to fully understand and quantify the potential effects on marine mammals, fish, birds, turtles and benthic ecology. Moderate to substantial seascape effects could be reduced/avoided by increasing the distance of developments from shore e.g. beyond 24km.
	1500 MW	3000 MW	4500 MW	
	Negligible	Negative	Negative	
	Number of Commercial Wave Developments			Potential cumulative effects across receptors for development of between 1500MW and 7000MW are generally negligible to negative as there is more flexibility for siting developments further offshore. More studies are needed to understand effects on marine wildlife. A large number of developments within 0 to 5km of the coast are likely to have moderate to substantial effects on the main sensitive seascape types in this area. These potential effects can be reduced to slight/negligible by increasing the distance of developments from shore (e.g. beyond 15km from the coast).
	1500MW	3000MW to 6000MW	7000MW to 8000MW	
	Negligible	Negative	Negative	
	Number of Commercial Tidal Developments			Potential cumulative effects across receptors for development of up to 750MW are generally negligible to negative. Installation of up to 1500MW in this area may have negative effects on shipping, commercial fishing and nature conservation. Potential effects in relation to collision risk and habitat exclusion impacts on birds, marine mammals, fish and reptiles and possible barrier effects to marine mammals and reptiles moving along the coast could also be of adverse significance. Clustering of a large number of tidal developments within 0km to 5km of the coast could have moderate to substantial effects on seascape character. These effects could be reduced by installing developments further offshore (10km/15km) or installing fully submerged devices.
	100 MW	750 MW	1500 MW	
	Negligible	Negative	Negative	
	Number of Commercial Floating Wind Developments			Potential cumulative effects across receptors for development of 7200 MW are generally negligible - negative. The likely significance of effects increase with larger areas exploited and the most significant potential effects are associated with commercial fisheries and marine wildlife, many of which require further work and site specific survey in order to better understand the likely significance of any potential effects. Potential effects on seascape can be reduced by siting developments more than 24km from the coast, preferably 35km offshore.
	3600 MW	7200 MW	10,800 MW	
	Negligible	Negative	**Unknown/ Significant adverse**	

Table 12.14: Assessment Area 1 East Coast North – Fixed Wind: Results of the Cumulative Assessment (based on likely Residual Effects INCLUDING MITIGATION)

The potential capacity for offshore wind farm identified here, includes offshore wind developments that are currently in the consenting process. In Assessment Area 1 this includes the Oriel windfarm (320MW), and the northern section of the Dublin Array windfarm (Kish Bank) which has a total generating lease for 364MW.

SEA Topic		Assessment Area 1: Fixed wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		2 (600 MW)	4 (1200 MW)	6 (1800 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown /Negative**	**Unknown /Negative**	**Unknown / Significant Adverse**	Development of up to 1500 MW is possible without direct overlap with existing protected sites. Potential for impacts on bird species accessing the Dundalk Bay SPA, South Dublin and River Tolka Estuary SPA, and Bull Island UNESCO reserve.
	Benthic ecology	**Unknown / Negligible**	**Unknown /Negative**	**Unknown / Significant Adverse**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is significant overlap between the fixed wind resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist, particularly associated with sublittoral sand and gravel or muddy sediment within the area. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.
	Fish and Shellfish	**Unknown / Negligible**	**Unknown /Negative**	**Unknown /Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. This impact is most likely for *Nephrops*, which are extensive over much of the area. Other shellfish species are localised and it is anticipated that these can be avoided during site selection. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 1: Fixed wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Fixed Wind Developments			
		2 (600 MW)	4 (1200 MW)	6 (1800 MW)	
	Birds	**Unknown /Negative**	**Unknown /Negative**	**Unknown / Significant Adverse**	The adjacent coastline contains protected seabird populations and breeding colonies. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. These effects will increase in significance as development increases.
	Marine Mammals	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Significant Adverse**	Significant adverse effects on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 1 has had comparably few turtle sightings when compared with the other areas. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Significant adverse**	Potential long term displacement from traditional *Nephrops* grounds, which are extensive in the area, and cover a large proportion of the fixed wind resource area. Area 1 also contains extensive spawning grounds for Cod, Haddock, Plaice and Whiting and associated seasonal fisheries which may be subject to direct disturbance. The fisheries for whitefish are focussed in the southern half of the area. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
	Mariculture	**Negligible**	**Negligible**	**Negligible**	No direct effects on fish farming within the adjacent areas i.e. Carlingford Lough. Limited potential for effects from export cables.

SEA Topic		Assessment Area 1: Fixed wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		2 (600 MW)	4 (1200 MW)	6 (1800 MW)	
	Ports, shipping and navigation	**Neutral**	**Negative**	**Significant adverse**	Consideration has been given to placing devices in the areas of lowest shipping intensity offshore Dundalk Bay, and offshore Bray to the south. Close proximity to shipping lanes entering and leaving Dundalk, Greenore and Dun Laoghaire increases the potential for collision risk and displacement. Placement of 6 arrays (1800MW) could introduce restricted areas for shipping on both sides of the Dundalk approach channel. Impacts of development on the Bray and Kish banks to the south of the Area could also result in a positive impact through placement of navigation aids on an acknowledged dangerous area for shipping.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negative**	Potential access and displacement impacts on recreational yachting. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There is potential to develop up to three arrays without siting devices within the Gormanstown Danger Area.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although the area is in close proximity to several disposal sites potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**Negligible**	**Negligible**	**Negligible**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. There is potential to overlap with a fairly extensive aggregate resource (sand) towards the south of the area, and there is therefore the potential to sterilise future resource.
	Oil and Gas exploitation	**Negligible**	**Negligible**	**Negligible**	There is an oil and gas lease option area to the south of Area 1 (which overlaps with the Dublin Array application area). Potential interactions with future oil and gas exploitation of the area.

SEA Topic		Assessment Area 1: Fixed wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		2 (600 MW)	4 (1200 MW)	6 (1800 MW)	
Seascape	Seascape (0km to 15km offshore)	**Slight**	**Moderate**	**Substantial**	Based on the general seascape character in this area which is predominantly seascape types 3 (low plateau) and type 4 (low lying coastal plain) it is likely that in most areas developments within 0 to 15km from the coast would have moderate cumulative effects on seascape, these effects reducing to slight with increased distance from shore. However, there are some localised areas where the potential effects of a number of developments within 15km from the coast would be more substantial.
	Seascape (15km to 24km offshore)	**Slight**	**Slight**	**Moderate**	
	Seascape (more than 24km offshore)	**Slight to Neutral**	**Slight to Neutral**	**Slight**	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.15: Assessment Area 2 East Coast South – Fixed Wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

The potential capacity for offshore windfarm identified here, includes offshore wind developments that are currently in the consenting process. In Assessment Area 2 this includes the southern section of the Dublin Array windfarm (Bray Bank) which has a total generating lease for 364MW, Codling Bank (1100MW) and Arklow Bank (520MW).

SEA Topic		Assessment Area 2: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		3 (900 MW)	6 (1800 MW)	9 (2700 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown /Negative**	**Unknown /Negative**	**Unknown / Significant Adverse**	Development is possible without direct overlap with existing protected sites. Potential for impacts on bird species accessing coastal breeding and wintering sites. The most sensitive area for birds is to the south of the area, at Wexford Harbour and Wicklow head, and more significant impacts would be associated with development immediately offshore of these areas.
	Benthic Ecology	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Significant adverse**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is significant overlap between the fixed wind resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist. Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.
	Fish and Shellfish	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown /Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Area 2 contains shellfish populations of edible crab, scallops, oysters, periwinkles and whelks. The greatest densities of Whelk are found in shallow water (<20m) and in strong tidal currents. Other shellfish species are localised and it is anticipated that these can be avoided during site selection. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 2: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		3 (900 MW)	6 (1800 MW)	9 (2700 MW)	
	Birds	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Significant Adverse**	The adjacent coastline contains protected seabird populations and breeding colonies. The most sensitive area for birds is to the south of the area, at Wexford Harbour and Wicklow head, and more significant impacts would be associated with development immediately offshore of these areas. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects.
	Marine Mammals	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Few breeding populations of harbour and grey seals occur throughout Area 2. There are comparatively few bottlenose dolphin and harbour porpoise sightings compared to other areas, especially given the increased sighting effort in this area. There are no SACs designated in Area 2 for marine mammals. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 2 has had comparably few turtle sightings when compared with the other areas, however it does hold a major jellyfish hotspot located in Rosslare and Wexford Bays. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 2: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		3 (900 MW)	6 (1800 MW)	9 (2700 MW)	
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Significant adverse**	Shellfish fisheries which may be impacted in Area 2 include whelk which are mainly concentrated in the southern offshore part of the Area. Much of the suitable areas for development of fixed wind are located in the nearshore area where sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. A significant concern in characterising the inshore fisheries in Ireland is the lack of data on inshore fishing vessels under 15 m. Area 2 also contains spawning grounds and associated fisheries for Cod (Northern edge) and ray species (central and southern area) which may be subject to direct disturbance. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	No direct effects on fish farming within the adjacent areas i.e. Rosslare Harbour. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negative**	Consideration has been given to placing devices in the areas of lowest shipping intensity. Close proximity to shipping lanes entering and leaving the main ports of Dublin and Rosslare increases the potential for collision risk and displacement. The impact significance increases with the size and number of areas developed.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negative**	Potential access and displacement impacts on recreational yachting. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no Department of Defence danger areas within Assessment Area 2, although, military use of the Area will include fishery protection and search and rescue operations.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.

SEA Topic		Assessment Area 2: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		3 (900 MW)	6 (1800 MW)	9 (2700 MW)	
	Aggregate Extraction	**Negligible**	**Negligible**	**Negligible**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. There is potential for some overlap with a very extensive aggregate resource (sand) towards the south of the area, and there is therefore the potential to sterilise future resource, but it is envisaged that wind development would only impact a small proportion of the identified resource.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are is no oil and gas exploitation or exploration within the nearshore areas suitable for deployment of fixed wind devices.
Seascape	Seascape (0km to 15km offshore)	**Moderate**	**Moderate**	**Moderate to Substantial**	As with Assessment Area 1 based on the general seascape character in this area which is predominantly seascape types 3 (low plateau) and type 4 (low lying coastal plain) it is likely that in most areas developments within 0 to 15km from the coast would have moderate cumulative effects on seascape, these effects reducing to slight with increased distance from shore. However, there are some localised areas where a number of developments within 15km of the coast would potentially have substantial effects on seascape character.
	Seascape (15km to 24km offshore)	**Slight**	**Slight**	**Moderate**	
	Seascape (more than 24km offshore)	**Slight to Neutral**	**Slight to Neutral**	**Slight**	
Climatic Factors	Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.16: Assessment Area 2 East Coast (South) – Tidal: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

The Marine Renewables Industries Association (MRIA) has identified "initial development areas" for wave and tidal energy development (MRIA, 2010). One of the MRIA areas (East Wicklow) is located within Assessment Area 2. This table therefore focuses on cumulative impacts of siting devices within the East Wicklow MRIA area, in line with developer's aspirations for tidal development in this area.

SEA Topic		Assessment Area 2: Tidal– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Tidal Developments			
		2 (100 MW)	15 (750 MW)	30 (1500 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	Development is possible without direct overlap with existing protected sites. Potential for impacts on bird species accessing coastal breeding and wintering sites. The most sensitive area for birds is to the south of the area, at Wexford Harbour and Wicklow head, and more significant impacts would be associated with development immediately offshore of these areas.
	Benthic ecology	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is significant overlap between the tidal resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.

SEA Topic		Assessment Area 2: Tidal– Potential Cumulative Effects WITH Mitigation Number of Commercial Tidal Developments			Comments
		2 (100 MW)	15 (750 MW)	30 (1500 MW)	
	Fish and Shellfish	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Area 2 contains shellfish populations of edible crab, scallops, oysters, periwinkles and whelks. The greatest densities of Whelk are found in shallow water (<20m) and in strong tidal currents, although these are most concentrated to the south. Other shellfish species are localised and it is anticipated that these can be avoided during site selection. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.
	Birds	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	The adjacent coastline contains protected seabird populations and breeding colonies. The most sensitive area for birds is to the south of the area, at Wexford Harbour and Wicklow head, and more significant impacts would be associated with development immediately offshore of these areas. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk (diving birds). The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. These effects will increase in significance as development increases.
	Marine Mammals	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	Few breeding populations of harbour and grey seals occur throughout Area 2. There are comparatively few bottlenose dolphin and harbour porpoise sightings compared to other areas, especially given the increased sighting effort in this area. There are no SACs designated in Area 2 for marine mammals. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 2 has had comparably few turtle sightings when compared with the other areas, however it does hold a major jellyfish hotspot located in Rosslare and Wexford Bays. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.

SEA Topic		Assessment Area 2: Tidal– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Tidal Developments			
		2 (100 MW)	15 (750 MW)	30 (1500 MW)	
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	The whelk shellfishery is mainly concentrated in the southern offshore part of the Area, away from the East Wicklow initial development area. The nearshore area is particularly sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. A significant concern in characterising the inshore fisheries in Ireland is the lack of data on inshore fishing vessels under 15 m. Area 2 also contains spawning grounds and associated fisheries for Cod (Northern edge) and ray species (central and southern area) which may be subject to direct disturbance. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	No direct effects on fish farming within the adjacent areas i.e. Rosslare Harbour. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negative**	**Negative**	Consideration has been given to placing devices in the areas of lowest shipping intensity. Close proximity to shipping lanes entering and leaving the main ports of Dublin and Rosslare, and the main north-south coast adjacent shipping lane increases the potential for collision risk and displacement. The impact significance increases with the size and number of areas developed.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	Potential access and displacement impacts on recreational yachting. Potential construction (short term) impacts on adjacent recreational beaches.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no Department of Defence danger areas within Assessment Area 2, although, military use of the Area will include fishery protection and search and rescue operations.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.

SEA Topic		Assessment Area 2: Tidal– Potential Cumulative Effects WITH Mitigation Number of Commercial Tidal Developments			Comments
		2 (100 MW)	15 (750 MW)	30 (1500 MW)	
Material Assets	Aggregate Extraction	**Negligible**	**Negligible**	**Negligible**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. There is potential for some overlap with a very extensive aggregate resource (sand) towards the south of the area, and there is therefore the potential to sterilise future resource, but it is envisaged that wind development would only impact a small proportion of the identified resource.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are is a small overlap between the tidal resource area in Area 2, and the existing petroleum lease area. However, the level of development indicated is possible without direct overlap.
Seascape	Seascape (0km to 5km offshore)	**Moderate**	**Moderate**	**Moderate to Substantial**	For developments located within 5km from the coast and with devices that protrude above the water surface the potential effects on seascape are likely to be of slight to moderate significance. The significance of these effects will reduce with increased distance offshore. As the number of developments increases it is likely that the significance of any potential effects will increase to moderate for developments located within 5km of the coast. These effects could increase to substantial where there are a high number of developments grouped in a small area. Again the overall significance of any potential effects will reduce to moderate and slight with distance from shore.
	Seascape (5km to 15km offshore)	**Slight Neutral**	**Slight**	**Moderate**	
Climatic Factors	Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.17: Assessment Area 3 South Coast – Fixed Wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 3: Fixed wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		3 (900 MW)	6 (1800 MW)	9 (2700 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	Possible coastal processes impacts due to the very close proximity to site of any fixed wind development potential in the area. Coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Negligible**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Development of up to 6 arrays is possible without direct overlap with existing protected sites. Placement of 7 or may is likely to necessitate direct overlap with Hook Head and Saltee Islands SACs, both designated for reef. Siting devices here would result in significant adverse impacts. Potential for impacts on bird species accessing coastal breeding and wintering sites, particularly in the mid-Waterford Coast SPA, and Saltee Islands.
	Benthic ecology	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Significant Adverse**	Development of up to 6 arrays is possible without direct overlap with areas of known for sensitive/important benthic habitat protected within existing SACs. Placement of 7 or more necessitates direct overlap with Hook Head and Saltee Islands SACs, both designated for reef. Siting devices here would result in significant adverse impacts. There is also significant overlap between the fixed wind resource and the area identified by NPWS as representing a best estimate of the distribution and range of further Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.

SEA Topic		Assessment Area 3: Fixed wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments 3 (900 MW)	6 (1800 MW)	9 (2700 MW)	Comments
	Fish and Shellfish	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Area 3 contains shellfish populations of lobster, crayfish, edible crab, velvet crab, shrimp, *Nephrops*, scallops and periwinkles. Other shellfish species are localised and it is anticipated that these can be avoided during site selection. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.
	Birds	**Unknown / Negligible**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	The adjacent coastline contains protected seabird populations and breeding colonies. Protected and breeding bird colonies are located along much of the coastline, and more significant impacts would be associated with development immediately offshore of these areas. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects.
	Marine Mammals	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Significant Adverse**	There are regular sightings of cetaceans in this Area, and Saltee Island SAC is designed for grey sea. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 3 is an important area for leatherback sea turtles. County Cork has the highest number of turtle sightings in Ireland. Many leatherbacks have also been sighted far off shore. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 3: Fixed wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		3 (900 MW)	6 (1800 MW)	9 (2700 MW)	
Population and Human Health	Commercial Fisheries	**Unknown / Negative**	**Unknown / Negative**	**Unknown / Significant Adverse**	Shellfish fisheries which may be impacted in Area 3 include Nephrops, edible crab, lobster, shrimp, scallop, crayfish and whelk. Much of the suitable areas for development of fixed wind are located in the nearshore area where sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. A significant concern in characterising the inshore fisheries in Ireland is the lack of data on inshore fishing vessels under 15 m. Area 3 also contains extensive spawning grounds for Herring, Cod, Haddock and Whiting and associated seasonal fisheries which may be subject to direct disturbance. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	The main shellfish aquaculture species in Area 3 is for Pacific oysters with localised production also of mussels and clams. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negative**	Consideration has been given to placing devices in the areas of lowest shipping intensity. Close proximity to shipping lanes entering and leaving the main ports of Cork and Waterford, as well as coast adjacent routes increases the potential for collision risk and displacement. The impact significance increases with the size and number of areas developed.
	Recreation and Tourism	**Negligible**	**Negative**	**Negative**	Potential access and displacement impacts on recreational yachting. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There is potential for the levels of development identified without siting devices within the Defence Danger Area D13.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.

SEA Topic		Assessment Area 3: Fixed wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments 3 (900 MW)	6 (1800 MW)	9 (2700 MW)	Comments
	Aggregate Extraction	**Negligible**	**Negligible**	**Negligible**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. There is potential for some overlap with a small aggregate resource (sand) towards the north of the area, and there is therefore the potential to sterilise future resource, but it is envisaged that wind development would only impact a small proportion of the identified resource.
	Oil and Gas exploitation	**Negligible**	**Negligible**	**Negligible**	There are no oil and gas lease, option or exploration areas within the shallow water area suitable for fixed wind development.
Seascape	Seascape (0km to 15km offshore)	**Moderate**	**Substantial**	**Substantial**	Due to the limitations relating to water depth it is likely that any fixed offshore wind development in this area would be located very close to the coast e.g., between 0km and 15km from shore. Consequently potential cumulative effects on seascape are likely to range from moderate to substantial, particularly where developments affect sensitive seascape types such as large bays which are prominent along the eastern section of the coast in this area. Potential moderate to substantial effects could be reduced/avoided by siting developments further offshore e.g. beyond 24km. However, opportunities for this are limited.
	Seascape (15km to 24km offshore)	**Slight to Moderate**	**Moderate**	**Moderate to Substantial**	
	Seascape (more than 24km offshore)	**Slight to Neutral**	**Slight**	**Slight**	
Climatic Factors	Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.18: Assessment Area 4 West Coast (South) – Fixed Wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 4: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		2 (600 MW)	4 (1200 MW)	6 (1800 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	As a result of water depths in the area, coastal processes impacts due to the very close proximity to the coast of any fixed wind development potential in the area. Development within this area is considered likely to require development within Dingle Bay, with the corresponding potential impacts on estuarine processes. Coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Development of up to 6 arrays is possible without direct overlap with existing protected sites. However, the coastline is heavily protected by national and international sites, many of which are designated for mobile species – birds and mammals, and it is difficult to avoid close proximity to these sites. Potential for barrier and/or collision impacts on birds and seals accessing the nearby coastal and marine protected sites.
	Benthic ecology	**Unknown / Negative**	**Unknown / Negative**	**Unknown / Significant Adverse**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is significant overlap between the fixed wind resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.

