Strangford Lough Marine Current Turbine

Environmental Statement

Marine Current Turbines

21 June 2005

Final report

A COMPANY OF

ROYAL HASKONING

ROYAL HASKONING LTD
ENVIRONMENT

10 Bernard Street
Leith
Edinburgh EH6 6PP
United Kingdom

+44 (0)131 555 0506	Telephone
0131 555 0502	Fax
info@edinburgh.royalhaskoning.com	E-mail
www.royalhaskoning.com	Internet

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List of acronyms or abbreviations

ADCP	Acoustic Doppler Current Profiling
AONB	Area of Outstanding Natural Beauty
ASSIs	Areas of Special Scientific Interest
ATBA	Area To Be Avoided
BDF	Biodegradable Drilling Fluid
CFD	Computer Flow Dynamics
COSHH	Control of Substances Hazardous to Health
COWRIE	Collaborative Offshore Wind Research into the Environment
DEFRA	Department for Environment Food and Rural Affairs
DETI	Department for Enterprise Trade and Investment of the NI Government
DoE	Department of Environment
EHS	Environment and Heritage Services
EIA	Environmental Impact Assessment
EMEC	European Marine Energy Centre
EMF	Electromagnetic fields
ES	Environmental Impact Statement
FEPA	Food and Environment Protection Agency
HAT	Highest Astronomical Tide
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
MarLIN	Marine Life Network
MCA	Marine Coastguard Agency
MCS	Marine Conservation Society
MCT	Marine Current Turbines Ltd
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
MNCR	Marine Nature Conservation Review
MNR	Marine Nature Reserve
NFFO	the Northern Ireland Non-Fossil Fuel Obligation Order
NGOs	Non Governmental Organisations
NIE	Northern Ireland Electricity
NNRs	National Nature Reserves
NTM	Notices To Mariners
NTS	A Non-Technical Summary
OFREG	Office for the Regulation of Electricity and Gas
QUB	Queens University Belfast
RIB	Rigid Inflatable Boat
ROCs	Renewables Obligation Certificates
RSPB	Royal Society for the Protection of Birds
SACs	Special Areas of Conservation
SCADA	Supervisory Control and Data Acquisition system
SMRU	Sea Mammal Research Unit
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
SPAs	Special Protection Areas
SSSI	Site of Special Scientific Interest
SWDC	Salt Water Drilling Clay
ZVI	Zone of Visual Influence

NON-TECHNICAL SUMMARY

Marine Current Turbines Ltd have constructed the first tidal power turbine in the UK off the coast of Devon, which has been in operation for over two years. A second, larger turbine to be known as "Seagen" is proposed in order to further develop this technology through investigation of its engineering, management systems and environmental impacts. Of several potential locations around the UK, the Strangford Lough Narrows has been chosen due to its wave-sheltered environment, its fast clearly defined directional tidal flows within a small sea level range, and its proximity to excellent services and local technical support. Experience off the Devon coast has shown that it is vital to have easy, frequent and consistent access to the test location, but this has been severely restricted due to weather exposure. This location will provide the opportunity to study the technology more frequently than exposed sites such as Devon, thereby ensuring full knowledge of both technical and environmental impacts is gained before commercial scale ventures are proposed in more remote offshore locations.

Seagen will be a twin turbine system with a mobile cross arm on a single supporting pile 3m in diameter and 9m above the average sea level as illustrated below. The twin rotors have an 8m radius and will begin to generate electricity once the tide runs faster than 1m/s. At maximum speed the tips move at around 12m/s, approximately 1/3 of the average wind turbine speed.

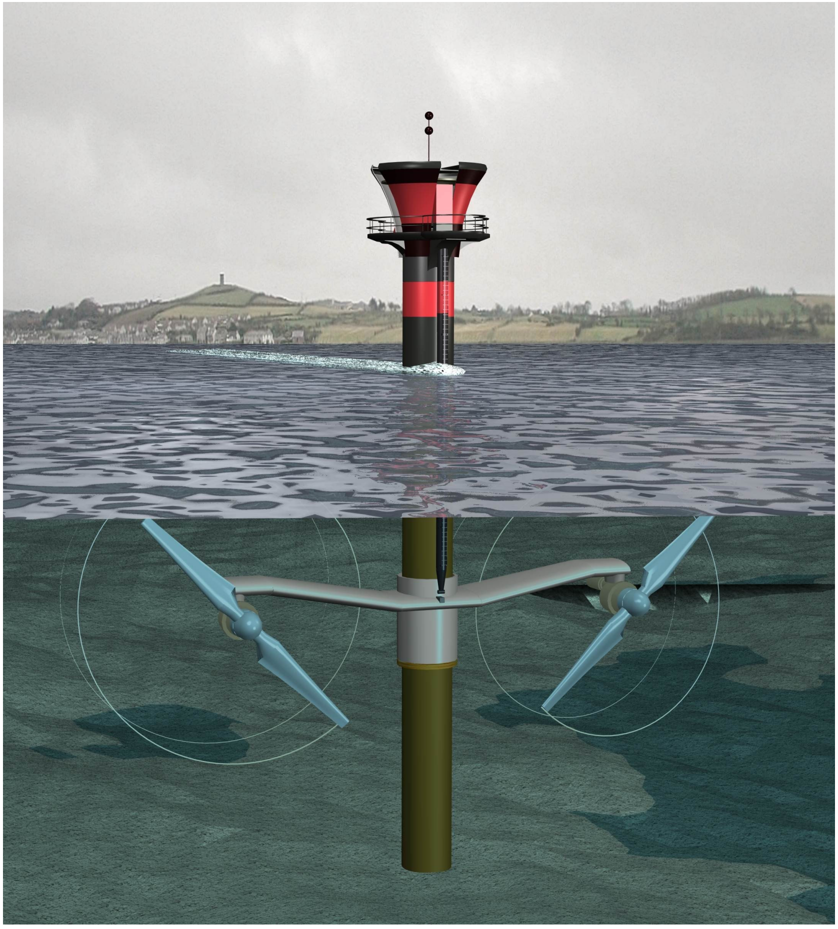
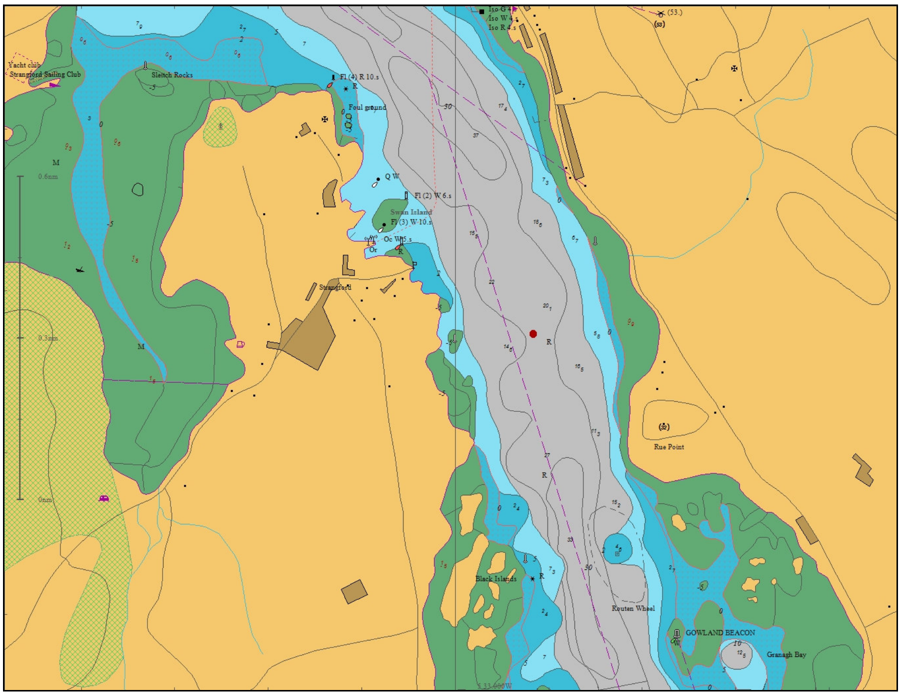


Image of Seagen

The Seaflow design allows for the cross beam and turbines to be raised above the water for maintenance and inspection. The system will be installed from a barge by drilling a hole in the sea bed and grouting the pile in place, and a location map is provided below. The electricity connection will be made to the national grid by drilling a small hole horizontally from the western side of the Narrows under the shore and sea bed, carefully directing the drill to emerge from the Lough bed within 15m of the turbine base. The system will be removed in approximately 2-5 years once it has successfully addressed all relevant technical and environmental performance requirements, leaving a 3m diameter depression slightly below sea bed level which will naturally fill with cobbles and boulders as a result of tidal flows.



Proposed location of Seagen

This Environmental Statement has been prepared in support of Marine Current Turbine Ltd's application to construct Seagen under the Food and Environment Protection Act (1985) in accordance with recognised environmental impact assessment procedures. The assessment involves the application of a standardised process to identify the likely impacts from all relevant issues identified through an initial scoping process and wider consultation with regulators, non-governmental organisations and other interested parties. As the proposed location falls within an area protected under domestic and European law, information considered relevant to a further 'appropriate assessment' process has been collected or collated from other sources in order to assist the Environment and Heritage Service as 'Competent Authority' in determining if the project is unlikely to damage the protected features.

Strangford Lough hosts internationally important subtidal and intertidal rock, sand and mud habitats and horse mussel beds. The Lough also supports internationally significant wintering waders, breeding terns and important populations of common seals. For these reasons all or parts of the Lough have been recognised as a Special Area of Conservation, Special Protection Area, Ramsar site, Area of Special Scientific Interest, National Nature Reserve and a Marine Nature Reserve. Extensive consultation with regulators, non-governmental organisations and the public has been carried out in order to ensure all relevant issues are considered. This process identified general local support for the project and support from regulators and non-governmental organisations for the need to develop this sustainable technology. It also highlighted concerns that the installation and operation of Seagen should not harm or deter seals, cetaceans or basking shark using the area for feeding or access to breeding areas in the main body of the Lough, nor should it have a detrimental effect on the internationally important breeding tern populations or the subtidal wildlife habitats in Strangford Lough. This was noted as particularly important in relation to recent discoveries on the extent of damage and loss of horse mussel beds.

Modelling of water movement in the Lough was carried out in order to assess the potential impacts of the turbine construction, operation and removal on water speed, the distribution of fine particles and the removal of energy as a result of Seagen. This information was used to predict that it is extremely unlikely that there will be any significant impact on marine life present in the Lough, except out to approximately 4m from the base of the turbine. The overall loss of reef and its marine communities, which will recover once Seagen is removed, is a tiny fraction of the habitat in the context of Strangford Lough and will not add to the justification for its present 'unfavourable conservation status' under the EC Habitats Directive.

The potential impacts of operating the turbine on seals have been subject to investigations of historic movement and population observations, extensive discussion with seals experts and academics, surveys and assessment of underwater noise and extensive consultation with experts. Despite this, due to the novel nature of the Seagen design and the lack of knowledge about seal behaviour, it is concluded that enough uncertainty remains over the possible behavioural reaction of seals to Seagen that a definitive assessment cannot be made. The same situation applies to possible impacts on cetaceans and basking shark. In order to ensure that there is an acceptably low risk of damaging these species or affecting their behaviour in ways that may damage their populations in the Lough (in particular common seals protected as part of the Special Area of Conservation) a comprehensive programme of monitoring is proposed alongside monitoring of birds and habitats in the Narrows. This is combined with a formal steering group likely to oversee the programme and a commitment from the developers to work in partnership with regulators and to modify or cease operations if the programme highlights problems or if the regulators and steering group decide it is necessary. This adaptive management approach is in line with recent developments on use of the 'precautionary principle' in order to facilitate sustainable development within protected areas such as Strangford Lough. Impacts on other ecological features in the area are considered highly unlikely due to the scale and duration of the commissioning process.

The effect of the project on navigation is likely to be beneficial due to the appropriate marking and lighting of the structure above sea level. The risk to vessels known to use the Narrows posed by operating rotors is generally negligible as the tips will be at least 3m below the lowest astronomical tide level. An area around the turbine may also be noted on charts as an 'Area To Be Avoided', providing further security.

Seagen is considered likely to be slightly beneficial to local businesses through increased visitors and workers to the area, and it is considered unlikely to have any effect on commercial fishing in the Narrows due to the current ban on activities that would normally fish the proposed location and the location of the turbine within the deep water of the middle of the Narrows. No impacts on archaeology are anticipated at the proposed turbine location.