SEA Topic		Assessment Area 4: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		2 (600 MW)	4 (1200 MW)	6 (1800 MW)	
	Fish and Shellfish	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.
	Birds	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Protected and breeding bird colonies are located along much of the coastline, and more significant impacts would be associated with development immediately offshore of these areas. Birds from these sites are likely to be present feeding or loafing in the nearshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects.
	Marine Mammals	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Large breeding populations of both harbour and grey seals occur throughout Area 4. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Assessment Area 4 is an important area for leatherback sea turtles. Counties Cork and Kerry have the highest and second highest number of turtle records respectively. Many leatherbacks have also been sighted far off shore. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 4: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		2 (600 MW)	4 (1200 MW)	6 (1800 MW)	
Population and Human Health	Commercial Fisheries	**Unknown / Negative**	**Unknown / Significant adverse**	**Unknown / Significant adverse**	Shellfish fisheries which may be impacted in Area 4 include edible crab, lobster, shrimp, spider crab, Nephrops, scallop and crayfish. The edible crab and Nephrops fisheries generally extend further offshore while other shellfish fisheries in the Area are mainly restricted to the nearshore area within the sheltered bays. Inshore finfish grounds are however also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. A significant concern in characterising the inshore fisheries in Ireland is the lack of data on inshore fishing vessels less than 15 m. Area 4 also contains extensive spawning grounds for Herring, Whiting, Megrim and Haddock and associated seasonal fisheries which may be subject to direct disturbance. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	Area 4 contains extensive shellfish cultivation areas for mussels, Pacific oysters, scallop and urchins. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negative**	**Significant adverse**	Consideration has been given to placing devices in the areas of lowest shipping intensity. Bantry Bay and Castletownbere are the only commercial ports, both in the Bantry Bay inlet. Close proximity to the coast adjacent route, and the TSS to the south of the Area increases the potential for collision risk and displacement. The impact significance increases with the size and number of areas developed.
	Recreation and Tourism	**Significant adverse**	**Significant adverse**	**Significant adverse**	Potential access and displacement impacts on recreational angling, yachting and wildlife watching. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches, and visual impacts from wind arrays sited close inshore.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There is potential for the levels of development identified without siting devices within the Defence Danger Area D14.

SEA Topic		Assessment Area 4: Fixed Wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Fixed Wind Developments			
		2 (600 MW)	4 (1200 MW)	6 (1800 MW)	
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. No potential aggregate resource areas have been identified in the Area.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are no oil and gas lease, option or exploration areas within Area 4.
Seascape	Seascape (0km to 15km)	**Substantial**	**Substantial**	**Substantial**	Seascape character throughout in this area is predominantly type 2: rugged peninsulas with drowned valleys. This seascape type is highly sensitive to offshore wind developments due to its remote, exposed and undisturbed character. The seascape is also of particular importance in regard to the setting of the Skellig Michael World Heritage Site. Any development within 15km of the coast is therefore likely to have a substantial effect on seascape and the Skellig Michael WHS. These effects are also likely to continue to be substantial to moderate significance up to 24km from the shore. These effects would reduce to slight/moderate further offshore e.g. more than 24km, with effects becoming slight to negligible at 35km.
	Seascape (15km to 24km)	**Moderate**	**Substantial**	**Substantial**	
	Seascape (more than 24km)	**Slight to Moderate**	**Moderate**	**Moderate**	
Climatic Factors	Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.19: Assessment Area 4 West Coast South – Wave: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

The Marine Renewables Industries Association (MRIA) has identified “initial development areas” for wave and tidal energy development (MRIA, 2010). No initial development areas were identified within Assessment Area 4. However, as an area that has been identified during this SEA as containing wave resource, this table focuses on cumulative impacts of siting devices within Area 4 off the south-west coast of Ireland.

SEA Topic		Assessment Area 4: Wave– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Wave Developments			
		300 MW	3000 MW	4500 MW	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Development is possible without direct overlap with existing protected sites. However, the coastline is heavily protected by national and international sites, many of which are designated for mobile species – birds and mammals. Potential for barrier and/or collision impacts on birds and seals accessing the nearby coastal and marine protected sites.
	Benthic ecology	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is significant overlap between the wave resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.
	Fish and Shellfish	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 4: Wave– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Wave Developments			
		300 MW	3000 MW	4500 MW	
	Birds	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	Protected and breeding bird colonies are located along much of the coastline, and more significant impacts would be associated with development immediately offshore of these areas. Birds from these sites are likely to be present feeding or loafing in the nearshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. These effects will increase in significance as development increases.
	Marine Mammals	**Unknown / Negative**	**Unknown / Negative**	**Unknown / Negative**	Large breeding populations of both harbour and grey seals occur throughout Area 4. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 4 is an important area for leatherback sea turtles. Counties Cork and Kerry have the highest and second highest number of turtle records respectively. Many leatherbacks have also been sighted far off shore. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 4: Wave– Potential Cumulative Effects WITH Mitigation – Number of Commercial Wave Developments			Comments
		300 MW	3000 MW	4500 MW	
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	Shellfish fisheries which may be impacted in Area 4 include edible crab, lobster, shrimp, spider crab, Nephrops, scallop and crayfish. The edible crab and Nephrops fisheries generally extend further offshore while other shellfish fisheries in the Area are mainly restricted to the nearshore area within the sheltered bays. Inshore finfish grounds are however also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. A significant concern in characterising the inshore fisheries in Ireland is the lack of data on inshore fishing vessels less than 15 m. Area 4 also contains extensive spawning grounds for Herring, Whiting, Megrim and Haddock and associated seasonal fisheries which may be subject to direct disturbance. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	Area 4 contains extensive shellfish cultivation areas for mussels, Pacific oysters, scallop and urchins. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negative**	**Negative**	Consideration has been given to placing devices in the areas of lowest shipping intensity. Bantry Bay and Castletownbere are the only commercial ports, both in the Bantry Bay inlet. Close proximity to the coast adjacent route increases the potential for collision risk and displacement. The impact significance increases with the size and number of areas developed.
	Recreation and Tourism	**Negligible**	**Negative**	**Negative**	Potential access and displacement impacts on recreational yachting and wildlife watching. There are several surf locations on the adjacent coast, and possible impacts from removal of wave energy will need to be considered. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.

SEA Topic		Assessment Area 4: Wave– Potential Cumulative Effects WITH Mitigation Number of Commercial Wave Developments			Comments
		300 MW	3000 MW	4500 MW	
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There is potential for the levels of development identified without siting devices within the Defence Danger Area D14.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. No potential aggregate resource areas have been identified in the Area.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are no oil and gas lease, option or exploration areas within Area 4.
Landscape/Seascape	Seascape (0 to 5km offshore)	**Substantial**	**Substantial**	**Substantial**	Wave developments are likely to have less of an effect on seascape character than fixed offshore wind developments. However, the seascape character along the south west coast is considered to be highly sensitive to all forms of development, particularly in regard to potential effects on the setting of the Skellig Michael WHS. Although potential effects on seascape can be reduced by increasing the distance of development from the shore, it is likely that, due to the sensitivity of the seascape in this area, even at a distance of up to 15km from the coast a large number of wave developments could have a moderate effect on seascape.
	Seascape (5km to 15km offshore)	**Slight to Moderate**	**Moderate**	**Substantial**	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.20: Assessment Area 5 West Coast North – Fixed Wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

The potential capacity for offshore windfarm identified here, includes offshore wind developments that are currently in the consenting process. In Assessment Area 1 this includes the Sceirde Rocks offshore windfarm application area, which has a generating capacity of 100 MW.

SEA Topic		Assessment Area 5: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		1 (300 MW)	2 (600 MW)	3 (900 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown /Negligible**	**Unknown / Negative**	**Unknown / Negative**	As a result of water depths in the area, coastal processes impacts due to the very close proximity to the coast of any fixed wind development potential in the area. Coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Development of up to 3 arrays is possible without direct overlap with existing protected sites. However, the coastline is heavily protected by national and international sites, many of which are designated for mobile species – birds and mammals, and it is difficult to avoid close proximity to these sites. Potential for barrier and/or collision impacts on birds and seals accessing the nearby coastal and marine protected sites.
	Benthic ecology	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is significant overlap between the fixed wind resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.

SEA Topic		Assessment Area 5: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		1 (300 MW)	2 (600 MW)	3 (900 MW)	
	Fish and Shellfish	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.
	Birds	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Protected and breeding bird colonies are located along much of the coastline, and more significant impacts would be associated with development immediately offshore of these areas. Birds from these sites are likely to be present feeding or loafing in the nearshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects.
	Marine Mammals	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Breeding populations of both harbour and grey seals occur throughout Area 5. Harbour porpoise and bottlenose dolphins also occur regularly throughout this area. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 5 is an important area for leatherback sea turtles. Many leatherbacks have also been sighted far off shore. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 5: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		1 (300 MW)	2 (600 MW)	3 (900 MW)	
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	Shellfish fisheries which may be impacted in Area 5include Nephrops, edible crab, spider crab, lobster, shrimp, oyster and crayfish. The edible crab and Nephrops fisheries generally extend further offshore while other shellfish fisheries in the Area are mainly restricted to the nearshore area within the sheltered bays. Inshore finfish grounds are however also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. A significant concern in characterising the inshore fisheries in Ireland is the lack of data on inshore fishing vessels under 15 m. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	Area 5 contains extensive shellfish cultivation areas for mussels, Pacific oysters and clams which could be adversely affected by any significant and prolonged rise in suspended solids. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negligible**	Consideration has been given to placing devices in the areas of lowest shipping intensity, avoiding the more intensely used routes into Galway Bay and the Shannon.
	Recreation and Tourism	**Negligible**	**Negative**	**Negative**	Potential access and displacement impacts on recreational yachting and wildlife watching. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no military practice or danger areas within the Assessment Area.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.

SEA Topic		Assessment Area 5: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments 1 (300 MW)	 2 (600 MW)	 3 (900 MW)	Comments
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. No potential aggregate resource areas have been identified in the Area.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are no oil and gas lease, option or exploration areas within Area 5.
Seascape	Seascape (0km to 15km offshore)	**Moderate to Substantial**	**Substantial**	**Substantial**	Seascape character throughout in this area is complex and varied, comprising a number of seascape character types, the majority of which are highly sensitive to offshore wind developments e.g. large bays, plateaus and high cliffs and complex indented coastline with small bays and offshore islands. Any development within 15km from the coast that could affect these sensitive seascape types is likely to have a substantial effect on seascape character. However, there are some stretches of the coast within this Assessment Area where potential cumulative effects on seascape of development within 15km of the coast would be of moderate significance. Due to the sensitivity of large sections of the coast it is likely that any potential effects will remain of moderate significance up to 24km from the coast, increasing to substantial as the number of developments increase. These effects would reduce to slight further offshore e.g. more than 24km, with effects becoming negligible at 35km.
	Seascape (15km to 24km offshore)	**Slight Moderate**	**Slight Moderate to Moderate**	**Moderate to Substantial**	
	Seascape (more than 24km offshore)	**Slight**	**Slight to Moderate**	**Moderate**	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.21: Assessment Area 5 West Coast North – Wave: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

The Marine Renewables Industries Association (MRIA) has identified "initial development areas" for wave and tidal energy development (MRIA, 2010). Assessment Area 5 completely contains the initial wave development areas identified by MRIA for North Kerry and West Clare. It also contains the southern half of the North Mayo area. The cumulative assessment for Area 5 therefore focuses on impacts of development within those areas that occur in the Assessment Area.

SEA Topic		Assessment Area 5: Wave– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Wave Developments			
		1000 to 3000 MW	3000 to 6000 MW	7000 MW	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Negative**	**Unknown / Negative**	**Unknown / Negative**	Development is possible without direct overlap with existing protected sites. However, the coastline is heavily protected by national and international sites, many of which are designated for mobile species. Potential for barrier and/or collision impacts on birds and seals accessing the nearby coastal and marine protected sites.
	Benthic ecology	**Unknown / Negative**	**Unknown / Negative**	**Unknown / Significant adverse**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is significant overlap between the wave resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.

SEA Topic		Assessment Area 5: Wave– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Wave Developments			
		1000 to 3000 MW	3000 to 6000 MW	7000 MW	
	Fish and Shellfish	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.
	Birds	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	Protected and breeding bird colonies are located along much of the coastline, and more significant impacts would be associated with development immediately offshore of these areas. Birds from these sites are likely to be present feeding or loafing in the nearshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk (diving birds). The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. These effects will increase in significance as development increases.
	Marine Mammals	**Unknown / Negative**	**Unknown / Negative**	**Unknown / Negative**	Breeding populations of both harbour and grey seals occur throughout Area 5. Harbour porpoise and bottlenose dolphins also occur regularly throughout this area. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could cause a collision risk, or act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 5 is an important area for leatherback sea turtles. Many leatherbacks have also been sighted far off shore. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 5: Wave– Potential Cumulative Effects WITH Mitigation Number of Commercial Wave Developments 1000 to 3000 MW	 3000 to 6000 MW	 7000 MW	Comments
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	Shellfish fisheries which may be impacted in Area 5 include Nephrops, edible crab, spider crab, lobster, shrimp, oyster and crayfish. The edible crab and Nephrops fisheries generally extend further offshore while other shellfish fisheries in the Area are mainly restricted to the nearshore area within the sheltered bays. Inshore finfish grounds are however also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. A significant concern in characterising the inshore fisheries in Ireland is the lack of data on inshore fishing vessels under 15 m. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	Area 5 contains extensive shellfish cultivation areas for mussels, Pacific oysters and clams which could be adversely affected by any significant and prolonged rise in suspended solids. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negligible**	Consideration has been given to placing devices in the areas of lowest shipping intensity, avoiding the more intensely used routes into Galway Bay and the Shannon, and adjacent to the coastline.
	Recreation and Tourism	**Negligible**	**Negative**	**Negative**	Potential access and displacement impacts on recreational yachting and wildlife watching. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no military practice or danger areas within the Assessment Area.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.

SEA Topic		Assessment Area 5: Wave– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Wave Developments			
		1000 to 3000 MW	3000 to 6000 MW	7000 MW	
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. No potential aggregate resource areas have been identified in the Area.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are no oil and gas lease, option or exploration areas within Area 5.
Seascape	Seascape (0km to 5km offshore)	**Moderate to Substantial**	**Substantial**	**Substantial**	In terms of seascape effects, there are a number of sections along the coast in this Assessment Area where seascape character is considered to be sensitive to wave developments e.g. plateaus and high cliffs, complex indented coastline with small bays and offshore islands. Development within 0 to 5km from the coast in these areas is therefore likely to have a substantial effect on seascape character. However, there are other sections along the coast where potential effects of wave developments on seascape would be moderate. Any potential effects on seascape can be avoided or reduced by siting developments further offshore e.g. potential effects of developments located more than 15km from the coast would be reduced to slight/negligible in relation to most seascape types.
	Seascape (5km to 15km offshore)	**Moderate to Slight**	**Moderate**	**Moderate to Substantial**	
	Seascape (more than 15km offshore)	**Negligible to Slight**	**Slight**	**Moderate**	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.22: Assessment Area 5a Shannon – Tidal: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 5a: Tidal– Potential Cumulative Effects WITH Mitigation – Number of Commercial Tidal Developments: 1 (50 MW)	2 (100 MW)	3 (150 MW)	Comments
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Commercial scale development in the Shannon would necessitate installing turbines within the existing SAC. The SAC is designated for benthic habitats and bottlenose dolphin. Potential collision and exclusion impacts on the resident bottlenose dolphin population which is a qualifying feature of the SAC, and protected benthic habitats, which it may not be possible to avoid due to the restricted space available within the estuary.
	Benthic ecology	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	Development may not be possible without direct overlap with areas of known sensitive/important benthic habitat within the SAC. Potential impacts include substratum loss and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). More detailed site specific assessment and benthic survey required to confirm sensitivities and level of potential effect.
	Fish and Shellfish	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood, but are much more likely to be significant in the Shannon which is used by several migratory species protected under the habitats directive, compared to more open nearshore and offshore waters. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 5a: Tidal– Potential Cumulative Effects WITH Mitigation Number of Commercial Tidal Developments 1 (50 MW)	2 (100 MW)	3 (150 MW)	Comments
	Birds	**Unknown / Negative**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	There are a number of SPAs within the Shannon, and it may not be possible to avoid close proximity to these sites. Birds from these sites are likely to be present feeding or loafing within the estuary in general. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. These effects will increase in significance as development increases.
	Marine Mammals	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	**Unknown / Significant Adverse**	The Shannon is a designated SAC because it is home to the only resident population of bottlenose dolphins in Ireland. It also contains a number of other cetaceans and is an important grey seal foraging area. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays, as well as the presence of the arrays themselves could act as a barrier to mammal movements.
	Marine Reptiles	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Assessment Area 5a is an important area for leatherback sea turtles. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Unknown / Negative**	**Unknown / Negative**	**Unknown / Significant adverse**	Shellfish fisheries which may be impacted in Area 5a include lobster and shrimp. Inshore and constrained finfish grounds are however also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. A significant concern in characterising the inshore fisheries in Ireland is the lack of data on inshore fishing vessels under 15 m. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.

SEA Topic		Assessment Area 5a: Tidal– Potential Cumulative Effects WITH Mitigation Number of Commercial Tidal Developments			Comments
		1 (50 MW)	2 (100 MW)	3 (150 MW)	
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	Area 5 contains extensive shellfish cultivation areas for mussels, Pacific oysters and clams which could be adversely affected by any significant and prolonged rise in suspended solids. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Significant adverse**	**Significant adverse**	**Significant adverse**	The entire estuary where tidal energy resource has been identified is recorded as experiencing a high shipping intensity. It is therefore not possible to avoid siting devices within existing shipping areas, and placement of devices will cause displacement and could increase collision risks.
	Recreation and Tourism	**Negative**	**Significant adverse**	**Significant adverse**	Potential access and displacement impacts on recreational yachting and wildlife watching. Any impact on dolphin populations will also have a knock-on effect on the wildlife watching industry the species supports. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no military practice or danger areas within the Assessment Area.
	Disposal Areas	**Negligible**	**Negligible**	**Negative**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. No potential aggregate resource areas have been identified in the Area.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are no oil and gas lease, option or exploration areas within Area 5a.
Seascape	Seascape (0km to 5km)	**Moderate**	**Moderate**	**Moderate**	Due to the scale of this Assessment Area it is likely that all development in this area would be within 0 to 10km of the coast. On the basis that most

SEA Topic		Assessment Area 5a: Tidal– Potential Cumulative Effects WITH Mitigation Number of Commercial Tidal Developments 1 (50 MW)	2 (100 MW)	3 (150 MW)	Comments
	Seascape (5km to 10km)	**Moderate**	**Moderate**	**Moderate**	tidal devices are fully submerged potential effects on seascape will be generally negligible to slight. However, where devices do protrude above the water surface the likely significance of potential cumulative effects on seascape is likely to increase to moderate, particularly where there are a number of developments in one location.
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.23: Assessment Area 6 North Coast – Fixed Wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 6: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		5 (1500 MW)	10 (3000 MW)	15 (4500 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	Development of up to 15 arrays is possible to the north of the area without direct overlap with existing protected sites. Potential for impacts on bird species accessing coastal breeding and wintering sites. There is potential for offshore wind development up to 15 – 40 km offshore from the nearest SPA or SAC. The area is important for mobile species such as birds and mammals which will be using the designated sites in the area.
	Benthic ecology	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is some overlap between the fixed wind resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat but it may be possible to avoid this area. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is required to confirm the presence of sensitive communities and the level of potential effect.
	Fish and Shellfish	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 6: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		5 (1500 MW)	10 (3000 MW)	15 (4500 MW)	
	Birds	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	The adjacent coastline contains protected seabird populations and breeding colonies. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects.
	Marine Mammals	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	Breeding populations of harbour and grey seals occur throughout Area 6. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 6 is an important area for leatherback sea turtles (historically Donegal has the third highest numbers of sightings in Ireland). Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known, however by providing new habitat for jellyfish polyps, arrays could actually increase the abundance of jellyfish in adjacent waters through a process of advection.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	Shellfish fisheries which may be impacted in Area 6 include Nephrops, crab, lobster, shrimp and oyster. Area 6 also contains spawning grounds and associated fisheries for herring which may be subject to direct disturbance. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	No direct effects on fish farming within the adjacent areas. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negative**	Consideration has been given to placing devices in the areas of lowest shipping intensity. The impact significance increases with the size and number of areas developed.