It is likely that Seagen will affect the landscape and cause some visual disturbance at all stages of the project as it will be visually obvious from Portaferry and will affect the relatively open seascapes seen from the ferry crossing. The level of this impact is mainly due to the requirement for specific colours and lighting on the superstructure for navigation as there are several similar beacons at various locations through the Narrows. The most significant visual impacts will be intermittent during maintenance periods when the cross arm is raised above sea level.

The project will have a negligible impact on road traffic in the area as most materials will be brought to the site by sea. The main sources of noise above water level will be power generators on board the jack-up barge and in the directional drilling compound during construction. Neither of these are expected to be significant as the noise ratings indicate levels will be low within very short distances from the source.

Impacts on air quality in the area are expected to be negligible in the short and medium term, but it must be recognised that this clean and sustainable energy source represents an opportunity to facilitate long term improvements in air quality and will contribute to the achievement of national and international targets to reduce emissions of gases attributed to accelerating climate change.

In conclusion, Seagen is a critical stage in the development of renewable tidal energy in the UK. Strangford Lough represents an ideal location for this temporary installation the environmental impacts have been assessed and are generally considered unlikely to be significant. Due to the novel nature of the proposed development and the lack of definitive information some uncertainty remains as to its likely impacts on marine mammals and basking shark.

1 INTRODUCTION

This section should be read in conjunction with Appendix 1.

Royal Haskoning gratefully recognises and acknowledges the input and support provided by EHS, the Strangford Lough Management Committee and other consultees.

1.1 Background

Marine Current Turbines Ltd (MCT) are seeking to install a single developmental marine current turbine system, to be known as 'Seagen' (Figure 1.1) in the Narrows area of Strangford Lough, Northern Ireland. Royal Haskoning Ltd has been commissioned to prepare an Environmental Impact Assessment (EIA) for the proposal. This Environmental Statement (ES) relates to several documents including a proposed strategic environmental monitoring programme, the original scoping document produced in June 2004, and the site investigations environmental assessment. In the production of this document, as a result of consultation with regulatory bodies, a preliminary ES was produced in anticipation of a number of key investigations and further data collection. The preliminary ES was provided to the Environment and Heritage Service (EHS) in February 2005 in order to provide regulators and other consultees with the opportunity to comment on the approach taken to the environmental assessment, and to address less complex issues at an early stage. This final ES builds on the work carried out to date and the key concerns identified during scoping and consultation over the preliminary ES.

As Strangford Lough is a candidate Special Area of Conservation (SAC), it is the duty of the Competent Authority under the Conservation (Nature Habitats, etc.) Regulations (Northern Ireland) 1995 as amended (the Habitats Regulations) to determine whether any proposed plan or project is likely to have a significant effect on the features for which the site is internationally important, and to carry out an Appropriate Assessment if a significant effect is deemed likely. It is envisaged that this document will provide information that would be used in any Appropriate Assessment, should one be required. This ES provides background information and determines the potential environmental constraints and benefits associated with the construction and installation of a marine current turbine in Strangford Lough. As such, this report has been produced to facilitate the identification and assessment of the environmental impacts associated with the project and to ensure that consultees are fully aware of and informed about the scheme.

This project forms a significant part of a MCT Ltd's R&D programme intended to develop new technology for the generation of electrical energy from renewable resources. It is proposed that the turbine be installed and operated for up to 5 years in the Strangford Narrows, where it will serve as a test case for the development of the technology under relatively sheltered conditions, after which it will be decommissioned and removed.

MCT is a leader in the development of power systems capable of exploiting tidal and marine currents; the company has already successfully installed and operated a smaller 300kW single rotor experimental test system off the North Devon coast near Lynmouth. This device, known as 'Seaflow', was the world's first full scale tidal turbine installed in an offshore location (see Figure 1.2).

The basic principle used by this technology is analogous to an 'underwater windmill', with the passing current turning large propeller-like rotors which drive generators from which electricity can be sent ashore through marine cables. As water is so much denser than air, the currents needed to generate useful power are quite slow, around 2 to 3m/s (4 to 6 knots). Consequently, the rotors of the tidal turbines are relatively slow turning compared with wind turbines, typically at speeds of around 10 rpm, with tip velocities of no more than about 12m/s.

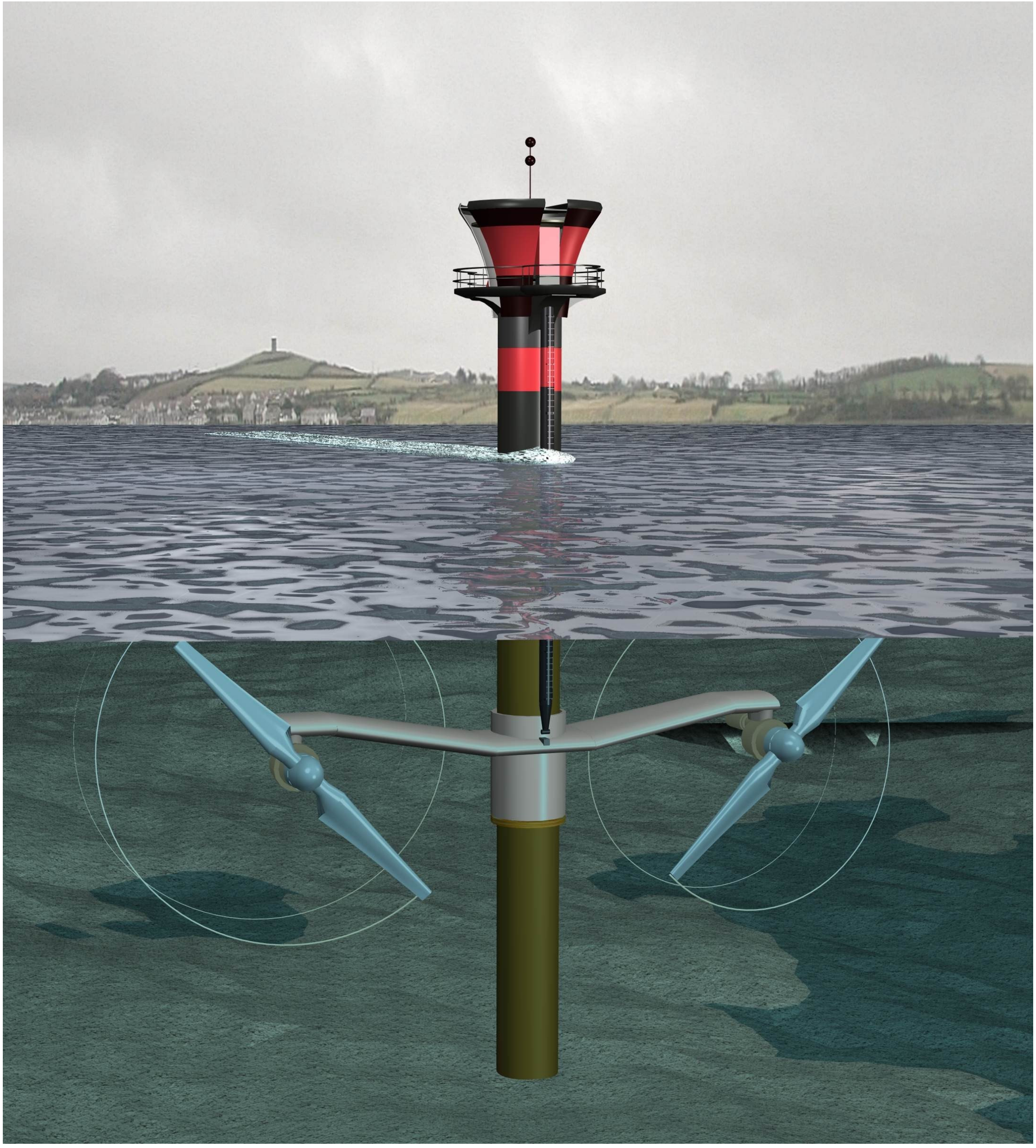


Figure 1.1 Artist's impression of proposed Seagen turbine showing both above and below water surface with Portaferry behind; as viewed at Mean Sea Level (MSL)

Figure 1.2 Seaflow shown with its rotor submerged (left) and raised out of the water (right)

Advantages of tidal current turbine power generation are:
- It produces no pollution from normal operation;
- Energy is delivered predictably (the tides can be predicted many years in advance); and
- The potential exists for this source to make a significant and cost-effective contribution to future energy needs.

Support for the development of energy resources such as tidal power is a key part of the UK government's strategy to develop renewable energy as a means to combat atmospheric pollution and mitigate climate change as agreed under the Kyoto Protocol. The rationale for developing this technology stems from the need to address escalating global energy consumption combined with the need to develop clean renewable energy (in line with the Protocol). However, key considerations are the socio-economic and environmental constraints associated with the construction and operation of large renewable energy production schemes from marine resources, due to the increasing difficulties associated with implementing large-scale renewable projects on land.

Recognising the novel nature of the proposal, and the inevitable uncertainties associated with this proposed development there is a strong commitment to ensure the technology performs as expected in terms of its very low anticipated environmental impact. To this end a large part of the planned programme of monitoring and testing the system in Strangford Lough will be for independent team of researchers to study ongoing impacts associated with operating the tidal turbine. This team will be led by a team from Queens University Belfast (QUB) Marine Station, based at Portaferry, with possible support from the European Marine Energy Centre (EMEC) based in Orkney, and the programme is expected to provide a significant benchmark upon which future development of commercial scale production can base impact assessment.

1.2 Tidal current technology

Recent technological developments have made tidal electricity generation a realistic proposal. Marine current turbines are, in principle, similar to submerged windmills, and are driven by high tidal current velocities, deriving energy from huge volumes of flowing water. The basic requirements for cost-effective power generation from tidal streams are a mean spring peak velocity exceeding about 2.25-2.5m/s (4.5-5kn) with a depth of water of 20-30m. These flows have the major advantage of being an energy resource as predictable as the tides that cause them, unlike wind or wave energy which are a response to the more random dynamics of weather systems. It is estimated that a tidal current turbine rated to work in a flow between 2-3m/s in seawater can typically access four times as much energy per rotor swept area as a similarly rated power wind turbine, so for a given power rating a tidal current turbine is significantly smaller than the equivalent wind turbine, as well as being mostly submerged.

Marine current turbine technology is being developed by a number of groups and companies. The technology under development by MCT consists of axial flow rotors of 16m in diameter that drive a generator via a gearbox much like a hydro-electric turbine or a wind turbine. The use of twin rotors is preferred, mounted on wing-like extensions either side of a tubular steel monopile some 3-4m in diameter which is set into a hole drilled into the sea bed (see Figure 1.1 and Figure 1.2).

In future, it is expected that turbines will be grouped into arrays or "farms" under the sea, in locations with high currents, in much the same way that wind turbines in a wind farm are set out in rows to catch the wind. The main difference is that marine current turbines of a given power rating are smaller, and they can be packed closer together because tidal streams are often bi-directional, whereas wind tends to be multi-directional. Such installations will generally be in areas of open sea, but such development cannot realistically occur until reliable technology has been perfected on a small scale under more sheltered conditions, such as those proposed at Strangford.

1.3 Previous work

The type of technology under development by MCT has been the subject of two previous environmental impact reviews, namely:

1. Feasibility Study of Tidal Current Power Generation for Coastal Waters: Orkney and Shetland, prepared for the European Commission DG VII and for the Orkney Islands and Shetland Islands Councils by Bryden, I & Bullen C., International Centre for Island Communities, Heriott Watt University, Stromness, March 1995.
2. Seaflow Project off Foreland Point, Devon: Environmental Statement, Casella Stanger Ltd., Liverpool, Nov 2001.

The first study related to a project where the technology now under development by MCT was originally conceived by its founding company, IT Power Ltd. In both cases the studies concluded that the main environmental impacts would range from “no impact” to “minor impact”.

The energy potential of tidal currents around Northern Ireland is considered in the report “The Potential for the Use of Marine Current Energy in Northern Ireland” prepared by MCT in June 2003, under contract to the Department for Enterprise Trade and Investment (DETI) of the NI Government with support from the DTI in London and Northern Ireland Electricity (NIE). This study considers the energy potential of tidal currents for Northern Ireland and demonstrates the importance of Strangford Narrows as a suitably sheltered location to develop the technology to the stage where it can safely be installed in open-sea conditions and environmentally sensitive locations.

1.4 Recent work

Royal Haskoning were commissioned by MCT in April 2004 to undertake an environmental scoping exercise for the Strangford Lough in preparation for the submission of a full ES. Through the detailed consultation and discussions that followed from the scoping exercise, it was determined that a preliminary environmental statement would be particularly useful in identifying and addressing the potential impacts of the proposed marine current turbine development on Strangford Lough.

Royal Haskoning completed a preliminary ES in February 2005, designed to allow discussion of key issues and clarification of areas of uncertainty.