SEA Topic		Assessment Area 6: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		5 (1500 MW)	10 (3000 MW)	15 (4500 MW)	
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	Potential access and displacement impacts on recreational yachting. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no Department of Defence danger areas within Assessment Area 6, although, military use of the Area will include fishery protection and search and rescue operations. Much of the area is also in use for fleet exercises and submarine exercise and transit, although, no ammunition firing is undertaken. Potential for interference with the existing use of this site, although possible wind development areas take up a small percentage of the total fleet exercise area.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are is no oil and gas exploitation or exploration within the shallow water areas suitable for deployment of fixed wind devices.
Landscape/Seascape	Seascape (0km to 15km)	**Moderate to Substantial**	**Substantial**	**Substantial**	The character of the seascape along the coast of this Assessment Area is complex and varied, comprising a number of seascape types, the majority of which are highly sensitive to offshore wind developments e.g. large bays, narrow coastal strip with raised hinterland, complex indented coastline with small bays and offshore islands and plateaus and high cliffs.
	Seascape (15km to 24km)	**Moderate**	**Moderate**	**Moderate to Substantial**	

SEA Topic		Assessment Area 6: Fixed Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Fixed Wind Developments			Comments
		5 (1500 MW)	10 (3000 MW)	15 (4500 MW)	
	Seascape (more than 24km)	**Slight**	**Slight to Moderate**	**Moderate**	A number of developments within 0 to 15km of the coast are likely to have a substantial effect on seascape character. However, with shallower water depths in this area there is potential for reducing the overall significance of these effects by increasing the distance of developments from the coast e.g. beyond 15km and ideally beyond 24km.
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.24: Assessment Area 6 North Coast – Wave: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 6: Wave– Potential Cumulative Effects WITH Mitigation Number of Commercial Wave Developments			Comments
		1500MW	3000MW to 6000MW	7000MW to 8000MW	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown** / **Negligible**	**Unknown** / **Negligible**	**Unknown** / **Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown** / **Negligible**	**Unknown** / **Negligible**	**Unknown** / **Negligible**	Development is possible to the north of the area without direct overlap with existing protected sites. Potential for impacts on bird species accessing coastal breeding and wintering sites. The area is important for mobile species such as birds and mammals which will be using the designated sites in the area.
	Benthic ecology	**Unknown** / **Negligible**	**Unknown** / **Negligible**	**Unknown** / **Negligible**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is some overlap between the wave resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat, but it may be possible to avoid this area. There is also, potential for other unrecorded sensitive habitat to exist. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.
	Fish and Shellfish	**Unknown** / **Negligible**	**Unknown** / **Negligible**	**Unknown** / **Negligible**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 6: Wave– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Wave Developments			
		1500MW	3000MW to 6000MW	7000MW to 8000MW	
	Birds	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	The adjacent coastline contains protected seabird populations and breeding colonies. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. These effects will increase in significance as development increases.
	Marine Mammals	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	Breeding populations of harbour and grey seals occur throughout Area 6. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 6 is an important area for leatherback sea turtles (historically Donegal has the third highest numbers of sightings in Ireland). Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	Shellfish fisheries which may be impacted in Area 6 include Nephrops, crab, lobster, shrimp and oyster. Area 6 also contains spawning grounds and associated fisheries for herring which may be subject to direct disturbance. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
	Mariculture	**Negligible**	**Negligible**	**Negligible**	No direct effects on fish farming within the adjacent areas. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negligible**	Consideration has been given to placing devices in the areas of lowest shipping intensity. The impact significance increases with the size and number of areas developed.

SEA Topic		Assessment Area 6: Wave– Potential Cumulative Effects WITH Mitigation Number of Commercial Wave Developments 1500MW	3000MW to 6000MW	7000MW to 8000MW	Comments
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	Potential access and displacement impacts on recreational yachting. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no Department of Defence danger areas within Assessment Area 6, although, military use of the Area will include fishery protection and search and rescue operations. Much of the area is also in use for fleet exercises and submarine exercise and transit, although, no ammunition firing is undertaken. Potential for interference with the existing use of this site, although possible wave development areas take up a small percentage of the total fleet exercise area.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	The level of development indicated is possible without any overlap with existing petroleum lease areas.
Seascape	Seascape (0km to 5km offshore)	**Moderate**	**Moderate to Substantial**	**Substantial**	The seascape character in this Assessment Area is complex and varied, comprising a number of seascape types, the majority of which are likely to be sensitive to wave developments e.g. large bays, narrow coastal strip with raised hinterland, complex indented coastline with small bays and offshore islands and plateaus and high cliffs. The likely significance of any
	Seascape (5km to 15km offshore)	**Slight to Moderate**	**Moderate**	**Moderate**	

SEA Topic		Assessment Area 6: Wave– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Wave Developments			
		1500MW	3000MW to 6000MW	7000MW to 8000MW	
	Seascape (more than 15km offshore)	**Negligible to Slight**	**Slight**	**Slight**	potential effects on seascape will vary depending on distance of developments from the coast. A number of developments within 0 to 5km of the coast are therefore likely to have a substantial effect on seascape character. However, based on the wave resource available in this area there are a number of opportunities for reducing potential effects by siting developments further offshore e.g. beyond 15km.
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.25: Assessment Area 6 North Coast – Tidal: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

The Marine Renewables Industries Association (MRIA) has identified "initial development areas" for wave and tidal energy development (MRIA, 2010). No initial development areas were identified within Assessment Area 6. However, as an area that has been identified during this SEA as containing a fairly large area of tidal resource, in a relatively unconstrained part of the sea, cumulative impacts of developing in this area. This table therefore focuses on cumulative impacts of siting devices within Area 6 off the north coast of Ireland.

SEA Topic		Assessment Area 6: Tidal– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Tidal Developments			
		2 (100 MW)	15 (750 MW)	30 (1500 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	Development of up to 30 arrays is possible without direct overlap with existing protected sites. Potential for impacts on bird species using coastal breeding and wintering sites. The area is important for mobile species such as birds and mammals which will be using the designated sites in the area.
	Benthic ecology	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	There is potential for development to avoid areas of known benthic ecological importance which are contained within existing SAC sites. There is significant overlap between the tidal resource and the area identified by NPWS as representing a best estimate of the distribution and range of Annex I reef habitat. These areas are fairly broad and further work will be needed to characterise the benthic habitat within them. There is also, potential for other unrecorded sensitive habitat to exist. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is therefore required to confirm the presence of sensitive communities and the level of potential effect.

SEA Topic		Assessment Area 6: Tidal– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Tidal Developments			
		2 (100 MW)	15 (750 MW)	30 (1500 MW)	
	Fish and Shellfish	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.
	Birds	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negative**	The adjacent coastline contains protected seabird populations and breeding colonies. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely effects include marine noise, physical disturbance, and habitat exclusion and collision risk (diving birds). The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. These effects will increase in significance as development increases.
	Marine Mammals	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Significant Adverse**	Breeding populations of harbour and grey seals occur throughout Area 6. Potential impacts on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 6 is an important area for leatherback sea turtles (historically Donegal has the third highest numbers of sightings in Ireland). Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 6: Tidal– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Tidal Developments			
		2 (100 MW)	15 (750 MW)	30 (1500 MW)	
Population and Human Health	Commercial Fisheries	**Unknown / Negligible**	**Unknown / Negative**	**Unknown / Negative**	Shellfish fisheries which may be impacted in Area 6 include Nephrops, crab, lobster, shrimp and oyster. Area 6 also contains spawning grounds and associated fisheries for herring which may be subject to direct disturbance. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	No direct effects on fish farming within the adjacent areas. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negative**	Shipping intensity within the area is generally low, and consideration has been given to placing devices in the areas of lowest shipping intensity, away from the main shipping lanes. The impact significance increases with the size and number of areas developed.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	Potential access and displacement impacts on recreational yachting. Potential construction (short term) and operation (long term) impacts on adjacent recreational beaches.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no Department of Defence danger areas within Assessment Area 6, although, military use of the Area will include fishery protection and search and rescue operations. Much of the area is also in use for fleet exercises and submarine exercise and transit, although, no ammunition firing is undertaken. Potential for interference with the existing use of this site, although possible tidal development areas take up a small percentage of the total fleet exercise area.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.

SEA Topic		Assessment Area 6: Tidal– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Tidal Developments			
		2 (100 MW)	15 (750 MW)	30 (1500 MW)	
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	The level of development assessed here is possible without any interaction with existing petroleum lease areas.
Seascape	Seascape (0km to 5km)	**Moderate**	**Substantial**	**Substantial**	There are a number of sections of the coastline in this Assessment Area that are likely to be sensitive to tidal developments comprising devices that protrude above the water surface. The most sensitive seascape types include plateaus and high cliffs, narrow coastal strip with raised hinterland, and complex indented coastline with small bays and islands. It is likely that a large number of developments located in clusters/groups within 0 to 5km of the coast would have a moderate to substantial effect on these seascape character areas. These effects could be reduced/avoided by siting developments further offshore (e.g. 10km to 15km).
	Seascape (5km to 15km)	**Slight - Moderate**	**Moderate**	**Moderate Substantial**	
	Seascape (more than 15km)	**Moderate**	**Substantial**	**Substantial**	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.26: Assessment Area 3 South Coast – Floating Wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 3: Floating Wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		10 (3000 MW)	20 (6000 MW)	30 (9000 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	Floating wind devices are likely to be located considerably further offshore compared to fixed wind devices which are limited by water depth. There is potential to develop the array areas indicated whilst maintaining a distance of at least 35 km from the coastline and any associated protected sites. There is still potential to impact on mobile bird and mammals species accessing these sites, depending on migration and transit routes which are not well understood
	Benthic ecology	**Unknown / negligible**	**Unknown / negligible**	**Unknown / negative**	Development of the array sizes indicated is possible without direct overlap with areas of known sensitive/important benthic habitat. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Potential for unknown sensitive habitat to exist. Benthic survey required to confirm sensitivities and level of potential effect.
	Fish and Shellfish	**Unknown / negative**	**Unknown / negative**	**Unknown / significant adverse**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas, particularly as the offshore part of the Assessment Area overlaps very extensively with the *Nephrops* stock in the west and with scallop grounds in the east. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 3: Floating Wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		10 (3000 MW)	20 (6000 MW)	30 (9000 MW)	
	Birds	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	Protected and breeding bird colonies are located along much of the adjacent coastline. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. Significance of impact is to a large degree dependent on migration and transit routes, which are not well understood.
	Marine Mammals	**Unknown / negligible**	**Unknown / negligible**	**Unknown / negative**	There are regular sightings of cetaceans in this Area, and Saltee Island SAC is designed for grey sea. . The presence of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 3 is an important area for leatherback sea turtles. County Cork has the highest number of turtle sightings in Ireland. Many leatherbacks have also been sighted far offshore, in the area likely to be exploited for floating wind. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 3: Floating Wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		10 (3000 MW)	20 (6000 MW)	30 (9000 MW)	
Population and Human Health	Commercial Fisheries	**Negligible**	**Negative**	**Significant adverse**	Fishing is widespread throughout the Assessment Area. All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds, and increasing pressure on adjacent areas, however offshore fisheries are less sensitive to these impacts, compared to the more spatially constrained inshore fishery. Significance of potential effect is also dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed. Potential positive impact from fish stock recovery within any exclusion areas.
	Mariculture	**Negligible**	**Negligible**	**Negligible**	The main shellfish aquaculture species in Area 3 is for Pacific oysters with localised production also of mussels and clams. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negligible**	Consideration has been given to placing devices in the areas of lowest shipping intensity. There is scope to place floating wind arrays offshore of the coast adjacent shipping route and to avoid the main routes across the area.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	Potential access and displacement impacts on recreational yachting. Floating wind devices are likely to be sufficiently far offshore to limit potential for interaction with recreation and tourism.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There is potential for the levels of development identified without siting devices within the Defence Danger Area D13.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**Negligible**	**Negligible**	**Negligible**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated.

SEA Topic		Assessment Area 3: Floating Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Floating wind Developments 10 (3000 MW)	 20 (6000 MW)	 30 (9000 MW)	Comments
	Oil and Gas exploitation	**Negligible**	**Negligible**	**Negligible**	The offshore part of the Assessment Area contains a number of oil and gas lease, licensing option and exploration licence areas. The levels of development indicated are considered possible whilst avoiding direct overlap with these areas.
Seascape	Seascape (0km to 24km)	**Moderate to Substantial**	**Substantial**	**Substantial**	In terms of seascape, potential effects reduce from moderate to slight between 24km and 35km from the coast and are generally considered to be negligible beyond 35km as it is difficult to see anything beyond this distance. Given that there is much more flexibility for siting floating wind developments in deeper water further offshore, potential moderate to substantial effects could be avoided/reduced to slight/negligible by locating developments more than 24km from the coast and ideally 35km.
	Seascape (24km to 35km offshore)	**Slight**	**Slight to Moderate**	**Moderate**	
	Seascape (more than 35km offshore)	**Negligible**	**Negligible**	**Negligible to Slight**	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.27: Assessment Area 4 West Coast South – Floating Wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 4: Floating wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		9 (2700 MW)	18 (5400 MW)	28 (8400 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	Floating wind devices are likely to be located considerably further offshore compared to fixed wind devices which are limited by water depth. There is potential to develop the array areas indicated whilst maintaining a distance of at least 35 km from the coastline and any associated protected sites. There is still potential to impact on mobile bird and mammals species accessing these sites, depending on migration and transit routes which are not well understood
	Benthic ecology	**Unknown / negligible**	**Unknown / negligible**	**Unknown / negative**	Development of the array sizes indicated is possible without direct overlap with areas of known sensitive/important benthic habitat. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Potential for unknown sensitive habitat to exist. Benthic survey required to confirm sensitivities and level of potential effect.
	Fish and Shellfish	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 4: Floating wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Floating wind Developments 9 (2700 MW)	18 (5400 MW)	28 (8400 MW)	Comments
	Birds	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	Protected and breeding bird colonies are located along much of the adjacent coastline. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. Significance of impact is to a large degree dependent on migration and transit routes, which are not well understood.
	Marine Mammals	**Unknown / negligible**	**Unknown / negligible**	**Unknown / negative**	Large breeding populations of both harbour and grey seals occur throughout Area 4. The presence of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 4 is an important area for leatherback sea turtles. Counties Cork and Kerry have the highest and second highest number of turtle records respectively. Many leatherbacks have also been sighted far offshore, in the area likely to be exploited for floating wind. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 4: Floating wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		9 (2700 MW)	18 (5400 MW)	28 (8400 MW)	
Population and Human Health	Commercial Fisheries	**Negligible**	**Negative**	**Significant adverse**	Shellfish fisheries which may be impacted in Area 4 include edible crab, lobster, shrimp, spider crab, Nephrops, scallop and crayfish. The edible crab and Nephrops fisheries generally extend further offshore while other shellfish fisheries in the Area are mainly restricted to the nearshore area within the sheltered bays. All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds, and increasing pressure on adjacent areas, however offshore fisheries are less sensitive to these impacts, compared to the more spatially constrained inshore fishery. Significance of potential effect is also dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed. Potential positive impact from fish stock recovery within any exclusion areas.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	Area 4 contains extensive shellfish cultivation areas for mussels, Pacific oysters, scallop and urchins. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negligible**	Consideration has been given to placing devices in the areas of lowest shipping intensity. There is scope to place floating wind arrays offshore of the coast adjacent shipping route and to avoid the main routes across the area.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	Potential access and displacement impacts on recreational yachting. Floating wind devices are likely to be sufficiently far offshore to limit potential for interaction with recreation and tourism.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There is potential for the levels of development identified without siting devices within the Defence Danger Area D14.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.

SEA Topic		Assessment Area 4: Floating wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Floating wind Developments			Comments
		9 (2700 MW)	18 (5400 MW)	28 (8400 MW)	
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. No potential aggregate resource areas have been identified in the Area.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are no oil and gas lease, option or exploration areas within Area 4.
Seascape	Seascape (0km to 24km offshore)	**Substantial**	**Substantial**	**Substantial**	Seascape character in this area is predominantly type 2: rugged peninsula's with drowned valleys which is highly sensitive to offshore wind developments. Given that floating wind developments are not restricted by water depth there is much greater potential for avoiding substantial effects on seascape character in this area by siting developments further offshore e.g. more than 24km from the coast. Potential effects would be further reduced (to slight/negligible) with increased distance offshore e.g. beyond 35km.
	Seascape (24km to 35km offshore)	**Moderate**	**Moderate**	**Moderate to Substantial**	
	Seascape (more than 35km offshore)	**Negligible**	**Slight to Negligible**	**Slight**	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.28: Assessment Area 5 West Coast North – Floating Wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 5: Floating Wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		12 (3600 MW)	24 (7200 MW)	36 (10,800 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	Floating wind devices are likely to be located considerably further offshore compared to fixed wind devices which are limited by water depth. There is potential to develop the array areas indicated whilst maintaining a distance of at least 35 km from the coastline and any associated protected sites. There is still potential to impact on mobile bird and mammals species accessing these sites, depending on migration and transit routes which are not well understood
	Benthic ecology	**Unknown / negligible**	**Unknown / negligible**	**Unknown / negative**	Development of the array sizes indicated is possible without direct overlap with areas of known sensitive/important benthic habitat. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Potential for unknown sensitive habitat to exist. Benthic survey required to confirm sensitivities and level of potential effect.
	Fish and Shellfish	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 5: Floating Wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		12 (3600 MW)	24 (7200 MW)	36 (10,800 MW)	
	Birds	**Unknown** / **negligible**	**Unknown** / **negative**	**Unknown** / **negative**	Protected and breeding bird colonies are located along much of the adjacent coastline. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. Significance of impact is to a large degree dependent on migration and transit routes, which are not well understood.
	Marine Mammals	**Unknown** / **negligible**	**Unknown** / **negligible**	**Unknown** / **negative**	Breeding populations of both harbour and grey seals occur throughout Area 5. Harbour porpoise and bottlenose dolphins also occur regularly throughout this Area. The presence of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown** / **Neutral**	**Unknown** / **Neutral**	**Unknown** / **Neutral**	Assessment Area 5 is an important area for leatherback sea turtles. Many leatherbacks have also been sighted far offshore, in the area likely to be exploited for floating wind. Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 5: Floating Wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Floating wind Developments 12 (3600 MW)	24 (7200 MW)	36 (10,800 MW)	Comments
Population and Human Health	Commercial Fisheries	**Negligible**	**Negative**	**Significant adverse**	Shellfish fisheries which may be impacted in the offshore part of Area 4 include edible crab and Nephrops. All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds, and increasing pressure on adjacent areas, however offshore fisheries are less sensitive to these impacts, compared to the more spatially constrained inshore fishery. Significance of potential effect is also dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed. Potential positive impact from fish stock recovery within any exclusion areas.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	**Negligible**	Area 5 contains extensive shellfish cultivation areas for mussels, Pacific oysters and clams which could be adversely affected by any significant and prolonged rise in suspended solids. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negligible**	Consideration has been given to placing devices in the areas of lowest shipping intensity. There is scope to place floating wind arrays offshore of the coast adjacent shipping route and to avoid the main routes across the area.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	Potential access and displacement impacts on recreational yachting. Floating wind devices are likely to be sufficiently far offshore to limit potential for interaction with recreation and tourism.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	There are no military practice or danger areas within the Assessment Area.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.