In anticipation of a requirement to collect borehole rock samples to inform the engineering aspects of the installation of the pile, an environmental assessment of the site investigations work was produced and circulated in draft to the Environment and Heritage Service in October 2004 and as final document in December 2004. Permission was granted for this element of the work programme and the site investigation work was carried out in April 2005.

1.5 Definition of the study area

Strangford Lough is a shallow sea Lough covering some 150km^2 on the east coast of County Down. The Lough is roughly 30km long and 8km wide, making it one of the largest sea Loughs in Ireland (Brown, 1990). Almost land-locked, the Lough is separated from the Irish Sea by the Ards Peninsula to the east and the Lecale coast to the south. The Strangford Narrows, an 8km long channel with a minimum width of 0.5km, connects it to the open sea. The study area is shown in Figure 1.3. The Narrows are subject to strong currents of up to 8 knots (4m/s) and, therefore, represent an ideal location for marine current turbine development and evaluation.

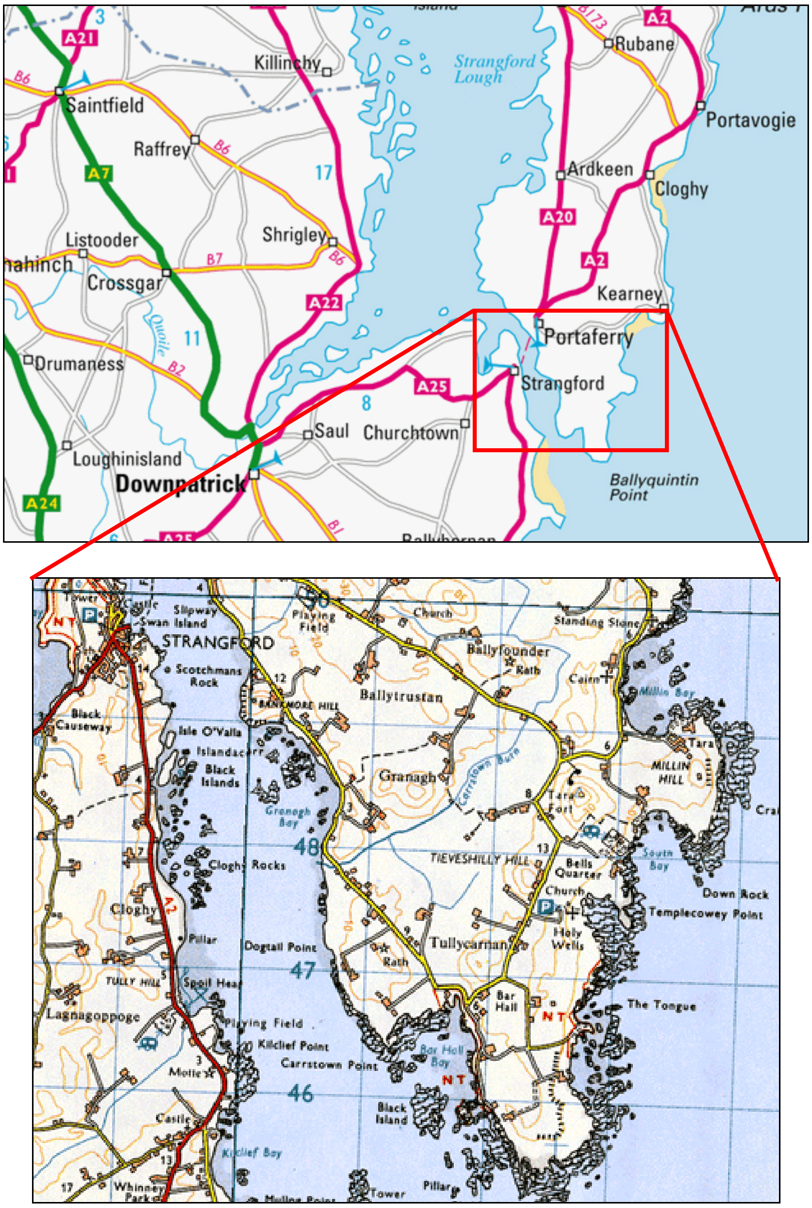


Figure 1.3 Study area showing Strangford Lough and the Narrows

From www.multimap.co.uk

2 DESCRIPTION OF THE PROPOSED SCHEME

This section should be read in conjunction with Appendices 1, 2, 3, 4, 5 and 6.

In developing the proposed scheme a number of key project design decisions were taken that were influenced by the environmental sensitivities of the study area, such as the decision to link the turbine to electrical grid connections through directional drilling as opposed to laying a cable on the sea bed (see Section 2.5). This shaped the direction of the development (representing 'mitigation through design'). This section of the ES sets out the main areas where several options have been considered and explains the rationale for the decisions that have resulted in the current proposal.

2.1 Site selection

A site selection process was carried out to identify and assess potentially suitable sites for the trial in the UK and Ireland. An evaluation of alternative sites using weighted comparative criteria was undertaken by the MCT project team to assess and justify site selection. Determination of site suitability comprises a number of components, characterised by the following main criteria:

- Weather exposure;
- Proximity to grid connection;
- Environmental sensitivities;
- Tidal flow regime energy;
- Bathymetry (20-30m depth);
- Site accessibility from local and national perspective; and
- Logistics and proximity to marine operations support.

Whilst it is recognised that each of the sites considered is unique, the multiple criteria approach outlined above justified the selection of Strangford Lough Narrows as the optimum site for the establishment of a temporary evaluation system of the marine current turbine. A detailed site selection justification is provided in Appendix 1. It is important to recognise that the high degree of environmental and consequent political sensitivity associated with Strangford Lough was considered in this process. However, even if this is factored in to the scoring system used in the comparison of sites the Strangford Narrows remains a more suitable location for this stage of development.