SEA Topic		Assessment Area 5: Floating Wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		12 (3600 MW)	24 (7200 MW)	36 (10,800 MW)	
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated. No potential aggregate resource areas have been identified in the Area.
	Oil and Gas exploitation	**No effect**	**No effect**	**No effect**	There are no oil and gas lease, option or exploration areas within Area 5.
Landscape/Seascape	Seascape (0km to 24km offshore)	**Moderate to Substantial**	**Substantial**	**Substantial**	Seascape character throughout in this area is complex and varied, comprising a number of seascape character types, the majority of which are highly sensitive to offshore wind developments e.g. large bays, plateaus and high cliffs and complex indented coastline with small bays and offshore islands. Given that floating wind developments are not restricted by water depth there is much greater potential for avoiding substantial effects on seascape character in this area by siting developments more than at least 24km offshore. However, the significance of any potential effects is likely to increase as the number of developments increases, even for developments sited more than 24km offshore. These potential effects would be further reduced (to slight/negligible) by increasing the number of developments located more than 35km from the coast.
	Seascape (24km to 35km offshore)	**Slight to Moderate**	**Moderate**	**Moderate to Substantial**	
	Seascape (more than 35km offshore)	**Negligible**	**Slight**	**Slight**	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	No receptors within area.

Table 12.29: Assessment Area 6 North Coast – Floating wind: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Assessment Area 6: Floating wind– Potential Cumulative Effects WITH Mitigation			Comments
		Number of Commercial Floating wind Developments			
		12 (3600 MW)	24 (7200 MW)	36 (10,800 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Unknown / Negligible**	**Unknown / Negligible**	**Unknown / Negligible**	Any effects on coastal processes are likely to be negligible and localised to the immediate vicinity of the array area. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	Floating wind devices are likely to be located considerably further offshore compared to fixed wind devices which are limited by water depth. There is potential to develop the array areas indicated whilst maintaining a distance of at least 35 km from the coastline and any associated protected sites. There is still potential to impact on mobile bird and mammals species accessing these sites, depending on migration and transit routes which are not well understood
	Benthic ecology	**Unknown / negligible**	**Unknown / negligible**	**Unknown / negative**	There is potential for development to avoid existing protected sites and areas of known benthic ecological importance which are mostly associated with the nearshore conservation areas. *Lophelia pertusa* reef, and seapen and burrowing megafauna communities have been recorded in the offshore area, and there is potential for other unrecorded sensitive habitat to exist within the area. Potential impacts include substratum loss, and sediment re-suspension during installation. Introduction of hard substrate (seabed foundations) can be positive (increasing biodiversity) or negative (changing ecological relationships). Benthic survey is required to confirm sensitivities and level of potential effect.
	Fish and Shellfish	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Herring and edible crab spawning areas extend into the deeper shelf waters of Area 6, where floating wind arrays are likely to be located. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.

SEA Topic		Assessment Area 6: Floating wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Floating wind Developments 12 (3600 MW)	24 (7200 MW)	36 (10,800 MW)	Comments
	Birds	**Unknown / negligible**	**Unknown / negative**	**Unknown / negative**	Protected and breeding bird colonies are located along much of the adjacent coastline. Birds from these sites may therefore be present feeding or loafing in the offshore resource area. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects. Significance of impact is to a large degree dependent on migration and transit routes, which are not well understood.
	Marine Mammals	**Unknown / negligible**	**Unknown / negligible**	**Unknown / negative**	Breeding populations of harbour and grey seals occur throughout Area 6. The presence of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown / Neutral**	**Unknown / Neutral**	**Unknown / Neutral**	Assessment Area 6 is an important area for leatherback sea turtles (historically Donegal has the third highest numbers of sightings in Ireland). Potential impacts include entanglement with mooring chains, collision, pollution, noise and barrier effects, although transit routes around Ireland are not known. Exclusion from jellyfish feeding hotspots during construction could be significant in this area, but operating arrays could provide new jellyfish habitat, actually increasing turtle food resources.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Assessment Area 6: Floating wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Floating wind Developments 12 (3600 MW)	24 (7200 MW)	36 (10,800 MW)	Comments
Population and Human Health	Commercial Fisheries	**Negligible**	**Negative**	**Significant adverse**	Commercial fishing is widespread throughout the assessment Area. All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds, and increasing pressure on adjacent areas, however offshore fisheries are less sensitive to these impacts, compared to the more spatially constrained inshore fishery. Significance of potential effect is also dependent on whether fishing is permitted within arrays. Significance of impact increases with area developed. Potential positive impact from fish stock recovery within any exclusion areas.
	Mariculture	**Negligible**	**Negligible**	**Negligible**	No direct effects on fish farming within the adjacent areas. Limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negligible**	Consideration has been given to placing devices in the areas of lowest shipping intensity. There is scope to place floating wind arrays offshore of the coast adjacent shipping route and to avoid the main routes across the area.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	Potential access and displacement impacts on recreational yachting. Floating wind devices are likely to be sufficiently far offshore to limit potential for interaction with recreation and tourism.
	Radar Interference	**Negligible**	**Negligible**	**Negligible**	It is anticipated that possible impact on aviation either from intermittent detections of turbines by air traffic controllers shadowing, or collision risk is with the Search and Rescue activities that are ongoing in this area can be mitigated through consultation with the IAA, avoidance and appropriate lighting and marking of devices.
	Military Practice Areas	**Negligible**	**Negligible**	**Negative**	There are no Department of Defence danger areas within Assessment Area 6, although, military use of the Area will include fishery protection and search and rescue operations. Much of the area is also in use for fleet exercises and submarine exercise and transit, although, no ammunition firing is undertaken. Potential for interference with the existing use of this site, although possible wind development areas take up a small percentage of the total fleet exercise area.

SEA Topic		Assessment Area 6: Floating wind– Potential Cumulative Effects WITH Mitigation Number of Commercial Floating wind Developments: 12 (3600 MW)	24 (7200 MW)	36 (10,800 MW)	Comments
	Disposal Areas	Negligible	Negligible	Negligible	Although there are a number of disposal sites within the Area potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	No effect	No effect	No effect	Potential interactions with cables and pipelines can be managed through good practice.
	Aggregate Extraction	No effect	No effect	No effect	There are no currently exploited aggregate extraction areas in the study area, and therefore no impacts are anticipated.
	Oil and Gas exploitation	No effect	No effect	No effect	There are a number of petroleum lease areas within Assessment Area 6. The indicated levels of development are considered possible without developing within the existing lease areas.
Seascape	Seascape (0km to 24km offshore)	Moderate to Substantial	Substantial	Substantial	The character of the seascape along the coast of this Assessment Area is complex and varied, comprising a number of seascape types, the majority of which are highly sensitive to offshore wind developments e.g. large bays, narrow coastal strip with raised hinterland, complex indented coastline with small bays and offshore islands and plateaus and high cliffs. Given that floating wind developments are not restricted by water depth there is much greater potential for avoiding substantial effects on seascape character in this area by siting developments more than at least 24km offshore. Potential effects of a large number of developments would be further reduced (to slight/negligible) by increasing the distance offshore to beyond 35km.
	Seascape (24km to 35km offshore)	Slight to Moderate	Moderate	Moderate to Substantial	
	Seascape (more than 35km offshore)	Negligible	Slight to Negligible	Slight	
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	Positive	Positive	Positive	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	No effect	No effect	No effect	No receptors within area.

Section 13: Cumulative Effects Other Plans and Programmes and Developments

13 In Combination Effects (Other Plans and Programmes and Developments) and Interactions

13.1 Introduction

This chapter assesses the potential in-combination effects on the environment and other marine users with respect to other plans and programmes and how they relate to the OREDP. This chapter also includes an assessment of the main interactions between the SEA issues/subjects and influence of the proposals in the OREDP on those interactions.

13.2 In-Combination Effects of Relevant Plans, Programmes and Policies

The potential in-combination effects in relation to other marine developments have been assessed in Chapter 12: Cumulative Effects – Testing OREDP Development Scenarios.

This part of the assessment focuses on the following:

- Other plans, programmes and policies relating to Irish waters and offshore renewable energy developments (e.g. Grid 25)
- Wider transboundary effects associated with other UK and European plans and programmes for the offshore renewable energy developments.

There is a wide range of plans, programmes and policies which could potentially influence, either directly or indirectly, the proposals set out in the OREDP for the development of offshore renewable energy in Ireland. A summary of the most relevant plans, programmes and policies is provided in Chapter 5: Policy Context.

A number of the plans, programmes and policies identified are regulatory instruments (International, European and domestic) which the Irish Government is statutorily obliged to implement appropriately e.g. the completion of this SEA in line with the EC SEA Directive. There are also a number of other regulatory instruments which have to be taken into account in, and which may have a direct influence over, the results of this assessment e.g. the EC Habitats and Birds Directives. The main environmental objectives of these regulatory instruments and how they influence the SEA and OREDP is discussed in Chapter 5.

In addition to the regulatory instruments there are also a number of plans and programmes that need to be taken into consideration in terms of this SEA and the developing OREDP. The plans and programmes discussed below are the ones that have been identified as having a direct influence on or an interaction with the OREDP in terms of the future management, use and protection of the marine environment and associated development. As noted above, specific offshore renewable energy developments which either have, or are in the process of applying for, a Foreshore Lease under the Foreshore and Dumping at Sea (Amendment) Act 2009, are discussed in Chapter 12.

The main plans, programmes and policies covered in this assessment include:

- Habitats Directive 1992 (92/43/EEC).
- OSPAR – designation of Marine Protected Areas (MPAs)
- Marine Strategy Framework Directive 2008 (2008/56/EC).
- Ireland proposals for Marine Planning.
- Grid 25 Implementation Programme.

A discussion of the potential in-combination effects or interactions between these plans and programmes is provided below.

13.2.1 EC Habitats Directive

The EC Habitats Directive 1992 sets out the framework for the establishment of a European network of protected sites (Natura 2000) sites. These include Special Areas of Conservation (SACs) which are designated for the protection of habitats listed under Annex I of the Directive and species listed under Annex II of the Directive, and Special Protection Areas (SPAs) which are designated for the protection of areas containing rare or vulnerable birds listed under Annex I of the EC Birds Directive 1979. Under this Directive member states are also required to extend protection afforded under the onshore and coastal Natura 2000 site designations further offshore.

There are currently four designated offshore marine SAC sites in Irish waters (Beligica Mound SAC, Hoyland Mound SAC, NW Porcupine Bank SAC and SW Porcupine Bank SAC). Although these sites fall outside the main SEA study area and there area covered by the OREDP, and are therefore unlikely to be affected by any proposals for set out in the OREDP for the future development of Offshore Renewable Energy in Irish waters, they have still been considered in this environmental report to ensure completeness of the assessment.

However, it should be recognised that in addition to these offshore SAC sites there are numerous SAC and SPA sites (including proposed and candidate) located around the coast of Ireland. These sites have been taken into account in both the assessment of potential effects presented in Chapters 10 and 11, and the assessment of potential cumulative effects presented in the Chapter 12. In terms of assessing the development scenarios presented in the OREDP, it was concluded that it would be possible to develop up to 4,500MW from offshore wind and 1,500MW from wave and tidal energy without likely significant adverse effects on the environment. This conclusion was based on the avoidance of all protected sites including World Biosphere Reserves, Ramsar sites, Natura 2000 sites and OSPAR MPAs (see below). However, these conclusions are heavily caveated by the need for further surveys at the project stage to determine the potential effects of a specific project on species and birds which are qualifying features of an SAC or SPA but which are not confined to the boundaries of the site and therefore could be affected by offshore renewable energy developments.

Further information on specific survey requirements for marine mammals, birds and reptiles, and the integration of these into the OREDP are provided in Chapters 14 and 15.

13.2.2 The OSPAR Convention

In 2002/3 the OSPAR Commission under the OSPAR Convention 1992 (Convention for the Protection of the Marine Environment of the North East Atlantic) set a requirement for the identification of an ecologically coherent network of well managed Marine Protected Areas (MPAs) by 2010. To date, Ireland has 19 formally designated OSPAR MPAs. It is also likely that a number of the existing coastal SAC sites and the four designated offshore SAC sites could also be declared as OSPAR MPAs in the future.

In terms of potential influence of these designated sites on the proposals within the OREDP and its implementation, the potential effects of offshore renewable energy developments on these sites have been taken into account as part of the main assessment, presented in Chapters 10, 11 and 12. It was concluded that, in terms of the OREDP and it would be possible to achieve the higher level scenario to develop up to 4,500MW from offshore wind and 1,500MW from wave and tidal energy without any likely significant effects on the environment. This included avoidance of all protected sites including MPAs, in order to avoid any likely significant adverse effects on the integrity of these sites. However, it should also be noted that, the conclusions are subject to qualification at the project stage where surveys and studies would be required to confirm that there would be no likely significant adverse effects, and in the case of the ongoing assessment and designation of MPAs and offshore SACs and SPAs as discussed above, any future site designations would also need to be taken into account at the project stage to ensure any potential significant adverse effects are avoided.

13.2.3 Marine Strategy Framework Directive (MSFD)

As discussed in Chapter 5, the Irish Government is obliged, under the Marine Strategy Framework Directive (MSFD), to 'take the necessary measures to achieve or maintain good environmental status (GES) of the marine environment by 2020 at the latest' and to adopt an ecosystem approach to the management of human activities in the marine environment. In order to meet the requirements of the MSFD, the Government is required to prepare a strategy for the management of Irish waters. This strategy includes a number of actions which must be delivered in specific timescales.

As part of this strategy there is a requirement to develop environmental targets and indicators by 2012 and to then implement a monitoring programme based on those targets and indicators by 2014. It is likely that these targets and indicators will be based upon the descriptors of Good Environmental Status (GES) that are set out in the MSFD. The results from the monitoring programme and the GES descriptors will be used to inform the preparation of a programme of measures (management actions) which needs to be developed by 2015 and implemented by 2016.

Although the timescales for these specific actions occur after the OREDP has been adopted, they will be implemented within the timescales set out for the delivery of the OREDP (by 2020 (review) then 2030). Potentially therefore there could be that a number of the actions included in the strategy could have a bearing on future offshore renewable energy developments and implementation of the OREDP.

In particular, based on the results of the assessment presented in Chapters 10, 11 and 12 of this environmental report, offshore renewable energy developments (offshore wind, wave and tidal) could potentially affect a number of the GES descriptors that would be included in the monitoring programme and programme of measures. These include:

- **GES Descriptor 1: Biological diversity** – this requires the quality and occurrence of habitats and the distribution and abundance of species to be kept in line with prevailing physiographic, geographic and climate conditions. Any potential effect on biological diversity as a result of offshore energy developments e.g. habitat loss, species displacement or barriers to movement from the installation and presence of devices and commercial developments/arrays could potentially effect species distribution and abundance and would need to be taken into account in terms of the obligations of the MSFD and addressed accordingly at the project design and consent stage.
- **GES Descriptor 6: Sea-floor integrity** – this descriptor sets out requirements for the integrity of the seafloor to be maintained to a level that ensures that the structure and function of the ecosystems are safeguarded and benthic ecosystems, in particular, a not adversely affected by a loss in the integrity of the seafloor. As noted in Chapters 10, 11 and 12 there is potential that the installation of devices with piled foundations and cable laying activities could have an adverse effect of the integrity of the seafloor and substratum loss. This could potentially have an adverse effect on benthic habitats and species in the area of development. Devices with gravity bases, whilst they will potential have less of an effect on the actual integrity of the seafloor, they may also lead to the loss or disturbance of important benthic ecology and would therefore also need to be taken into consideration in terms of the Northern Ireland's obligations under MSFD and addressed accordingly at the project design and consent stage.
- **GES Descriptor 7: Hydrographical conditions** – this descriptor requires that any permanent alterations to the hydrographical conditions do not adversely affect marine ecosystems. The results from the assessment do indicate that there is potential for wave and tidal arrays to extract energy from either the wave or tidal stream regime. This could have a direct effect on ecosystems by affecting certain benthic habitats and species that are sensitive to changes in wave or tidal regimes. There could also be indirect effects on benthic ecosystems resulting from changes in coastal process and sediment transfers. Although potential adverse effects can be avoided through site selection and modelling these effects will still need to be taken into account in the context of MSFD and addressed accordingly at the project design and consent stage.
- **GES Descriptor 8: Concentrations of contaminants** – this descriptor requires that concentrations of contaminants are at levels that do not give rise to pollution effects. The results of the assessment identify that there is potential for the installation devices with piled foundations and cable laying activities to disturb potential contaminants that are present in the area e.g. disposal areas. The release of contaminants could lead to water pollution. Although these potential effects can be avoided through careful site selection they will need to be taken into consideration in the context of MSFD and addressed accordingly at the project design and consent stage.

- **GES Descriptor 11: Introduction of energy** – this descriptor relates to the introduction of energy, including underwater noise, at levels that not adversely affect the marine environment. The assessment results have identified that there is potential for all forms of offshore renewable energy developments to introduce noise into the marine environment, either during the installation stages (e.g. pile driving) or from the operation of devices e.g. noise from the rotation of tidal turbines. There are still levels of uncertainty around the precise effects of noise from offshore renewable energy developments on the marine environment in particular the behaviour and distribution of marine mammals, seabirds and fish. There is potential that the levels of noise generated from large commercial arrays could, depending on the location of the development e.g. at the mouths of loughs or on migration/foraging routes, could cause barriers to movement. This would potentially have a negative effect on species distributions within the area. Although these potential effects can be avoided through careful site selection (avoiding migratory routes and lough mouths etc) and the implementation of appropriate mitigation e.g. avoidance of breeding seasons, they will need to be taken into consideration in the context of MSFD and addressed accordingly at the project design and consent stage.

There are other GES descriptors that could also be affected by offshore renewable energy developments e.g. GES Descriptor 2: Non-indigenous species, GES Descriptor 4: Marine food webs and GES Descriptor 9: Contaminants in fish and other seafood. Although the effects are less direct they will still need to be considered at the project design and consent stage.

13.2.4 Marine Planning in Ireland

As noted above, one of the requirements of the MSFD is to adopt an ecosystem approach to the management of human activities in the marine environment. Marine planning is recognised as a possible mechanism for achieving the delivery of this requirement of the MSFD by integrating the integrating the principal of the ecosystem approach to the management of the marine environment.

At present there are no formal requirements for marine planning in Ireland. However, it is recognised that in terms of the OREDP and longer terms development of offshore renewable energy development that marine planning could assist at a regional level with the implementation of the OREDP.

13.2.4.1 Marine Planning

The focus of marine planning is to enable a more coordinated and joined up approach to the use, management and protection of the marine environment. Ultimately this will be achieved through preparation of plans for the marine area. This may include for example a national plan and a series of regional or local plans which could include for example:

- Identification of key issues currently affecting the marine environment.
- A vision for the marine area covered by the plan.
- Objectives for the management and protection of the marine environment.
- Strategic priorities for growth and development of marine sectors/activities.
- Action plan for delivering strategic priorities.
- Management policies for specific sectors and activities.
- Policies for the protection of the marine environment.
- A framework for decision making in respect of development consent.
- Guidance on taking nature conservation measures into account in the decision making process and the implementation of local nature conservation objectives and measures.
- Identification of certain areas for development or use by certain sectors/for certain activities.
- Links to the land use planning system and other plans.

In terms of this SEA and the developing OREDP, whilst it is necessary to take into consideration likely future proposals for marine planning in Ireland, there is currently no regulatory framework under which the preparation of these plans will become a statutory requirement. Therefore at this current time the marine planning process cannot directly influence the SEA process, its findings or the content of the OREDP. However, it is likely that, in the longer term, the process of marine planning will have an important role in the delivery of offshore renewable energy developments.

In particular, as the offshore renewable energy sector in Ireland grows it will become increasingly important to assess how the proposals for the future development of the offshore renewable energy sector can be accommodated within the current environment and how development and growth of this sector can best be managed to minimise adverse effects on other marine sectors and activities such as navigation and commercial fisheries.

It is likely that there will be much greater emphasis on managing multiple commercial developments in certain locations (e.g. cumulative effects). It will therefore become increasing important to adopt a coordinated and joined up approach to the growth of this sector in a way that recognises, and minimises disruption to, other marine sectors and activities. There is an opportunity therefore to use marine planning as a mechanism to assist with the longer term implementation and delivery of the OREDP.