Key factors that identified Strangford Lough Narrows as an ideal site to locate the proposed temporary, tidal power turbine included:

- The high current velocities likely to be encountered, predominantly in well defined bi-directional flows, providing a complete spectrum of velocities for the prototype technology to be trialled under;
- The relatively limited tidal range of only 3.6m at Strangford in comparison to the tidal flow velocities, facilitating safe access to the installation, reduced cost and more straightforward servicing and maintenance arrangements;

- The wave sheltered environment of the Narrows presents a number of advantages. Given the intention to evaluate aspects of the system's management and performance before developing a full scale commercial array in more open areas at various locations around the UK and Ireland, frequent and regular visits to the installation will be required. The low wave environment increases overall operational safety, facilitates easy and reliable access to the installation and permits safe winter installation, maintenance and decommissioning;
- The diverse natural habitats of Strangford provide the opportunity to study the interaction of the turbine with natural tidal flows and with marine flora and fauna, including marine mammals such as seals and to confirm the expected low environmental impact of the technology in a location with readily available local expert advice and marine biological facilities;
- The grid connection on shore can be made within a distance of only around 500m to the existing 11kV spur to the Strangford sewage works, which offers the prospect of a grid connection at relatively low cost; and
- High quality support skills and expertise required for the installation of the turbine, as well as its maintenance and monitoring, are available locally in Strangford and at the Marine Biological Station in Portaferry. Northern Irish contractors, service providers and expertise will be utilised wherever possible.

In addition to the key points above, the 'in principle' support from the relevant authorities and stakeholders in Northern Ireland and on the shores of Strangford was an important factor in the decision to site this development in this ecologically important location.

It is therefore considered that siting a single temporary developmental tidal turbine in the Strangford Narrows could significantly accelerate the development of a clean renewable energy technology in the UK in a way not possible at other sites.

2.2 Project location and scale of system in relation to the site

Within Strangford Lough, two possible preferred locations for the project were identified, approximately 50m apart, near the sewage outfall from the sewage works just to the south of Strangford town. The preferred position in relation to the Narrows is shown in Figure 2.1. There is an existing 11kV mains spur which could be used to take the power from the turbine into the local grid and permission is being sought to place the grid interface equipment within proximity of the spur.

This location offers the benefit of a short connection to the grid, combined with high velocities and it is considered to be one of the less environmentally sensitive areas of sea bed in the Lough, being swept by such fast currents and close to the sewage outfall. It is also the favoured of the two proposed locations by the Maritime & Coastguard Agency and the Commissioner for Irish Lights from a navigational and maritime safety perspective.

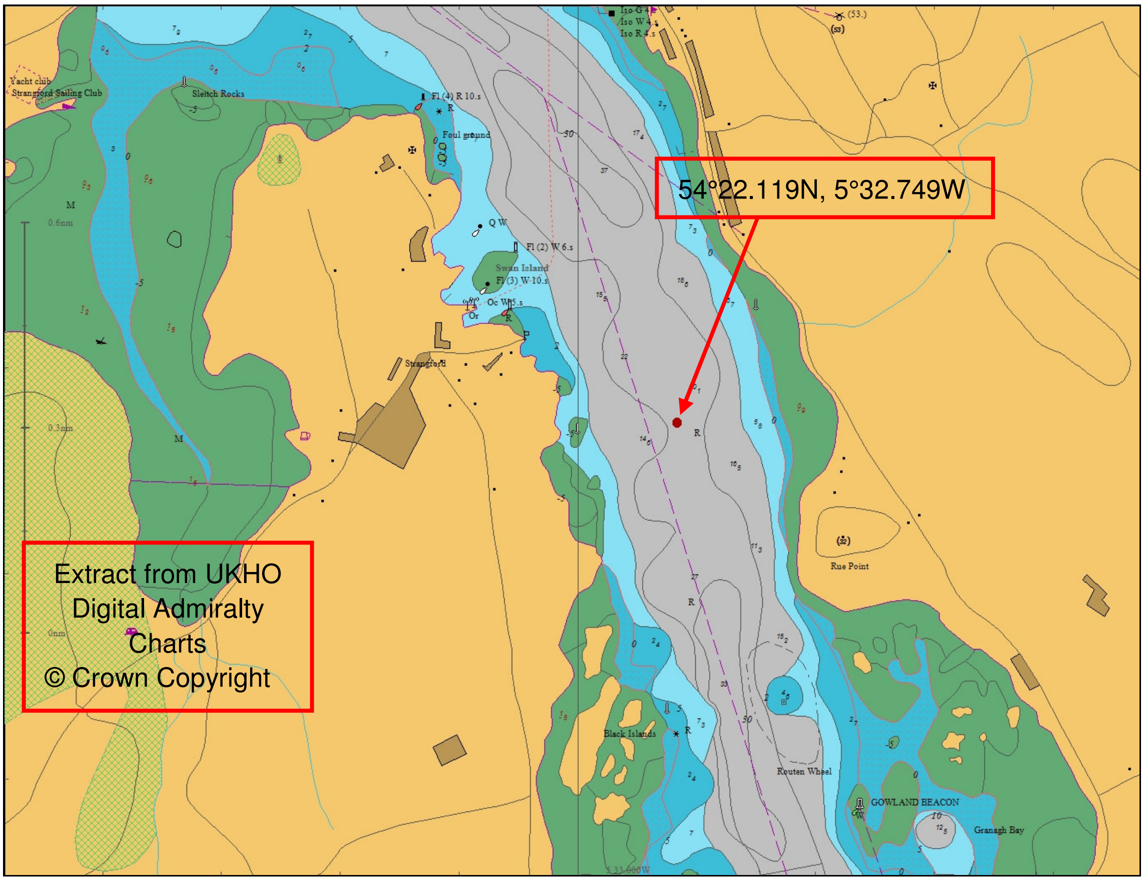


Figure 2.1 Map showing preferred location for turbine

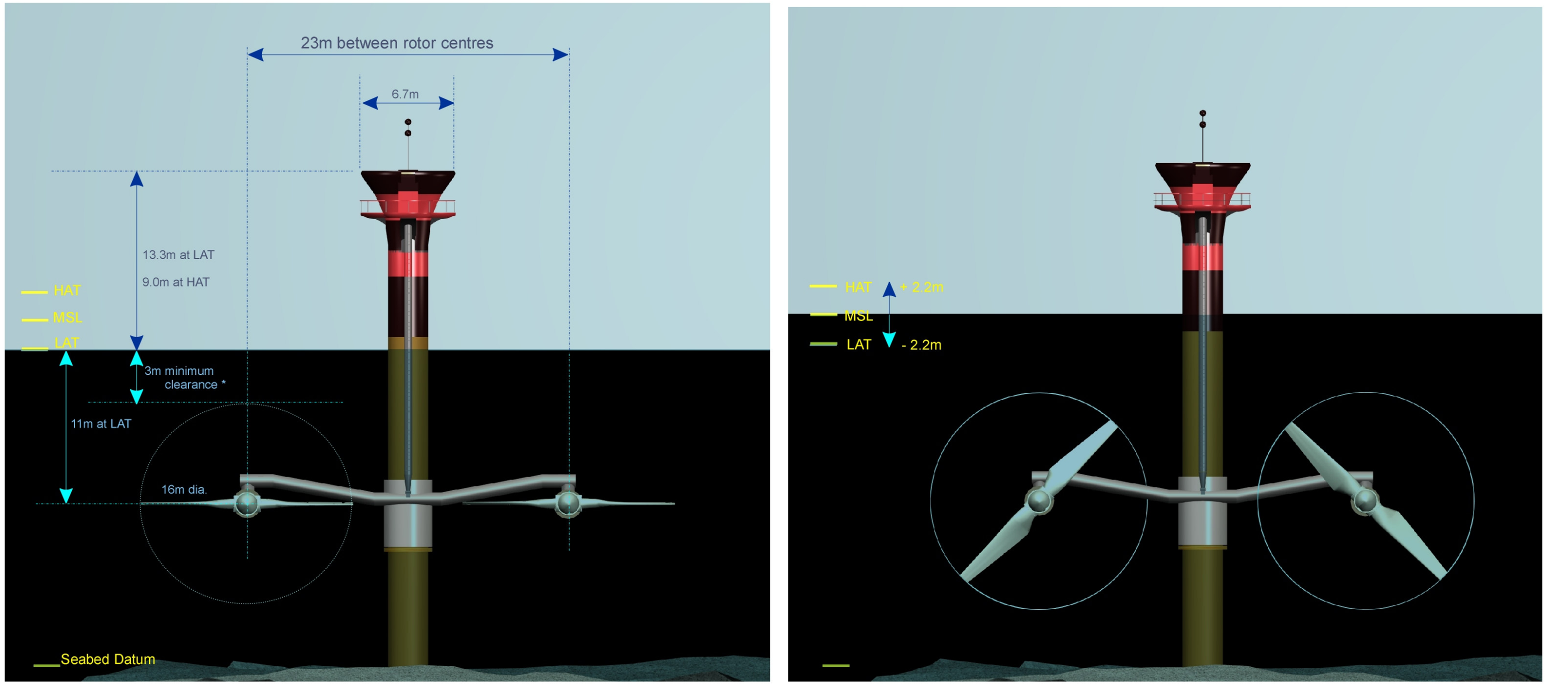
Location provided in decimal latitude & longitude to WGS84 map datum

2.3 Turbine design

The proposed turbine for installation in Strangford Narrows will comprise a twin rotor machine consisting of a central monopile with two 16m diameter rotors mounted on either side as illustrated in Figure 2.2, which indicates the proposed structure at lowest astronomical tide and mean sea level and the dimensions of the Seagen turbine.

SEAGEN GEOMETRY AT L.A.T.

SEAGEN GEOMETRY AT M.S.L.



Note: LAT coincides with slack tide so the system will generally be parked as indicated. However there is 3m clearance to the top of the rotor at LAT

Figure 2.2 Comparative positions of the twin turbine in operational position at LAT and MSL

2.4 Installation

The basic approach used in the construction of the experimental marine current turbine (Seaflow) off Lynmouth, Devon, will be employed in Strangford and is summarised below. A more detailed description of the installation procedure is provided in Appendix 2 of this report.

A simplified sequence of the operations that are to be undertaken to enable the construction of the turbine will be as follows:

- Design and procure all temporary works elements required by MCT design;
- Provide plant and equipment to undertake construction works;
- Load jack up barge 'Excalibur' with drill spread and required temporary works and tow to site;
- Lower sacrificial shoe to seabed and advance to bedrock, install rock socket to full depth as required;
- Float pile and tow to jack up location, buoyant lift pile into vertical elevation
- Deliver pile to socket location confine within pile gates and lower into socket to final level;
- Grout pile into place within rock socket;
- Lower transformer platforms into pile;
- Fit collar/crossbeam onto pile and temporary lock into place;
- Install pod frame to top of pile;
- Install lift and access legs through frame and attach to collar;
- Fit pod onto pod frame;
- Connect umbilicals from lift leg to pod;
- Connect umbilicals from lift leg to drive trains;
- Connect mains supply cable from shore into pile;
- Install drive trains to cross beam;
- Fit ancillaries to pod – navigation requirements etc.; and
- Demobilise construction plant.

The drilling of the hole for the monopile and the installation of the turbine will be undertaken from a large mobile platform known as a jack-up barge (see Figure 2.3). The type of jack-up that is needed for the planned installation is an 8 legged vessel measuring 60m x 32m. The barge will be manoeuvred into position using tugs and will drop its legs at slack tide so that it stands on the sea bed over the final drilling position; to be determined through survey work. Based on experience from use of the jack-up barge during site investigations it is not anticipated that there will be a requirement to re-position the barge in order to obtain the final drilling position, although this possibility should not be discounted.

Installation of the vertical monopile involves drilling a hole 3.1-3.25m in diameter by 15-20m in depth. It is possible that a very brief (15 minute) period of hammering will be required using a PTC vibratory hammer Type 175HD to guide the drill casing into place. However this is considered very unlikely (Seacore *pers comm*).

Monopile drilling will take a total of approximately 28 hours, including occasional breaks to add extensions to the drill string. Reverse circulation drilling will be used and the cuttings sucked up through a central pipe where they are mixed with seawater. The resulting mixture will be settled through a series of tanks aboard the jack-up barge to remove cuttings over 3.5mm diameter and the fines will be released back into the current for dispersion. A total of approximately 200t is expected to be released into the water, with a further 200t removed and disposed of on land (Seacore *pers comm*). It is hoped that this material can be reused, e.g. in local road schemes, but if not it will be put to landfill. The flushing material to be used for the drilling process is solely seawater, so there is no possibility of drilling fluid contamination during the drilling process.

Figure 2.3 Seacore's "Excalibur" jack-up barge which is most likely to be used in the installation of the marine current turbine

The final part of the drilling process leaves a steel cylindrical casing in the top part of the hole, projecting about 1m above the sea bed to prevent the current from sweeping debris into the hole and filling it up before the pile can be installed.