A number of ways in which this could be achieved include:

- Identification of regional e.g. county or local level (and wider national etc) issues affecting the commercial scale development of offshore renewable energy developments.
- Examination, at a regional e.g. county or local level, of potential solutions for resolving overlapping interests to help maximise opportunities for offshore renewable energy developments (possibility multiple) whilst minimising the potential effects on other marine sectors and activities.
- Identification, at a regional e.g. county or local level, of specific areas for the development of offshore renewable energy taking into account interactions within other marine sectors and activities.
- Set out guidance and advice for developers and decision makers on:
    - Requirements for consultation (based on local, regional, national and European issues)
    - Compliance with environmental management and protection policies
    - Consenting framework within which individual offshore renewable energy development applications would be determined

There is also an opportunity to use the findings from the SEA to assist with the development of marine plans in terms of baseline data collection. Large amounts of baseline data have been collected through the SEA process, some of which will be essential to the preparation of marine plans. The SEA has also identified a number of gaps in the available data and information. It is likely that some of these gaps will need to be filled to inform to development of specific local level environmental management and protection polices and to assist the decision making process.

13.2.5 Onshore Grid – Grid 25 Implementation Programme

The focus of the Grid 25 Implementation Programme is to identify potential solutions for projects which will facilitate the transfer of renewable energy generated particularly in the west to the major demand centres in the east and also reinforce the existing transmission network in the west.

In terms of the links between this SEA and the SEA of the Grid 25 Implementation Programme it is recognised that one of the main factors influencing the longer term development and growth of the offshore renewable energy industry is the availability of onshore grid connections and the capacity of the onshore transmission infrastructure to accommodation increased electricity generated from offshore renewable.

However, both SEAs and associated plans are currently being prepared at a high national strategic level, where detail on the precise location of specific projects is unknown. Consequently this makes it difficult to align the plans and SEAs together, particularly along the south and west coast, where, at this stage in the development of offshore renewables, it is still only possible to identify broad future areas for development, rather than specific sites. Additionally, in absence of information on the locations of offshore renewable energy developments in Irish waters, the main focus for the Grid 25 Implementation Programme is on onshore renewable energy developments and onshore grid reinforcements.

Through consultation with Eirgrid it is understood that although, the location of offshore renewable energy developments in Irish waters, and associated onshore connections, is in most cases unknown (the exception being certain offshore wind projects), the Grid 25 Implementation Programme still recognises the need to provide sufficient capacity within any transmission network reinforcements to accommodate future increases in electricity generation from offshore renewable electricity generation. However, there is still some uncertainty over where this increased capacity will be provided. It is also acknowledged that both plans (OREDP) and Grid 25 Implementation Programme will need to remain flexible in order to respond to future proposals for offshore renewable energy developments, particularly along the west coast where connection to the existing transmission network is limited.

13.3 Transboundary In-Combination Effects of Other Plans and Programmes

In addition to the relevant legislation the OREDP and this SEA also needs to take into consideration other offshore plans and programmes that could have in-combination effects with this plan.

There are a number of ongoing initiatives, plans and programmes relating to offshore renewable energy developments within Irish and UK waters. These include:

- Petroleum Affairs Division – Ireland Offshore Strategic Environmental Assessments (IOSEAs) 1-4
- Northern Ireland Offshore Renewable Energy Strategic Action Plan (ORESAP)
- The Crown Estate (TCE) Leasing Round for Wave and Tidal Development in the Pentland Firth and Orkney Waters.
- The Crown Estate (TCE) Scottish Offshore Wind Licensing Round.
- Islay Tidal Project
- The Crown Estate (TCE) Offshore Wind Licensing Rounds 1, 2 and 3 including extensions to Rounds 1 and 2.
- Department of Energy and Climate Change (DECC) UK Offshore Energy SEA 2 (UK OESEA2).
- Potential development in Isle of Man Waters.

All of the plans and programmes listed above could potentially influence, or affect, the proposals presented within the OREDP. An assessment of the potential interactions between these plans and programmes and the OREDP, and the associated environmental implications is discussed below.

13.3.1 Assessment of Potential Cumulative Effects

Table 13.1 below provides a summary of the main potential cumulative effects associated with other plans, programmes and projects proposed in the surrounding UK waters.

Table 13.1: Summary of Potential Cumulative Effects of other Plans, Programmes and Developments

Plan/Programme and Project	Potential for Significant Cumulative Effects in Relation to the OREDP	Comments
Petroleum Affairs Division – Ireland Offshore Strategic Environmental Assessments (IOSEAs) 1-4	Habitat exclusion (marine mammals, fish and marine reptiles) Barriers to movement (marine mammals, fish and marine reptiles)	In general the areas covered by the IOSEAs are outside the main Assessment Areas covered by this SEA. However, there could be potential cumulative effects in relation to habitat exclusion and barriers to movement associated with noise generated during drilling and exploration activities and piling of offshore wind or tidal devices.
	Sterilisation of potential oil and gas fields.	Although the IOSEA areas are outside the main areas for development as development extends further offshore there would be a need to consider possible interaction with oil and gas infrastructure and floating offshore wind and wave developments in offshore locations and the potential for the sterilisation of future oil and gas fields.
Northern Ireland Offshore Renewable Energy Strategic Action Plan (ORESAP)	Collision risk (birds)	There is potential for a number of cumulative effects in relation to offshore wind developments located in areas around the state boundaries between Northern Ireland and Ireland (Lough Foyle and Carlingford Lough). In particular, one of the main areas where there is potential for likely significant adverse cumulative effects to occur includes potential collision risk with migratory birds that breed along the north and east coast of Ireland and Northern Ireland. These potential effects could be reduced by siting developments to avoid key breeding/migratory colonies.
	Seascape effects Recreation and tourism	There is also the potential for cumulative effects of a number of effects on seascape, especially effects on the Giant's Causeway WHS.
	Habitat loss and exclusion (benthic habitats (Annex I), marine mammals, marine reptiles and fish). Barriers to movement (marine mammals, fish and marine reptiles).	Other potential cumulative effects relate to exclusion from key feeding and breeding grounds and the creation of barriers to movement associated with the physical presence of developments, noise from the installation of piled foundations and increased risk of collision relating to wind or tidal devices in coastal and transboundary locations. These effects will be of particular significance where developments affect movement of marine mammals, fish and marine reptiles between key feeding grounds and breeding grounds and along migration routes. Further studies would be required to determine the overall significance these potential effects.
	Collision risk (shipping and navigation).	The Irish Sea/Irish Channel (North Chanel) is a recognised route of international importance for shipping and navigation. There is potential that a number of offshore wind developments off the east coast of Ireland and Northern Ireland could result in the displacement of vessels from these areas into the very busy main shipping channel, increasing the potential for collision risk and reduced navigational safety in these areas. Where possible developments should be constrained to areas where shipping densities are low to minimise the risk of vessels being displaced into busier shipping channels.
	Displacement from commercial fishing grounds.	There is also increased potential for the permanent displacement of fishermen from traditional commercial fishing grounds (along both the north and east coasts of Ireland and Northern Ireland). These potential effects will be more significant in the inshore areas where displacement could lead to increased competition and fishing efforts in certain locations. This would not only have potential adverse effects on the fishing industry but also adverse effects on the sustainability of fish stocks. By avoiding key fishing grounds these potential cumulative effects could be reduced although further studies/consultation is required to determine the precise location of these fishing grounds.

Plan/Programme and Project	Potential for Significant Cumulative Effects in Relation to the OREDP	Comments
The Crown Estate Leasing Round for Wave and Tidal Developments in the Pentland Firth ad Orkney Waters.	No identified cumulative effects.	This plan/programme applies to the development of wave and tidal energy in the Pentland Firth and waters around the Isles of Orkney. Due to the location of this plan/programme in relation to Ireland it is unlikely that there would be any likely significant adverse cumulative effects in association with this plan and the OREDP.
The Crown Estate (TCE) Scottish Offshore Wind Licensing Round.	Seascape effects Habitat loss and exclusion Barriers to movement Reduced navigational safety	In May 2008 The Crown Estate announced its leasing round for the Offshore Wind development in Scotland. The sites were awarded to the successful applicants in February 2009. In total there were nine sites awarded for development, of which five are located in the west coast and could potentially have cumulative effects with developments in Irish Waters. The sites where there is greatest potential for cumulative effects to occur include: ▪ Site 4 – West Coast of Islay ▪ Site 5 – Argyll Array ▪ Site 3 - Kintyre In terms of the potential cumulative effects, these include: ▪ Potential cumulative effects in relation to the development of Sites 3, 4 and 5 in terms of cumulative effects on seascape along the north coast of Ireland and transboundary cumulative effects on sensitive seascape areas in Northern Ireland and effects on the Giant's Causeway World Heritage Site. ▪ Potential effects in terms of habitat loss and exclusion (marine mammals, seabirds and benthic habitat) mainly due to the presence of a number of offshore renewable energy developments in key feeding areas and areas of potential sensitive Annex I habitat. ▪ Barriers to movements around the north coast and west coast of Scotland due to the physical presence of developments and noise generated during the installation of piled foundations. This will be of particular importance where developments affect movement along key migration routes and between feeding/breeding grounds. Further studies would be required to determine the likely significance of these effects. ▪ Potential reduced navigational safety and increased risk of collision due to the displacement of vessels from coastal waters into the main shipping and navigation channel between Scotland, Northern Ireland and Ireland. Where possible developments should be sited in areas of low vessel densities to avoid the potential for vessel displacement.
Islay Tidal Project	No potential likely significant adverse cumulative effects identified.	ScottishPowerRenewables have submitted a proposal to develop a demonstration project in the Sound between Islay and Jura off the south west coast of Scotland. The development will comprise 10 devices and generate 10MW. Due to the location of the proposed development (which is situated along the sound between two areas of land), it is unlikely that there would be any potential likely significant adverse cumulative effects in association with this development and the OREDP.

<table>
<tr><th>Plan/Programme and Project</th><th>Potential for Significant Cumulative Effects in Relation to the OREDP</th><th>Comments</th></tr>
<tr><td rowspan="4">The Crown Estate (TCE) Offshore Wind Licensing Rounds 1, 2 and 3 including extensions to Rounds 1 and 2.</td><td>Reduced navigational safety.</td><td rowspan="4">As part of the most recent leasing round for offshore wind in UK waters (Round 3) which focuses on areas for the development of up to 25GW from offshore wind, there are two main offshore wind areas that have been awarded (Irish Sea Area and the Bristol Channel Area) that could potentially have likely significant cumulative effects in association with offshore renewable energy developments in Irish Waters. The main likely significant cumulative effects that could occur include:
Effects on shipping and navigation – development of the Irish Sea area in combination with offshore wind developments off the east coast of Ireland (Assessment Areas 1 and 2) could lead to increased risk of collision from vessel displacement and physical presence of developments in the main Irish Sea/North Channel shipping channel which is recognised as being of international importance and has very high intensities of vessel movements. Where possible developments should be sited in areas of low vessel densities to avoid the potential for vessel displacement.
There could be cumulative effects on seascape off the east coast although it is likely that the offshore wind developments in the Round 3 Irish Sea Area would be of sufficient distance from the Irish shore for them to fall outside the 35km limit of visibility, therefore reducing the likely significance of any potential effect to negligible.
Barriers to movements (physical presence of developments and noise from installation of piled foundations) on either side of the Irish Sea/North Channel. These effects would be more significant where developments affect movement along key migration routes and between feeding/breeding grounds. Further studies would be required to determine the likely significance of these effects.
Long term displacement from commercial fishing grounds.</td></tr>
<tr><td>Seascape effects.</td></tr>
<tr><td>Barriers to movement</td></tr>
<tr><td>Long term displacement from commercial fishing grounds.</td></tr>
<tr><td rowspan="2">Department of Energy and Climate Change (DECC) UK Offshore Energy SEA 2 (OESEA2)</td><td>Barriers to movement</td><td rowspan="2">The Department of Energy and Climate Change (DECC) is currently undertaking an update to the UK Offshore Energy SEA (UK OESEA) carried out in 2008/2009. This current SEA (UK OESEA2) is broader ranging than the original UK OESEA and covers the majority of energy related activities in UK Waters (excluding the Scottish Renewable Energy Area and Northern Ireland territorial waters). In terms of potential cumulative effects with the OREDP, these are most likely to occur with developments located either side off the Irish Channel e.g. off the coast of Wales and east coast of Ireland. There could also be cumulative effects associated with developments within the Liverpool Bay area.
The main potential effects relate specifically to:
Barriers to the movement of marine mammals, fish and marine reptiles along the North Channel as a result of the physical presence of developments on either side of the channel, the cumulative effects of noise generated during the installation of a piled foundations and increased risk of collision with operational devices (offshore wind and tidal). Further studies would be required to determine the importance of the north channel as a key migratory route for marine mammals, marine reptiles and fish.</td></tr>
<tr><td>Habitat loss and displacement</td></tr>
</table>

Plan/Programme and Project	Potential for Significant Cumulative Effects in Relation to the OREDP	Comments
	Reduced navigational safety	Reduced navigational safety and increased risk of collision as a result of vessels from Irish and Welsh water and from Liverpool Bay being displaced into the busier North Channel. Where possible developments should be sited in areas of low vessel densities to avoid the potential for vessel displacement.
	Long term displacement from commercial fishing grounds	There is also potential for likely significant cumulative effects resulting from the long term displacement of fishermen from traditional commercial fishing grounds. These potential effects will be more significant where developments affect the inshore fishing grounds located off the east coast of Ireland and coast of Wales. In particular where displacement leads to increased pressures on other fishing grounds which could affects both the fishing industry and the overall sustainability of fish stocks. It may also lead to the displacement of fishing activities into the busier North Channel, increasing the potential for conflict between fishing and shipping and navigation.
	Seascape effects	There is potential for cumulative effects on seascape resulting from offshore wind farms of both the east coast of Ireland and the coast of Wales. It is likely that, in most locations, the distances between these developments would be more than 35km. However, in some locations there could still potentially be cumulative effects.
Potential development in Isle of Man Waters	Barriers to movement	At present there is no formal plan for the development of offshore renewable energy developments in Isle of Man Waters. However, it is recognised that, should a plan be taken forward, it is likely that this plan would have potential cumulative effects in relation to the OREDP. The main cumulative effects that could occur include: ▪ Reduced navigational safety and increased risk of collision as a result of vessels being constrained to the busy North Channel by developments off the east coast of Ireland and off the coast of the Isle of Man. ▪ Barriers to the movement of marine mammals, fish and marine reptiles along the North Channel as a result of the physical presence of developments on either side of the channel (off the east coast of Ireland and in Isle of Man waters, cumulative effects of noise generated during the installation of a piled foundations and increased risk of collision (migratory birds with offshore wind developments and marine mammals, birds (diving and pursuit), fish and marine reptiles in terms of tidal arrays. ▪ Potential cumulative effects on seascape resulting from offshore wind developments off the east coast of Ireland and Isle of Man waters.
	Habitat loss and displacement	
	Reduced navigational safety	
	Seascape effects	

13.3.1.1 <u>Summary of Potential Cumulative Effects of Other Plans and Programmes</u>

Although there is potential that the implementation of other plans and programmes relating to offshore wind and marine renewable energy developments could, in-combination with the SAP have potential significant adverse effects on the environment, the likelihood of these adverse effects occurring is fairly low.

The plans and programmes with the greatest potential to give rise to significant adverse effects or negative effects are:

- Northern Ireland Offshore Renewable Energy Strategic Action Plan (ORESAP)
- The Crown Estate (TCE) Scottish Offshore Wind Licensing Round.
- The Crown Estate (TCE) Offshore Wind Licensing Rounds 1, 2 and 3 including extensions to Rounds 1 and 2.
- Department of Energy and Climate Change (DECC) UK Offshore Energy SEA 2 (UK OESEA2).
- Potential development in Isle of Man Waters.

In terms of potential cumulative effects relating to other plans and programmes the main potential significant effects that have been identified include:

- Loss of large areas of benthic and intertidal habitats from occupation of large areas of the seabed with offshore wind and tidal array developments.
- Increased risk of collision from birds (offshore windfarms).
- Increased exclusion of species (birds, marine mammals and fish) from key feeding and breeding areas
- Increased disturbance and displacement of marine mammals, seabirds and fish due to high levels of marine noise generated from a number of arrays either being installed at the same time (e.g. high frequently of piling noise) or continuous installation of different arrays over time (steady but increased noise levels) and noise from the operation of a number of separate arrays.
- Increased risk of barriers to movement as a result of increased noise and risk of collision this could cause some species to become disorientate (noise) and affect the ability of species to move between feeding ground and migrate to breeding areas.
- There is potential that increased intensity/high numbers of offshore wind farms in certain locations could have significant adverse cumulative effects on seascape.
- Increased displacement of commercial fisheries – this could lead to increased pressure on resources (fish stocks) in other areas or displacement of fishing activities into less productive or high yielding fishing grounds.
- Increased displacement of shipping – this could lead to the movement of vessels into areas where there are already high intensities of vessel movements (reducing navigational safety and increasing the risk of collision).
- Climate – in delivering the levels of development suggested in some of the plans and programmes the UK and Ireland will be making significant progress towards achieving the 2020 targets for renewable energy. Strategically this would have significant positive effects on the environment by working towards reducing/offsetting the global and local effects of climate change.

13.3.1.2 Potential Cumulative Effects in Relation to the ORESAP

The assessment has identified that although there are a number of plans and programmes that could potentially have adverse cumulative effects in relation to the OREDP, the plan where there is greatest potential for these effects to be of likely significance is the Northern Ireland Offshore Renewable Energy Strategic Action Plan (ORESAP). In terms of this plan, the most significant potential effects identified relates to the potential effects of a number of offshore wind farm developments located of the north coast of Ireland and Northern Ireland around Lough Foyle and the potential effects of these on seascape character in the area, in particular on the setting of the Giant's Causeway World Heritage Site. It is likely that any potential developments in this area would require close consultation with both Irish and Northern Ireland authorities in order to inform the siting on any future offshore wind farm developments in this area to minimise potential effects on seascape and the Giant's Causeway WHS.

In addition to potential effects on the Giant's Causeway WHS, there is also potential for likely significant cumulative effects on seascape along the east coast of Ireland and Northern Ireland around Carlingford Lough. Other potential adverse cumulative effects relating to the OREDP include potential effects on shipping and navigation, in particular the potential for the displacement of vessels from areas along the east coast into busier shipping channels around Dublin and Killkeel and the North Channel further offshore. However, these potential effects could be reduced by avoiding development in areas where vessel intensities are moderate to high.

There is also potential that a number of developments along the east coast and north coast of Ireland and Northern Ireland could have likely significant adverse effects in terms of habitat exclusion (exclusion from feeding and breeding areas for marine mammals, seabirds, fish and marine reptiles), species disturbance (noise), habitat loss (loss of benthic habitats) and increased collision risk, in particular in relation to migratory birds and offshore wind developments. There are also likely to be potential effects in terms of developments creating barriers to movement along main migratory routes for marine mammals and fish and between feeding and breeding grounds due to physical presence of a number of developments, noise from the installation of piled foundations and increased risk of collision. Again, coordination between Ireland and Northern Ireland Authorities would be required to ensure that developments are sited in locations where the potential to create barriers to movement are avoided/reduced. The installation of developments may also need to be phased to reduce noise levels.

Other potential effects relating to the ORESAP and the OREDP include potential effects on the long term displacement of fishermen from traditional fishing grounds. This will be of particular importance along both the north and east coast, in particular for inshore fisheries. Further studies and consultation is required to determine the precise location of the key traditional fishing areas in these transboundary locations in order to minimise the risk of long term displacement and the potential effects on other fishing grounds and fish stocks.

13.3.1.3 Potential Cumulative Effects in Relation to Other Plans and Programmes

The other plans and programmes where there is potential for cumulative adverse effects in relation to the OREDP all relate to development in UK waters (include Scotland and Wales) or development in Isle of Man waters. The most significant effects relate to the potential for developments along the coast of Wales, north west England and south west Scotland, combined with developments off the east coast of Ireland, to increase the displacement of vessels from areas of moderate shipping intensity into the busier North Channel which is recognised as a navigation route of international importance. There is also potential for developments either side of the North Channel to constrain vessel movements through this channel. Consequently this could potentially lead to a reduction in navigational safety along this shipping channel and increase the risk of collision with other vessels and developments.

Developments on either side of the North Channel could also have likely significant effects on marine mammals, fish and marine reptiles by creating barriers to movement along key migration routes and between feeding and breeding grounds. The main causes of barriers to movement include the physical presence of developments, noise from the installation of devices leading to the disorientation and confusion of species and increased risk of collision leading to the diversion of routes to avoid developments. The potential significance of these effects is increased around the North Channel where marine mammals, fish (e.g. Basking sharks) and marine reptiles, by avoiding offshore renewable energy developments in coastal waters move into the North Channel where they are at increased risk of collision with vessels.

There could also be potential cumulative effects in relation to seascape. These are most likely to occur off the north coast of Ireland where developments within the areas identified as part of The Crown Estate's (TCE) round of offshore wind leasing in Scotland may be visible from the north coast of Ireland. There is also potential that developments in the Liverpool Bay TCE Offshore Wind Round 3 Area could also be visible from the east coast of Ireland, increasing the potential risk of cumulative effects in this area (Assessment Areas 1 and 2). Offshore wind developments off the coast of Wales may also be visible in Assessment Areas 1 and 2. However, it is likely that due to the overall distances between these developments, the overall significance of these potential effects would generally be slight.

13.3.1.4 Suggested Mitigation

It is likely that the potential for any significant adverse and negative in-combination effects can be avoided or reduced through close consultation with relevant Government Departments in Ireland and Northern Ireland and the UK to liaise closely on the development and implementation of relevant plans and programmes e.g. through the SEA process. Such co-operation is a requirement of the EIA and Habitats Directive and will also be required under MSFD and MSP.

13.4 Interactions (SEA Issues/Subjects)

Table 13.2 below presents the main findings from the assessment of the main interactions between the different SEA issues/subjects and how those interactions are influenced by the proposals presented in the OREDP.

Table 13.2: Interactions

Water, Soil (Sediment)	**Water, Soil (Sediment)**													
Biodiversity	×	Substratum loss will have direct effects on benthic habitats and species.	**Biodiversity**											
	××	Changes in water quality as a result of accidental contamination could affect all marine species and habitats.	××	Key interactions relate to changes in food chains/ecosystems. Loss or damage of benthic habitats and species could affect the distribution and abundance of species that rely on these habitats for feeding/breeding and refuge e.g. fish. This could affect food sources for seabirds, marine mammals, marine reptiles and larger fish species.										
			××	Habitat exclusion in certain areas could lead to increased pressure on populations of seabird, fish, and marine mammals in other locations. This could have adverse effects on breeding and availability of food sources.										
Cultural Heritage	×	Substratum loss/damage associated with piled devices and gravity bases could also affect unrecorded archaeological remains and wrecks.	×	Offshore wrecks occasionally provide habitats for certain species. Loss or damage of these features could result in loss of habitat and effects species.	**Cultural Heritage**									
Population	××	Changes in water quality as a result of accidental contamination could affect fish stocks, the quality of bathing beaches and other marine activities.	××	Long term displacement from traditional fishing grounds could result in increased pressure on fish stocks and supporting habitats in other locations where fishing efforts are increased.	××	Offshore renewable energy developments could affect the setting of key archaeological and cultural heritage sites e.g. Skellig Michael WHS.	**Population**							
							××	Displacement of fishermen from traditional fishing grounds may lead to increased fishing vessel movements in key navigation channels, potentially reducing navigational safety.						
			×	Possible disturbance or displacement of seabirds and marine mammals could affect wildlife watching activities.	×	Loss or damage or wrecks and archaeological features could affect recreational diving activities.	××	Long term displacement from traditional fishing grounds could increase competition in other fishing areas which may affect the quantities/ value of individual catches.						
Material Assets	×	Disturbance of disposal sites and oil and gas infrastructure could lead to reductions in water quality.	-	No interactions with respect to Offshore Renewable Energy Developments	-	No interactions with respect to Offshore Renewable Energy Developments	×	Displacement of vessels from/into key navigation channels could lead to reduced access to major ports.	**Material Assets**					
Seascape	-	No interactions with respect to Offshore Renewable Energy Developments	-	No interactions with respect to Offshore Renewable Energy Developments	×	Seascape character is essential for the setting of some cultural heritage sites e.g. Skellig Michael.	×	Potential changes in seascape character could also influence the wider recreational and tourism value of the area.	×	Potential interactions in relation to onshore/coastal infrastructure required to support development of offshore renewable e.g. harbours and grid upgrades.	**Seascape**			
Climate (growth of offshore renewable energy sector)	**Direct/indirect potential effects of offshore renewable energy developments on these SEA issues are discussed in rest of the Environmental Report (Chapters 10, 11 and 12).**												**Climate**	
	✓	**Offsetting/reducing the effects of climate change could reduce effects of rising water temperatures and increased salinity on water quality.**	✓	**There is potential that climate change could lead to increased water temperatures and possible water salinity which could have negative effects on keystone species and habitats and wider marine ecosystems and overall quality of the marine environment. Offshore renewable energy sector would contribute towards combating these effects.**	✓	**Contribute to offsetting effects of climate change such as sea level rise and potential effects of this on preservation of coastal archaeology (sites and features).**	✓	**Contribute towards offsetting effects of climate change such as rising water temperatures and increased salinity on distribution and abundance of fish stocks. Developments may also provide possible refuges for recovery of fish stocks.**	✓	**Contribute to offsetting effects of climate change such as sea level rise and potential effects of this on coastal infrastructure and properties.**	✓	**Contribute to offsetting effects of climate change such as sea level rise and potential effects of this coastal seascapes character.**	✓	**Overall contribution to combating global climate change.**

Section 14: Data Gaps

14 Data Gaps

14.1 Introduction

This chapter provides a summary of the main data, information and knowledge gaps identified as part of this SEA and looks at possible solutions or opportunities for filling these gaps.

As discussed in Chapter 1: Introduction, data, information and knowledge gaps have been identified as a key limitation to this SEA. They can affect the level of confidence with which potential effects on the environment are identified and evaluated. Additionally, not only are they generally very difficult to fill at a strategic level due to the geographical scale of the study area and the relative inaccessibility of the marine environment in comparison to the terrestrial environment, the assessment itself it based on a plan that focuses on the development of a relatively new and emerging industry where longer term environmental effects are little understood.

14.2 Reasons for Data and Knowledge Gaps

In terms of this SEA, data and information gaps generally relate to the environmental baseline whereas knowledge gaps relate to limitations in our understanding as to how different offshore renewable energy developments interact with the environmental baseline.

14.2.1 Data and Information Gaps

Our awareness of the importance of the marine environment and its vulnerability to change has increased significantly over the last few decades. However, there are still significant gaps in the data and information that we have about the marine environment, in particular in relation to the abundance and distribution of certain species and habitats. This is mainly due to the sheer geographical scale, harsh conditions and relative inaccessibility of the marine environment making data collection very challenging, costly and time consuming.

Consequently, data and information has historically been collected on a site by site basis in relation to specific coastal and marine developments e.g. coastal defences, oil and gas infrastructure, aggregate dredging and disposal and the installation of cable and pipelines or as part of area based or receptor based research studies/surveys, depending on the potential for effects associated with the different developments. Consequently, a large proportion of the datasets and information that is available tend to contain gaps in geographical coverage e.g. where there are no developments or vary from receptor to receptor in terms of the level of detail that is available (e.g. some information may be very detailed for specific sites/areas and more generic in other locations).

In addition to collection of environmental baseline data and information for specific projects, some data and information has been collected as part of wider research studies into the potential effects of overfishing on fish populations, the fishing industry, other marine species and habitats and the wider marine ecosystems. More recently, data collection and survey efforts have focused on acquiring data to form ‘evidence bases’ for the designation of coastal and marine protected areas including Natura 2000 sites.

However, due to the challenges and costs associated with collecting data in the marine environment, there are still a number of limitations associated with the current data and information that is available. For example, in terms of offshore SPAs designated for seabirds, the areas identified are based on data/ survey information which indicate where large proportions of the seabirds that are recorded to be breeding or present in coastal SPAs may forage or loaf. However, beyond these areas the precise locations where seabirds forage or loaf are still relatively unknown. There are a large number of tagging exercises being carried out, for example RSPB have recently released some information on puffin feedings areas and offshore behaviour which was obtained from information recorded by electronic tags.

The gaps that do exist are gradually being filled. However, there is still a fairly piecemeal approach to the filling of data gaps, so while our knowledge may be increasing significantly in certain locations e.g. where there is a lot of interest for offshore wind developments, or certain receptors, e.g. seal tagging to obtain more information on their distribution and behaviour, there are still significant gaps (geographical and receptors) where survey efforts are fairly limited.

In terms of offshore renewable energy developments, as well as challenges associated with knowing what is where and how it behaves, there is also a need to understand also how certain receptors are affected by the different technologies, device types and large scale commercial developments. This is not just important for identifying significant adverse effects on the environment but also, equally important to identify where potential significant adverse affects are not likely to occur, and therefore additional surveys to collect lots of data may not be necessary.

14.2.2 Knowledge Gaps

As noted above, there is still a relatively high level of uncertainty surrounding offshore renewable energy developments, in particular the potential effects that certain device types (mainly wave and tidal) have on the environment. This is mainly a result of a lack of data and knowledge on how marine renewable energy developments, in particular, interact with the environment.

In general the effects of offshore wind developments on the environment are better known and understood than wave or tidal developments. This reflects how the information, experience and knowledge gained from the onshore wind industry helped to inform and enable the deployment of a number of the initial offshore wind farms, which subsequently helped to inform further offshore wind developments and the successful growth and expansion of this industry.

In comparison, the wave and tidal industry is still at the testing and demonstration stage. As a consequence of this, and without any similar onshore or established industries from which experience and knowledge can be gained, there is still a relatively high level of uncertainty and lack of confidence with which potential effects can be identified. This has a knock on effect in terms of the consenting and licensing process as it is felt that, in a number of cases gaps in data and knowledge means that there is insufficient information and therefore evidence available for decision makers to determine whether a project would or would not have a significant adverse effect on the environment.

The consequence of this is that there is often a requirement for developers of individual projects to undertake significant amounts of survey work and monitoring to either inform consent or as a condition of consent. In an industry where financial margins are tight as scales of economies have not been reached/optimised, additional survey and monitoring work can place significant financial pressure on developers. These financial pressures can influence location decisions taken by developers, in particular areas which have been subject to additional monitoring or surveying as part of more strategic initiatives for promoting the development of offshore wind and marine renewable energy in certain locations e.g. Pentland Firth, could be considered more attractive to developers.

An objective of the OREDP and the SEA is set out a strategic framework for offshore renewable energy and increase confidence amongst developers, decision makers and all stakeholders by identifying key environmental constraints or considerations that need to be taken into account in certain locations. The SEA also has an important role to play in identifying the data gaps and knowledge gaps that are likely to influence the level of potential constraint in certain locations and to identify opportunities for managing those data and knowledge gaps and associated uncertainties.

14.3 Identifying Data, Information and Knowledge Gaps

The main data, information and knowledge gaps that have been identified as part of this SEA, and related surveys, research or monitoring that may be required to fill those gaps are discussed in Table 14.1 below. The survey, research and monitoring requirements discussed in Table 14.1 relate to the specific data and knowledge gaps that have been identified in this SEA and which have influenced the levels of confidence of the assessment and the certainty with which significant adverse effects in certain locations have been identified. **However, it should be noted that there will still be a requirement for certain additional standard surveys and monitoring to be undertaken as part of specific project level mitigation. These are discussed in Section 14.4.**

Table 14.1: Data and Knowledge Gaps and Possible Survey and Monitoring Requirements

SEA Issue	Data and Knowledge Gap	Survey Requirements	Monitoring Requirements
Water, Soil (Sediment)	Integrated mapping for the Sustainable Development of Ireland's marine Resource (INFORMAR) delivers high resolution bathymetry covering the continental shelf around Ireland. Currently large areas of the shelf remain un-mapped.	Bathymetric surveys in key areas of interest for developments. These would be required as part of the detailed design for the project as bathymetry in a specific area will influence method of attachment to the seabed etc.	
	Large areas of seafloor sediment to the west and south of the Irish coast remain uncharacterised.	Surveys to identify seabed character in key known areas of interest off the west and south coast of Ireland.	
	Data and knowledge gaps relating to the effect of offshore wind, wave and tidal developments on coastal processes and hydrodynamics. In particular the potential cumulative effects associated with multiple developments.	Hydrodynamic and coastal process modelling in known areas of interest e.g. specific Assessment Areas and linked areas to establish current regimes.	Monitoring hydrodynamic and coastal processes to identify any changes that can be attributed to offshore renewable energy developments, in particular in areas of multiple developments.
	Data relating to the distribution, abundance and behaviour of seabirds, marine mammals, marine reptiles and fish in Irish waters for example in terms of seabirds: ➢ Some remote island colonies were not covered by the survey for the 2000 census of species of breeding seabirds. ➢ Both summer and winter seasons ESAS survey coverage for seabirds at sea was generally below the desired level of coverage. ➢ There are major data gaps of coverage in oceanic waters north-west of Ireland, as well as along the shelf break south-west of Ireland in summer months. ➢ Winter survey coverage almost entirely restricted to shelf waters (within 200m depth) and totally lacking in some inshore areas of the south-west and north-west. ➢ Land based counts of wildfowl and waders tend to underestimate numbers of divers, grebes and seaduck. ➢ Incomplete counts, geographical coverage in remote areas of wildfowl and waders in larger sites and reduced coverage of non-estuarine habitat. ➢ Some species included as 'optional' species to count are not always recorded, e.g. gulls and terns. ➢ Marine mammal migration routes around the coast of Ireland are not well understood.	Surveys to confirm abundance and distribution of certain species that could be affected by offshore renewable energy developments including for example migratory and transit routes, foraging areas and loafing (seabird) areas. Further work would be required as part of delivering the plan level mitigation measures relating to filling data and information gaps (see Chapter 15, Action 2) to establish clear criteria regarding future survey requirements e.g. threshold for surveys to be undertaken may be based on specific minimum distance of a proposed development from an SAC designated for marine mammals, and SPA or any other known breeding, feeding, haul out, loafing colony or habitat.	Data and evidence from monitoring of other developments (e.g. in UK or Europe) and small demonstration projects in Ireland may be required to assist in developing specific survey criteria or guidelines for future development. This monitoring data should include for example changes to species behaviour or evidence of displacement resulting from habitat loss etc.

SEA Issue	Data and Knowledge Gap	Survey Requirements	Monitoring Requirements
	➢ Abundance and distribution of marine turtles is not well understood		
Biodiversity, Flora and Fauna	Limited knowledge on the distribution of benthic habitats and species to determine effects of substratum loss and disturbance.	Surveys to identify presence of key benthic species and habitats in development areas (this is also usually carried out as part the design/consenting for specific projects although for smaller localised areas.	Monitoring response to certain benthic habitats and species to changes in wave or tidal regimes (to be linked to or informed by hydrodynamic studies).
	Considerable lack of empirical knowledge of collision risk of fish with wave and tidal device operation.	Surveys to confirm presence of key fish species in areas affected by wave and tidal developments.	Monitoring responses of certain fish species to wave and tidal developments. Would be required as part of the deploy and monitor approach to development (See Chapter 15). Also review monitoring data and evidence from wave and tidal developments elsewhere (UK and Europe).
	For most fish species likely to be present in the study area the sensitivity to copper in antifouling coatings on wave and tidal devices is not known.	Surveys to identify fish species present in areas affected by wave and tidal developments. Review evidence to identify if fish species present have known sensitivity to copper.	Monitor effects of antifouling coatings on certain fish species. Collect monitoring/research data from other offshore developments (UK and Europe) to build better evidence base regarding potential effects of copper on fish species.
	Limited knowledge of the effects of noise and EMF from the installation and operation of devices/arrays on marine mammals, marine reptiles and fish including increased risk of barrier effects, habitat exclusion and species displacement.	Noise surveys to determine ambient noise levels in areas of interest for development e.g. resource areas. Surveys around current offshore wind farms during installation phase to establish: ▪ Noise levels generated during pile driving ▪ Effectiveness of mitigation measures to reduce noise levels ▪ Effect of noise from piling on sensitive receptors e.g. marine mammals and fish ▪ Whether noise from piling activities associated with large wind farms is creating barriers to movement of certain species (would need links to species abundance and distribution surveys)	Monitoring to determine: ▪ Noise levels generated from operational wave and tidal devices. ▪ Effects of noise on sensitive receptors e.g. marine mammals and fish. ▪ Whether noise levels are causing barriers to movement for certain species e.g. along migratory routes and transit pathways. ▪ Whether noise from devices is leading to habitat exclusion or species displacement

SEA Issue	Data and Knowledge Gap	Survey Requirements	Monitoring Requirements
		▪ Surveys to determine effects of EMF on fish.	
	Limited knowledge on interactions between seabirds (diving), marine mammals and fish and submerged devices e.g. tidal turbines (collision risk).	Surveys on species abundance and distribution. Surveys or research to understand the behaviour of diving seabirds e.g. dive depths, vertical diving or swimming underwater, distance from coast etc.	Monitoring seabird, marine mammal and fish responses to tidal and wave devices e.g. avoidance or collision. How these responses are affected by conditions such as increased turbidity and monitor effectiveness of mitigation e.g. spacing of devices and visibility.
	No knowledge on the presence of bats in offshore locations and the interaction with offshore wind turbines and associated effects.	See above for species abundance and distribution. Survey or obtain data collected elsewhere from current offshore wind farms to establish whether there is an interaction/effect on bats.	Monitoring effect of offshore wind farms on bats (this likely to be part of wider collaborative approach with UK and Europe to identify opportunities for sharing data and research.
Cultural Heritage including Archaeological Heritage	Much of the seabed is unsurveyed for marine archaeological interest, and there is therefore potential for previously unrecorded sites of archaeological importance to exist throughout the study area.	Surveys to establish presence of archaeological features in areas affected by renewable energy developments.	No specific monitoring solutions identified at this stage.
Population and Human Health	Available maps of fishing effort in Irish Waters from the Vessel Monitoring System (VMS) do not include smaller vessels (under 15m). Consequently there is a large data gap in terms of information on the location of important inshore fishing areas.	Suggest a workshop with expert representative from the Marine Institute, BIM (Bord Iascaigh Mhara – Irish Sea Fisheries Board), NPWS (National Parks and Wildlife Service), industry and other stakeholders to identify key areas for inshore fisheries that could be affected by offshore renewable energy developments.	Continued consultation to establish how offshore renewable energy developments are affecting inshore fisheries in certain locations.
	Further understanding is required in terms of key navigation routes and clearance distances / depths for vessels and offshore renewable energy developments, e.g. tidal.	Consultation with navigation authorities, MCA and ports and harbours to understand more accurate location of key navigation routes and	Monitoring interactions between offshore renewable energy developments and navigation activities.

SEA Issue	Data and Knowledge Gap	Survey Requirements	Monitoring Requirements
		examine options for how certain devices (e.g. submerged tidal devices) could co-exist e.g. establish optimal clearance depths.	
	No specific data gaps identified for military areas, disposal areas or radar interference.	Site specific surveys will be required at the project design/consent stage.	No specific monitoring solutions identified at this stage.
Material Assets	No specific data and knowledge gaps identified although there are likely to be specific surveys required at the project design/consent stage to confirm potential effects on cables and pipelines.	Site specific surveys will be required at the project design/consent stage.	No specific monitoring solutions identified at this stage.
Seascape	There is considerable variation in content, length, presentation and methodology of available LCAs in Ireland. Landscape Character Assessments are not available for Donegal, Sligo, Kerry and Waterford.	Site specific assessments will be required at the project design/consent stage.	Suggested monitoring of offshore renewable energy developments to confirm appropriateness of assessment criteria and mitigation e.g. spacing and configurations of farms/arrays in particular with regard to cumulative effects.
	More detailed assessments will be required at the project design / consent stage to determine effects on Seascape.		
Climatic Factors	No survey of Irelands deep geology has been undertaken, thus at present there is insufficient data to determine whether there are any suitable aquifers in existence in Irish territorial waters for carbon storage.	Where known potential interest for development coincides with areas that have been identified as having potential for carbon storage, surveys may be required to ensure an area would not be sterilised for future use. However, these surveys may not be a mandatory requirement for any foreshore lease application or EIA.	No specific monitoring solutions identified at this stage.

14.4 Opportunities for Filling Data and Knowledge Gaps

Most of these data, information and knowledge gaps listed above relate directly to SEA issues/subjects where potential likely significant adverse and unknown effects have been identified. It is therefore likely that additional survey work and monitoring will be required to help fill these data and knowledge gaps and provide greater resolution on the likely effect that would occur in a particular location.

The type and level of surveying or monitoring required will be dependent on the nature of the data and knowledge gaps that have been identified. Taking this into account there are three possible options to be considered in terms of identifying the most effective and appropriate solution for filling these data and knowledge gaps. These options include:

- Filling certain data and knowledge gaps at a strategic level e.g. Irish Government Departments/Authorities would identify options for carrying out certain surveys or monitoring or identifying options for data sharing and collaborative working with Europe and the UK. These would be dependent on a number of factors including appropriate funding mechanisms and opportunities for collaborative working (See Mitigation Measures in Chapter 15).
- Filling data and knowledge gaps at an individual project level e.g. to inform the project consenting and associated assessments e.g. EIAs. The nature and types of surveys and monitoring required would depend upon the potential site specific constraints identified through consultation and as part of EIA screening and scoping.
- Filling data gaps through the 'deploy and monitor' process. This approach may be required where knowledge gaps require the deployment of devices to enable their interaction and any associated effects on the marine environment and key receptors to be identified through monitoring. This approach may involve Government Departments, regulatory authorities, individual developers or combinations of these organisations. Further detail on the deploy and monitor approach is provided in Chapter 15: Mitigation.

The options for filling data and knowledge gaps listed above are considered in terms of both the plan level and project level mitigation measures discussed in Chapter 15. It is important to note that at this stage the focus is on identifying the data and knowledge gaps that exist and identifying solutions for filling those gaps. Further work will be required to determine what the priorities are for filling data and knowledge gaps, how they should/could be filled and who will be responsible for filling those gaps. This will be one of the potential and early roles of the proposed data management Forum to be established as part of the plan level mitigation (Chapter 15).

Section 15: Mitigation

15 Mitigation

15.1 Introduction

The results from the SEA indicate that there is potential to develop up to 4500MW offshore wind and 1500MW of wave and tidal energy within Irish waters without any likely significant adverse effects on the environment. However, there are a number of important qualifications to this general conclusion, primarily resulting from the significant data gaps discussed in Chapter 14, limited evidence/knowledge on the effects of certain types of devices on the environment (e.g. collision risk) and the potential differences of opinion on the acceptability of significance effects (e.g. seascape).

Whilst the conclusions identified that the higher development scenario presented in the OREDP could be achieved it is necessary that the qualifications of this conclusion are taken into account appropriately to ensure that significant adverse effects do not occur. This will be achieved through developing appropriate measures to avoid, reduce or offset any potential significant adverse effects and for these measures to be integrated into the OREDP as appropriate.

In terms of this SEA two forms of mitigation have been identified in this SEA as being required to avoid or reduce adverse effects on the environment.

These are:

- **Suggested Actions –** these are measures/actions that could be incorporated into the plan (OREDP) to avoid/reduce or offset significant adverse effects. These relate to strategic level measures that have been identified as being necessary for the scenarios for the development of offshore renewable energy, as set out in the OREDP, to be achieved in a way that avoids or minimises any significant adverse effects on the environment. Plan level mitigation measures, could include for example, measures for filling strategic data and information gaps or implementing the deploy and monitor approach to development which aims to control the scaling up of commercial developments so that necessary data (evidence) in relation to potential effects on the environment can be obtained before development is extended to its full commercial scale.
- **EIA Guidance and project level mitigation –** these are measures that are not necessary incorporated into the plan but are recognised as good practice and it is assumed that these would be incorporated into future projects. It is recognised that the OREDP cannot guarantee that these measures will be implemented (hence the use of the words could and should as opposed to will in the assessment of effects present in Chapters 11, 12 and 13). However, it is considered reasonable to assume that these measures would be implemented by a responsible developer and they are likely to be necessary in order to achieve development consent/Foreshore Leases at the project level.

15.2 Suggested Actions

To ensure that the Actions developed as part of this SEA as sufficiently robust they should reflect the main conclusions from the SEA and the findings from the assessment of potential effects. Overall the SEA concludes that it would be possible to achieve the scenario for the development of 4,500MW from offshore wind and 1,500MW from wave and tidal. However, there are a number of uncertainties and unknowns associated with this conclusion where there is still potential for significant adverse effects to occur. These uncertainties and unknowns are discussed below.

This conclusion is also based on a number of factors that were taken into consideration in the assessment of potential cumulative effects and identification of the overall amount of development (MW) that could be accommodated within each of the assessment areas without significant adverse effects on the marine environment or other marine activities and users. These factors included:

- Siting developments outside all known protected areas (MPAs, Ramsar Sites, SPAs, SACs (including candidate and proposed sites)).
- Maximising distance from shore where possible to reduce potential significant effects on seascape character.
- Avoiding all technical constraints e.g. oil and gas infrastructure, telecommunications, electricity cables, aggregate, dredging and disposal areas and aquaculture sites.

15.2.1 Uncertainties and Unknowns

The main areas of uncertainty/unknown effects identified as part of this SEA are summarised in Table 15.1 below:

Table 15.1: Summary of Uncertainties and Unknown Effects

SEA Issues/Subject	Potential significant adverse/unknown effect	Technology/device types	Reason for Uncertainty/Unknown Effect
Protected Sites	Potential effects on the integrity and the conservation objectives of the site where qualifying features are mobile species that are not constrained to the boundaries of the site.	All technologies	See below in relation to birds, marine mammals, marine reptiles and fish.
Benthic Ecology	Potential for loss/disturbance to Annex I habitats and communities.	All devices with piled foundations or gravity bases.	Unknown distribution/presence of Annex I habitats/communities outside protected sites.
Birds **Marine mammals** **Marine reptiles** **Fish**	Habitat loss/disturbance – mainly in relation to offshore feeding, loafing (birds) and breeding areas.	All devices that occupy large areas of the water surface or protrude above the water surface.	Unknown/limited information on the location of key offshore feeding, loafing (birds) and breeding areas.
	Collision risk – above surface. Mainly effecting migratory bird species.	Offshore wind developments.	Limited information on bird migratory routes.
	Collision risk - below and on surface. Potential significant effects in relation to collision with operational devices (mainly tidal).	Mainly tidal devices. Also potential effects with piled foundations and wave devices that occupy large parts of the water surface or have submerged moving parts.	Limited knowledge/information in relation to interactions between tidal and wave devices and key sensitive receptors (in particular diving and pursuit feeder birds, marine mammals and large fish) and these species respond to these devices.
	Noise generated during installation. Temporary effects in terms of habitat exclusion/species displacement. Effects likely to be of significance during breeding/spawning seasons – could have longer term effects.	All devices with piled foundations.	Limited information on distribution and abundance of key species that could be affected by noise (diving birds and pursuit feeders, marine mammals, marine reptiles and fish e.g. cod)

SEA Issues/Subject	Potential significant adverse/unknown effect	Technology/device types	Reason for Uncertainty/Unknown Effect
Birds **Marine mammals** **Marine reptiles** **Fish**	Noise generated during operation of devices. Long term effects in terms of habitat loss and species displacement. Effects more significant where effect key breeding/spawning and feeding habitats.	All devices with submerged moving parts (mainly tidal devices)	Limited information on distribution and abundance of key species that could be affected by noise (diving birds and pursuit feeders, marine mammals, marine reptiles and fish e.g. cod)
	Barriers to movement along migratory routes and between feeding and breeding area due to noise and risk of collision.	All devices with piled foundation and submerged moving parts.	Limited information/data on key migratory routes for certain species (in particular cetaceans), marine reptiles and basking sharks
Commercial fisheries	Long term displacement from traditional fishing grounds (inshore and offshore areas)	All device types	Limited information on location of key traditional fishing grounds, in particular for inshore fishing grounds due to a lack of data on the movement of vessels that are less than 15m length.
Seascape	Potential adverse effects on seascape character.	All device types but effects are likely to be more significant for offshore wind where a greater proportion of the development is visible above the water.	The seascape character around the coast of Ireland is very complex. The seascape assessment has only been able to identify seascape types and their relative sensitivity to different types of development at a very high level. However, there are likely to be significant local variations in seascape sensitivity along the entire coast that can only be identified at a project level.

15.2.2 Proposed Actions

Most of the unknown effects listed above relate to lack of data and knowledge of how different technologies and device types/characteristics interact with the environment and individual sensitive receptors. In order to try and address these areas of potential uncertainty and unknowns the following actions have been identified to try and minimise/avoid likely significant adverse effects on the environment.

It is suggested that the actions described below are integrated, where possible into the plan (OREDP) to minimise or reduce the potential for significant adverse effects to occur from offshore wind and marine renewable energy developments in Irish waters. These actions include:

Collaboration and Co-ordination:

- **Action 1:** Development of a mechanism for greater coordination between state bodies concerned to improve the effectiveness of the delivery of the OREDP as policy develops. This could include an enhanced role for the existing multi-body Ocean Energy Steering Committee.
- **Action 2:** Collaborative working with the existing Ocean Energy Advisory Group to assist/advise SEAI and DCENR with taking forward the OREDP.

SEA Monitoring Requirements:

- **Action 3:** In accordance with Article 17 of the SEA Regulations 2004, the group identified in the mechanism for enhanced co-ordination in Action 1 shall ensure the significant environmental effects of the implementation of the plan is monitored. This will ensure that unforeseen adverse effects are identified at an early stage and appropriate remedial action can be taken as required. **Further detail on monitoring is provided in Chapter 16.**

Addressing Data, Information and Knowledge Gaps:

- **Action 4:** DCENR and SEAI, in the context of the offshore renewable energy sector, should collaborate with the lead authorities on the MSFD (Marine Strategy Framework Directive) and other statutory requirements that are taking forward requirements relating to collation, management and dissemination of data and information collected for the marine environment so that data is made publicly available so that it may be taken into account by those developers and bodies involved in the siting, design, consenting and permitting of individual projects.

Consenting and Permitting:

- **Action 5:** Future foreshore consenting processes by the relevant authorities should take into account the broad findings and assessment of this SEA and AA in terms of location and constraints.
- **Action 6:** The foreshore consent process should require developers to put in place appropriate monitoring programmes to assess the effects of their development.
- **Action 7:** The foreshore consenting authority should consider the application of an incremental (the 'deploy and monitor') approach as part of the scaling up of offshore renewable energy developments. **Further detail on the 'deploy and monitor' approach to development is provided in Section 15.4 below.**

Guidance and Advice:

- **Action 8:** The project level mitigation measures/EIA Guidance prepared as part of the SEA should be incorporated into National EIA Guidance for offshore renewable energy developments. Further detail on the project level mitigation measures is provided below.
- **Action 9:** Development and maintenance of a GIS database tool to inform the foreshore consenting process, lead by the Marine Institute.

15.3 EIA Guidance and Project Level Mitigation Measures

One of the outputs from the SEA process includes the preparation of guidance for carrying out future EIAs for offshore renewable energy projects. The main focus for the EIA Guidance will be the provision of advice and guidance on the future siting (e.g. site selection criteria), surveying and monitoring requirements, assessment procedures likely to be required for the consenting of individual offshore wind, wave or tidal developments and mitigation measures that could be included in individual schemes to reduce, avoid or offset significant adverse effects.

The EIA Guidance should take into account the following factors:

- Audience for the guidance e.g. developers, regulators, environmental bodies, local councils (planners), other stakeholders.
- Likely scale of development e.g. guidelines will have to be appropriate for demonstration projects through to commercial projects.
- Baseline data requirements for EIAs including survey and monitoring requirements.
- Preparation of maps illustrating baseline data collected for the SEA (e.g. other sea users and environmental conservation requirements) for certain areas to assist with identification of development sites.
- Approach for assessing cumulative effects - this will be of particular importance for the regulatory authorities in determining a number of applications within a certain area/location or a number of developments that are expected to occur over a similar timescale.
- Procedures/approaches to identifying potential overlapping interests.
- Solutions for resolving overlapping interests (e.g. based on good practice examples from other areas and developments) and identification of key consultees and stakeholders involved in the resolution of overlapping interests.
- Clear guidance on the consenting process including:
  - The type of consent required
  - The responsible authority for determining the consent
  - Statutory consultees
  - Length of time required for consultation
  - Information to be provided to consultees

- Project level mitigation strategy which sets out a range of measures that may need to implemented for certain projects to reduce, avoid or offset any significant adverse effects. This mitigation strategy is likely to include the following information:
  - Recommended mitigation measures – these should be practical and suitable for adoption by developers.
  - Whether they are legal requirements or standard ‘good practice’.
  - Whether there are any specific guidelines available.
  - When they would be required.
  - Who would be required to implement the project level mitigation measures.

Table 15.2 below provides a summary of the key mitigation measures that may be appropriate for specific project developments and were considered as part of the assessment of potential effects in Chapters 11, 12 and 13. However, it should be noted that possible additional mitigation measures may also need to be identified on a project specific basis, and developers may be obliged to apply specific mitigation as part of the individual project consenting process. Required mitigation will be set out in the conditions of the consent issued to the project developer.

15.4 Additional Information on the Deploy and Monitor Approach to Development

The aim of the incremental (deploy and monitor approach) to the development of commercial scale offshore renewable energy developments is to increase the knowledge and understanding of possible effects of these developments on the environment and build on information collected from other developments elsewhere and additional baseline data on the marine environment collected through other initiative and under other legal obligations e.g. MSFD and OSPAR.

The deploy and monitor approach to development has been identified as one of the mechanisms for acquiring necessary information on how offshore renewable energy developments interact with the marine environment, and in particular how interactions, and associated potential effects, change as developments are scaled up from demonstration and test projects through to a full scale commercial developments. This information is essential for helping to increase confidence and certainty amongst environmental authorities on the potential effects of commercial scale offshore renewable energy developments and associated potential cumulative effects.

This approach would also help to reduce the potential barriers to development associated with knowledge and data gaps and the subsequent requirement to adopt a precautionary approach to development where there is uncertainty over potential effects on the environment. It will also demonstrate support to the industry and encourage investment by enabling commercial offshore renewble energy developments to be deployed on a stage by stage basis within an agreed framework of monitoring and research.

The main aim of the incremental or deploy and monitor approach to development would be to:

- Adopt a stage by stage approach to the deployment of commercial scale offshore renewable energy developments by attaching conditions to site leases that would specify that developments of a certain size or scale may only be permitted within the first few years of the lease award.
- Only permit consents for larger scale commercial developments where there is evidence (from surveying and monitoring) that the current development is not having an adverse effect on the environment and that there is sufficient evidence to support conclusions that a large scale development would also not have adverse effects on the environment. This may require the inclusion of more than one deploy and monitor stage within a lease agreement.

Table 15.2: Project Level Mitigation Measures

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Geology, geomorphology and hydrography			
Changes in hydrodynamic/ coastal processes and seabed morphology	CD CC OD	▪ Site specific geophysical and geotechnical surveys to establish a baseline and inform the impact assessment for individual developments. ▪ Modelling of hydrodynamics and sediment transport ▪ Avoidance of placement of devices in areas where sediment transport pathways are modelled as highly sensitive to change ▪ Modelling the effects on coastal processes should form part of pre-project activities to optimise location. ▪ Avoidance of placement of devices within areas where coastal processes are modelled as highly sensitive to change	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Seabed contamination and water quality			
Accidental release of contaminants (hydraulic fluids / vessel fuel)	CD CC OD	▪ Carry out potentially hazardous operations under appropriate weather/tide conditions ▪ Use low toxicity and biodegradable materials ▪ Use minimum quantities ▪ Design for minimum maintenance ▪ Risk assessment and contingency planning ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Disturbance of contaminated sediments	CD CC	▪ Avoid device/infrastructure placement within 500m of areas of known sediment contamination ▪ Carry out pre-installation bottom surveys ▪ Use installation methods that minimise disturbance of sediments ▪ Carry out work in appropriate tidal conditions to minimise effect ▪ Avoid sensitive time periods for local receptors ▪ Risk assessment and contingency planning ▪ If munitions are encountered advice such as that given in Department of the Marine and Natural Resources 2001 (Marine Notice No. 16 of 2001. (i.e. explosives picked up at sea in trawls or sighted; and ii. the removal of explosive items from wrecks)) should be followed.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Protected sites and species			

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Degradation of protected sites	CC CD	▪ Careful site selection avoiding sensitive sites for devices and export cables (i.e. existing and proposed protected sites). ▪ Modelling of sediment transport ▪ Possible mitigation measures relevant to the specific interest features of the sites and their seasonal and other sensitivities are described elsewhere in this table for the relevant topic areas.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Impacts on protected species	CC CD	▪ See sections below on benthic ecology, fish and shellfish, seabirds, turtles and marine mammals.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Benthic Ecology			
Physical disturbance	CC CD	▪ Careful site selection avoiding sensitive sites for devices and export cables (i.e. areas with known sensitive intertidal and subtidal benthic habitats) ▪ Benthic survey to characterise seabed and identify sensitive sites and species. ▪ Avoid installation during sensitive seasons	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Smothering	CC CD	▪ Careful site selection avoiding sensitive sites for devices and export cables (i.e. areas with known sensitive intertidal and subtidal benthic habitats) ▪ Benthic survey to characterise seabed and identify sensitive sites and species. ▪ Avoid installation during sensitive seasons	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Contamination – from sediment disturbance	CC CD	▪ Avoid device/infrastructure placement within 500m of areas of known sediment contamination ▪ Benthic survey to characterise seabed and identify sensitive sites and species	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Accidental contamination (hydraulic fluids or vessel cargo/fuel)	CC CD OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan) ▪ Benthic survey to characterise seabed and identify sensitive sites and species	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Changes in wave regime and tidal flow	OD	▪ Avoidance of important habitats though careful site selection to reduce the potential effects of energy extraction ▪ Benthic survey to characterise seabed and identify sensitive sites and species	▪ Project design stage ▪ EIA stage
Substratum change	CC CD OD	▪ Careful site selection avoiding sensitive sites for devices and export cables (i.e. areas with known sensitive intertidal and subtidal benthic habitats) ▪ Benthic survey to characterise seabed and identify sensitive sites and species	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Fish and Shellfish			
Smothering	CC CD	▪ Avoid sensitive sites/species/periods	▪ Project design stage ▪ EIA stage ▪ Project installation
Noise	S CC CD OD	▪ Adherence to IDWC recommendations to minimise impacts on marine mammals (Irish Whale and Dolphin Group 2005) ▪ Undertaking studies to determine site specific noise effects ▪ Minimise use of high noise emission activities such as impact piling ▪ Avoid installation during sensitive periods ▪ Consider using alternatives (i.e. clump weights, gravity bases, cable protection rather than burial) ▪	▪ Project design stage ▪ EIA stage ▪ Project installation
Collision	OD	▪ Design device for minimal impact ▪ Do not site devices in particularly sensitive areas – e.g. migration routes, feeding, breeding areas ▪ Maximise device visibility ▪ Use of Acoustic Deterrent Devices (there is concern regarding the benefit of using these devices) ▪ Use of protective netting or grids	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project operation
Hydraulic injury	OD	▪ Use of protective screens to prevent marine organisms from entering the device (i.e. shrouded turbines) ▪ Do not site devices in particularly sensitive areas – e.g. migration routes, feeding, breeding areas	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project operation
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	CC CD OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Avoid shipping routes where collision risk is high ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan)	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Habitat exclusion	OD	▪ No specific mitigation identified	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Substratum loss	CD CC OD	▪ Avoid sensitive sites/species ▪ Site specific surveys to establish a baseline and inform the impact assessment for individual developments ▪ Workshops with expert representatives from the Marine Institute, B.I.M., N.P.W.S., industry and other appropriate bodies	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Changes in wave and tidal regime	OD	▪ Avoid sensitive sites/species/periods	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Barrier to movement	OD	▪ Avoid constrained waterways ▪ Avoid sensitive areas	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
EMF	OC OD	▪ Cable configuration and orientation can reduce field strength Cable burial, where possible to minimise field effect at the seabed	▪ Project design stage ▪ EIA stage
Marine Birds			
Physical disturbance	CC CD	▪ Avoid sensitive sites/species (i.e. SPAs) ▪ Avoid installation during sensitive seasons (i.e. breeding and moulting) ▪ Site-specific surveys at project level to identify the presence of key foraging hotspots and/or resting areas and to aid site selection	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Noise	CD CC OD	▪ Minimise use of high noise emission activities such as impact piling or blasting ▪ Avoid installation during sensitive periods ▪ Review and consideration of noise reduction techniques (e.g. bubble curtains around the pile) ▪ Use full sound insulation on plant equipment device design. ▪	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Avoid shipping routes and other areas of potential high collision risk ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan)	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Collision risk	OD	▪ Appropriate siting of developments e.g. away from seabird breeding colonies, important feeding/roosting areas, nearshore areas and "migration corridors"; ▪ Alignment of turbines in rows parallel to the main migratory direction; ▪ Several kilometre-wide free migration corridors between wind farms; ▪ No construction of wind farms between e.g. resting and foraging areas; ▪ Shut-down of turbines at night with bad weather/visibility and high migration intensity; ▪ Avoiding large-scale continuous illumination; ▪ Measures to make wind turbines more recognisable to birds ▪	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Habitat exclusion	OD	▪ Appropriate siting of developments e.g. away from important feeding/roosting areas	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Barrier to movement	OD	▪ Appropriate siting of developments e.g. away from seabird breeding colonies, important feeding/roosting areas, nearshore areas and "migration corridors" ▪ Site-specific surveys at project level to identify the presence of key foraging hotspots and/or resting areas and to aid site selection	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Marine Mammals			
Physical Disturbance	CC CD	▪ Detailed study would be required to examine marine mammal distribution around the coast in order to fully understand and mitigate for this risk. ▪ Avoid sensitive sites/species ▪ Avoid installation during sensitive seasons	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Noise	S CC CD ODOC	▪ Minimise use of high noise emission activities such as impact piling and blasting. ▪ Avoid installation during sensitive periods ▪ "soft starting" piling activities / passive acoustic deterrents – gradually increasing noise produced to allow mammals to move away from activities ▪ Underwater noise during operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. This requires further research. ▪ Noise from operating turbines can be reduced by using isolators. However this has not been tested over long term and to account for cumulative effects ▪ Use sound insulation on equipment. ▪ Use of bubble curtains (this is expensive and may only be effective in shallow water). ▪ Use acoustic deterrent or disturbance devices to scare sensitive species away ▪ Use of mammal observers and passive acoustic monitoring to facilitate implementation of exclusion area during noisy activities ▪ Use of IWDG recommendations for multibeam survey and cetacean impacts	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Collision risk	CD CC OD	▪ Design device for minimal impact ▪ Do not site devices in particularly sensitive areas – e.g. migration routes, feeding, breeding areas ▪ Increase device visibility, or use of acoustic deterrent devices ▪ Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance. ▪ Use of protective netting or grids ▪ Seasonal restrictions could be placed on operation to avoid impacting on marine mammals at vulnerable times such as breeding season. ▪ The use of acoustic deterrents such as pingers or acoustic harassment devices. ▪ Soften collision by adding smooth edges or padding. ▪ Protect against entrapment by incorporating escape hatches into device design.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Accidental contamination (hydraulic fluids or vessel cargo/ fuel)	CC CD OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan)	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Habitat Exclusion	OD	▪ Avoid sensitive sites/species ▪ Surveys of habitat use by marine mammals	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Barrier to movement	OD	▪ Detailed study would be required to examine coastal distribution in order to mitigate for this risk and avoid large installations in migratory corridors ▪ Avoid sensitive areas ▪ Avoid placement of devices within constrained areas where array could completely block or cause a significant perceptual barrier to marine mammals	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
EMF	OC OD	▪ Cable configuration and orientation can reduce field strength ▪ Cable burial, where possible to minimise field effect at the seabed	▪ Project design stage ▪ EIA stage
Marine Reptiles			
Collision	CC CD OD	▪ Design device for minimal impact ▪ Do not site devices in particularly sensitive areas – e.g. migration routes, feeding, breeding areas ▪ Increase device visibility, or use of acoustic deterrent devices ▪ Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine reptiles both during construction activities and in transit to the construction area if entering areas of high animal abundance. ▪ Use of protective netting or grids ▪ Seasonal restrictions could be placed on operation to avoid impacting on marine reptiles at vulnerable times such as breeding season. ▪ The use of acoustic deterrents such as pingers or acoustic harassment devices. ▪ Soften collision by adding smooth edges or padding. ▪ Protect against entrapment by incorporating escape hatches into device design.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	CC CD OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan)	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Barrier to movement	OD	▪ Detailed study would be required to examine coastal distribution in order to mitigate for this risk and avoid large installations in migratory corridors ▪ Avoid sensitive areas ▪ Orientating arrays parallel to the coastline rather than perpendicular to the coastline may help minimise a barrier effect as marine reptiles swim past ▪ Avoid placement of devices within constrained areas where array could completely block or cause a significant perceptual barrier to marine reptiles	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Noise	S CC CD OC OD	▪ No specific mitigation identified	▪ NA
EMF	OD OC	▪ Cable configuration and orientation can reduce field strength ▪ Cable burial, where possible to minimise field effect at the seabed	▪ Project design stage ▪ EIA stage
Habitat exclusion	OD	▪ No specific mitigation identified	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Marine and Coastal Archaeology and Wrecks			
Direct disturbance of unknown and known sites	CC CD	▪ Conform to the legislative requirements of the National Monuments Acts 1930-2004 and follow the codes of practice published by the National Monument Service ▪ Carry out seabed investigations in preferred site locations prior to device installation. ▪ Avoid sites of interest and exclusion areas for marine archaeology ▪ Submit any artefacts recovered to the National Monuments Service ▪ Avoid protected and other sites of interest ▪ In addition to desk based studies, carry out field walkovers in preferred terrestrial site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with the National Monuments Service and Local Authorities.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Changes to sediment regime	OC OD	▪ Conform to the legislative requirements of the National Monuments Acts 1930-2004 and follow the codes of practice published by the National Monument Service ▪ Carry out seabed investigations in preferred site locations prior to device installation. ▪ Avoid sites of interest and exclusion areas for marine archaeology ▪ Record and report potential archaeological and vessel remains to the National Monuments Service.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Data acquisition	CC CD	▪ Conform to the legislative requirements of the National Monuments Acts 1930-2004 and follow the codes of practice published by the National Monument Service ▪ Record and report potential archaeological and vessel remains to the National Monuments Service.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Commercial Fisheries			
Direct disturbance	CC CD	▪ Avoid device placement in sensitive areas ▪ Avoid key and peak fishing seasons for installation ▪ Clear area of debris post installation ▪ Early liaison with the fishing industry could help identify key fishing areas, particularly in the area where there is a lack of fishing effort distribution information for vessels under 15m ▪ Minimise effects by using procedures and structures that reduce the area of seabed disturbed for turbine foundations	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Temporary displacement from traditional fishing grounds	CC CD	▪ Avoid device placement in sensitive areas ▪ Avoid key and peak fishing seasons ▪ Liaison with the fishing community to keep them informed of installation operations.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Long term displacement from traditional fishing grounds	OC OD	▪ Avoid device placement in sensitive areas ▪ Consider spacing of turbines at wide enough intervals to permit use of mobile fishing gear. ▪ Workshops with expert representatives from the Marine Institute, B.I.M., N.P.W.S., industry and other appropriate bodies ▪ Liaison with industry and B.I.M	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project operation and maintenance
Aquaculture			
Smothering	CC CD	▪ Avoid sensitive sites/species/periods ▪ Consider cable installation methods that minimise suspended sediment (e.g. plough installation)	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Substratum loss	CC CD	▪ Avoid device placement in or near to existing fish farms	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Accidental contamination (hydraulic fluids or vessel fuel / cargo)	CC CD OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Avoid shipping routes ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Ports, Shipping and Navigation			
Displacement of shipping	CD CC OD	▪ Where feasible site devices away from constraints and areas of high vessel densities ▪ Undertake a navigation risk assessment (NRA) which should include a survey of all vessels in the vicinity of the proposed development ▪	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation stage ▪ Project operation and maintenance
Decreased trade / supply	CD CC OD	▪ Maintain good communications with the relevant ports ▪ Issue the appropriate notifications during installation and maintenance ▪ Site selection for device arrays to take into account the requirement for continued access to port and harbours	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation stage ▪ Project operation and maintenance
Reduced visibility	CD CC OD	▪ Avoiding areas of high vessel densities and areas constrained by land e.g. adjacent to the entrances of ports and Lochs. ▪ In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation would reduce the potential impact on visibility. ▪ Any vessels and devices should be lit and marked in accordance with the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) guidelines, in agreement with the Commissioners of Irish Lights.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation stage ▪ Project operation and maintenance

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Collision risk	CD CC OD	▪ Avoid constrained areas or areas of high shipping densities and regularly used shipping routes. ▪ In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. ▪ Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. ▪ The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation stage ▪ Project operation and maintenance
Recreation and Tourism			
Access Restrictions	CC CD OD	▪ Undertake construction, where possible, outside of peak tourist seasons (June to September) to minimise disruption to visitors and local people. ▪ Identify and avoid popular routes for sailing or other water sports such as kayaking. ▪ Where possible, facilitate safe access through arrays for sailing or other water sports.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Noise	CC CD OD	▪ Avoid key recreational periods for installation works ▪ Identify and avoid popular recreational areas when possible	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation stage
Safety and Collision Risk	CC CD OD OC	▪ Avoid popular cruising routes, diving areas and key water sport locations ▪ Incorporate suitable safety features such as lighting, netting and buoys into the device design. ▪ Provide suitable information for the public regarding safety ▪ Restrict access to construction sites ▪ Observe good practice during construction, removal and maintenance	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage ▪ Project installation stage ▪ Project operation
Disturbance to Wildlife	CC CD OD OC	▪ Avoid areas that are popular with tourists and wildlife tour operators. ▪ Other mitigation measures aimed at reducing or avoiding disturbance to wildlife including sea mammals and birds is set out in the relevant parts of this table.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Aviation Radar			
Collision	OD	▪ Ensure wind devices are lit with aviation lights in accordance with OAM 09/02 “Offshore Wind Farms Conspicuity Requirements” ▪ As required under the Obstacles to Aircraft in Flight Order, S.I. 215 of 2005, provide notification of the erection of wind devices to the IAA	▪ Site selection stage ▪ Project design stage ▪ Project EIA stage ▪ Project installation stage ▪ Project operation

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Radar interference	OD	▪ Consultation with the IAA will be required and the location of wind devices supplied so they can be accurately plotted on the radar and any signals received from that area will not be confused with aeroplanes.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Military Exercise Areas			
Disruption to general activities	CC CD OD OC	▪ Avoidance of byelawed and danger sites ▪ Carry out site selection studies in conjunction with liaison with the Department of Defence, ROI and the Ministry of Defence, UK where applicable	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation
Cables and Pipelines			
Direct damage	CC CD OC OD	▪ Use of recommended 500m avoidance area ▪ Use of crossing agreements in accordance with ICPC guidelines ▪ The seabed lease pertaining to existing infrastructure will legally need to be observed when selecting sites for devices and export cables	▪ Site / cable route selection stage ▪ Project design stage
Access Restrictions	CC CD OC OD	▪ Use of recommended 500m avoidance area ▪ Use of crossing agreements in accordance with ICPC guidelines ▪ The seabed lease pertaining to existing infrastructure will legally need to be observed when selecting sites for devices and export cables	▪ Site / cable route selection stage ▪ Project design stage
Dredging and Disposal Areas			
Access restrictions	CC CD OD OC	▪ Avoid development within 500m of dredging and/or disposal sites ▪ Notification of port and harbour authorities of the proposed works	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation ▪ Project operation and maintenance
Existing Renewable Infrastructure			
Access restrictions	CC CD OD OC	▪ Careful site selection to factor in the access needs of existing infrastructure to ensure that the proposed sites do not conflict with the activities of existing renewable infrastructure ▪ Communication with existing wind farm operators	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage ▪ Project operation and maintenance

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Removal of energy resource	OD OC	▪ Careful site selection taking into account resource assessment and modelling to determine if and how commercial-scale arrays could coexist with the existing renewable infrastructure.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Natural Gas and CO_2 Storage			
Sterilisation of region	OD OC	▪ No specific mitigation measures identified ▪ Consultation with the relevant regulatory body to establish areas of search for possible future gas/carbon storage sites within Irish waters	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Oil and Gas Activity			
Access restrictions	CC CD OD OC	▪ Consultation with the relevant regulatory body would be required prior to siting of any renewable devices ▪ Careful site selection avoiding areas of existing and proposed oil and gas activity	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage ▪ Project operation and maintenance
Collision	CC CD OD OC	▪ Consultation with the relevant regulatory body would be required prior to siting of any renewable devices ▪ Careful site selection avoiding areas of existing and proposed oil and gas activity	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage ▪ Project operation and maintenance
Sterilisation of region	OD OC	▪ Consultation with the relevant regulatory body would be required prior to siting of any renewable devices ▪ Careful site selection avoiding areas of existing and proposed oil and gas activity	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Seascape			

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Effects on seascape from offshore wind developments	CD OD	▪ Consideration should be given to locating devices at a maximum distance from the shore/coast (within technological constraints) ▪ Wind farms should not be sited where they appear to block or close the entrance to bays/loughs/narrows/sounds or where they separate a bay from the open sea ▪ Wind farms should reflect the shape of the coastline and align with the dominant coastal edge ▪ Wind farms should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate ▪ Wind farms should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement ▪ Wind farms should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms ▪ Consideration should be given to locating devices in already industrialised and developed seascapes	▪ Project design stage
Climate			
Potential sterilisation of future gas/carbon storage areas	OC OD	▪ Consultation to establish areas of search for possible future gas/carbon storage sites within Ireland waters	▪ Site selection ▪ Project design

Key: CC – construction/decommissioning cables; CD – construction/decommissioning devices; OC – operation cables; OD – operation devices; S - survey

Section 16: Monitoring

16 Monitoring

16.1 Introduction

It is a requirement of the SEA Directive and the EC Environmental Assessment of Plans and Programmes Regulations 2004 (S.I.435/2004) that the responsible authority (in this case SEAI and DCENR) monitors the significant effects of the implementation of the plan or programme for which it has carried out the assessment. The 2004 Regulations states that the responsible authority '*shall monitor the significant environmental effects of the implementation of each plan or programme with the purpose of identifying unforeseen adverse effects at an early stage and undertaking appropriate remedial action'*. This chapter of the SEA sets out the proposed monitoring framework required as part of the overall SEA. Following consultation the monitoring framework will be reviewed and finalised in the post-adoption SEA Statement.

16.2 Focus of the Monitoring Framework

The main focus of a monitoring framework is to set out measures that could be used by SEAI and DCENR to monitor the implementation of the OREDP and the effects that it has on the environment.

The OREDP provides a framework for the development of offshore renewable energy in Irish waters up to 2030 and a longer term vision for the growth of the offshore renewable energy sector in Ireland. It set out specific scenarios for different levels of development range from low to high. It also identifies a number of actions to support and facilitate the development of offshore renewable energy in Ireland but which fall out with the remit of the OREDP and therefore will need to be delivered through other plans, programmes or initiatives.

However, the OREDP is not responsible for the physical deployment of individual offshore renewable energy projects as this will be the responsibility of individual developers. Nor is it responsible for the consenting and licensing of individual offshore renewable energy projects, although conformance with the OREDP will be a material consideration in the determination of future consent /licence applications (current developments (as of October 2010) awaiting determination of Foreshore Lease applications will not be affected by the SEA or the OREDP).

The monitoring framework therefore needs to focus on monitoring the effectiveness of the OREDP in promoting offshore renewable energy development in a way that minimises adverse effects on the environment and other marine users, rather than monitoring individual projects.

16.3 Approach to Monitoring Framework

By providing a framework for taking forward offshore renewable energy developments, the OREDP could potentially have adverse effects on marine and coastal environment of Ireland. These potential adverse effects have been assessed as part of this SEA.

The results from the SEA (presented in Chapters 11, 12 and 13) concluded that it would be possible to achieve the high development scenario of 4,500 MW from offshore wind and 1,500MW from wave and tidal energy without likely significant adverse effects on the environment. However, these conclusion are qualified by the fact that in certain locations/areas due to data, information and knowledge gaps, some potential effects are unknown and there is uncertainty over the likely level of significant of a potential effect should it occur.

Addressing these unknowns and areas of uncertainty is therefore a key requirement of the monitoring strategy.

A number of mitigation measures (presented as actions (Chapter 15)) have been developed specifically to focus on reducing the potential for the OREDP and individual projects taken forward under the OREDP, to have likely significant adverse effects on the environment. These actions include the following:

Collaboration and Co-ordination:

- **Action 1:** Development of a mechanism for greater coordination between all state bodies concerned to improve the effectiveness of the delivery of the OREDP as policy develops. This could include an enhanced role for the existing multi-body Ocean Energy Steering Committee.
- **Action 2:** Collaborative working with the existing Ocean Energy Advisory Group to assist/advise SEAI and DCENR with taking forward the OREDP.

SEA Monitoring Requirements:

- **Action 3:** In accordance with Article 17 of the SEA Regulations 2004, the group identified in the mechanism for enhanced co-ordination in Action 1 shall ensure the significant environmental effects of the implementation of the plan is monitored. This will ensure that unforeseen adverse effects are identified at an early stage and appropriate remedial action can be taken as required. **Further detail on monitoring is provided in Chapter 16.**

Addressing Data, Information and Knowledge Gaps:

- **Action 4:** DCENR and SEAI, in the context of the offshore renewable energy sector, should collaborate with the lead authorities on the MSFD and other statutory requirements that are taking forward requirements relating to collation, management and dissemination of data and information collected for the marine environment so that data is made publicly available so that it may be taken into account by those developers and bodies involved in the siting, design, consenting and permitting of individual projects.

Consenting and Permitting:

- **Action 5:** Future foreshore consenting processes by the relevant authorities should take into account the broad findings and assessment of this SEA and AA in terms of location and constraints.
- **Action 6:** The foreshore consent process should require developers to put in place appropriate monitoring programmes to assess the effects of their development.
- **Action 7:** The foreshore consenting authority should consider the application of an incremental (the 'deploy and monitor') approach as part of the scaling up of offshore renewable energy developments. **Further detail on the 'deploy and monitor' approach to development is provided in Section 15.4 below.**

Guidance and Advice:

- **Action 8:** The project level mitigation measures/EIA Guidance prepared as part of the SEA should be incorporated into National EIA Guidance for offshore renewable energy developments. Further detail on the project level mitigation measures is provided below.
- **Action 9:** Development and maintenance of a GIS database tool to inform the foreshore consenting process, lead by the Marine Institute.

The main aim of these actions is to minimise adverse effects of offshore renewable energy developments on the environment by identifying ways in which the OREDP and future developments can be managed taking into account other sea users and the environmental receptors, increasing the certainty with which the likely significance of potential adverse effects of individual projects can be identified and reducing the number of areas/environmental receptors where potential effects are unknown.

16.4 Monitoring the Implementation of these Actions

Each of the actions developed as part of the plan level mitigation (Chapter 15) have specific deliverables which would need to be achieved in order reduce the potential for offshore renewable energy developments to have likely significant adverse effects on the environment and other marine users. However, given the strategic nature of the OREDP and the likely timescales involved in the growth and development of offshore renewable energy developments, it is recognised that it will be difficult to set specific timescales against the delivery of each of the individual actions.

It is therefore suggested that, as part of the implementation of the OREDP, there is a five yearly review of the progress made towards achieving the developments scenarios set out in the OREDP. This review would focus on the following:

- What level of development (offshore wind, wave and tidal) has occurred during the review period?
- Have any significant adverse effects been identified as a result of those developments?
- How have the findings of the SEA and AA been integrated into existing consenting and licensing mechanisms?
- What new data, information and knowledge has been collated and obtained during the review period?
- Does the SEA need to be updated to reflect any new data/information that has emerged that could affect/influence longer term proposals for development set out in the OREDP?
- Does the target for 4,500MW from offshore wind and 1,500MW for wave and tidal still appear to be a realistic development scenario for 2020/2030?
- Have new potential areas of developments been identified as a result of new information becoming available?
- Does the SEA need to be updated to review/assess these new areas?
- Has the EIA guidance prepared as an outcome from the SEA been integrated into National EIA Guidance for offshore renewable energy developments?
- What progress has been made in terms of marine planning and how is this assisting with the management of offshore renewable energy developments in certain locations?

Section 17: References

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