The monopile is then floated into position and presented to the jack-up, from where it will be picked up by the on-board crane ready for insertion into the drilled hole (Figure 2.4) through the shield. This operation needs to take place during slack water and involves the pile being raised vertically and then lowered by crane into the hole. The pile is filled with seawater in order to sink it effectively into the hole. Once in place, the annulus surrounding the pile is filled with cement based polymer grout with anti washout properties (CMS Pozament BC82P or a similar blended ordinary Portland Cement and pulverised fuel ash mix – see Appendix 2 for material sheets).

The grout will be pumped into the void at the base of the pile through grout tubes which are incorporated internally into the monopile. The process of evenly filling the annular void between the pile and its surrounding socket is carefully monitored and is applied to a precisely defined cavity volume to ensure even application of the grout material and to avoid over usage resulting in any significant quantity washing away into the surrounding environment. Normal procedures involve 'overspilling' the grout to create a hard shoe around the pile base, but in this case it has been decided to avoid this process and to fill the cavity to only the level of the top of the outer casing (Seacore *pers comm*). This grouting procedure can be expected to take 6-12 hours.

Figure 2.4 Installation of the monopile for the Seaflow marine current turbine off Foreland Point near Lynmouth

Following initial setting of the grout, the turbine and associated components are then installed on the pile. The jack-up rig will remain on site during the commissioning and testing process to ensure that the turbine is fully operational. The total construction process would be expected to last up to one month.

A geological site investigation was carried out to inform the final design of the monopile and the size of the socket required for the single pile support. Further information on the geological conditions under the Narrows is provided in Section 7.2. This work was subject to a separate site investigation Environmental Assessment (Royal Haskoning, 2004a). The results of geotechnical investigations into conditions in the Narrows are provided in Appendix 4 and a summary of post-site investigation work sea bed surveys is provided in Appendix 5.

2.5 Cable connection

Connecting the turbine to the national electricity grid is a significant issue for any renewable energy project. For a small demonstration project such as this, connection to the grid is a highly significant location and project cost factor. Moreover, cable laying and grid connection also have potential environmental impacts, so a shorter connection distance has the potential to decrease the associated residual impacts. A number of issues arise which need to be taken into account in determining the route and technique for installing the sea to shore electricity cable. In this case several options to address the issues were assessed based on environmental, technical and economic grounds.

Two primary techniques were considered for cable installation; direct laying of a cable on the sea bed and the use of directional drilling. The principle considerations are summarised below.

A cable laid directly on the sea bed in the proposed area of Strangford Narrows would be particularly vulnerable to movement or impact from strong currents or the movement of coarse sediment and rocks along the sea bed. Additionally, the area is a busy recreational boating area and is fished by creel fishermen. A cable fixed directly to the sea bed in this area may pose an entanglement risk to other Lough users, may be vulnerable to physical damage from anchors or fishing gear and would also be likely to have a greater impact on the benthic ecology.

The options of trenching the cable into the bedrock or covering the cable in a protective blanket of articulated concrete material were considered and discounted, primarily on environmental grounds, as the potential impact of these techniques on the benthic communities within the Strangford Lough SCI was considered to be significant. Alongside this, the cost considerations of trenching or covering the cable were sufficient to rule out these options.

Directional drilling from above the high water mark through the underlying rock strata was therefore investigated. This method would allow the cable to emerge within a few metres of the monopile and is considered to offer the best practicable environmental solution. A full method statement has been prepared by the preferred sub-contractor for the directional drilling process and this is provided in Appendix 3. In brief the method will be as follows:

- Set-up a working area ashore and build pipe string (cable duct);
- Drill a hole from location near Sewage Farm to exit point near foundation of Current Turbine, approximately 500m with a 180mm diameter;
- Pull the cable duct into drilled hole utilising winch onboard Seacore jack-up platform;
- Connect the cable duct with J-tube conduit inside the pile;
- Pull the power cable into cable duct utilising winch onboard Seacore jack-up platform; and
- Secure the cable duct between exit point drilling and entry J-tube to seabed.

The drilling fluid chosen for use with the directional drilling will be either Salt Water Drilling Clay (SWDC) or Biodegradable Drilling Fluid (BDF – a composition of the polymers Xantham Gum (MC Zan XT/TN) and MC DS HV). Both of these water-based muds are considered non-toxic, and full Material Safety Data Sheets are provided in Appendix 3. A final choice on which mud to use will be made nearer the engineering phase, but any impact of either option will be limited to the physical (smothering) effect from the mud. This mud will be mixed with sea water abstracted from the Narrows and used to remove cuttings during the drilling process. The drilling fluid will be passed through a recycling unit on shore and virtually all solids removed (Visser Smit *pers comm*). The volume of water required will approximately 50m^3 per day.

When the drill breaks through the sea bed near the monopile location the volume of mud and seawater mixture released is expected to be 1-2m^3. There will be a further release of around 25m^3 comprising a mixture of approximately 2t of mud and 23m^3 seawater as the drilled hole is cleared and filled by the cable and its housing.

The cable duct to be fed along the drilled hole will be laid out along the A2 road for 500m heading east although no impact on the A2 traffic flow is expected (Visser Smite Hanab *pers comm*), which has the potential to involve temporary closure or restrictions to traffic entering the Sewage Treatment Works. A total compound area of 40x60m will be required, which will involve the removal of topsoil. This will be stored and reinstated immediately on completion of the drilling activities.

Directional drilling methods provide the opportunity to significantly reduce the risk of damaging adjacent biotopes during installation of the cable as the alternative options would involve ploughing, open cut dredging or laying a cable over the bed, thereby losing an area of habitat. Impacts that may arise from dispersion of sediments arising from the drilling process on water quality and fisheries, and the possible smothering of sensitive benthic fauna and flora are considered in Section 7.

2.6 Scheme operation

The Seagen system is planned to be operated in Strangford Lough for a minimum of 2 years and a maximum of 5 years. During the operation period the system will be operated and maintained in the following phases. An outline Gantt chart providing expected timings for all phases of the commissioning programme is provided in Appendix 6:

2.6.1 Commissioning phase

Once the system has been installed, it will be subjected to a short commissioning phase which is planned to last up to 6 weeks. During this phase the system will be subjected to various sub system trials, which include:

- Raising and lowering the generators and turbines to the surface;
- Diver assessment to evaluate the sea bed condition in the area of jack up operations post installation;
- Visual inspection of pile and turbine components to ensure that they were not damaged during the installation phase;
- Electrical operational checks;

- Commissioning and installation of shore side monitoring and control systems;
- Verification of calibration of instrumentation;
- Grid connectivity tests; and
- Initial operation of the system.

During this phase of testing, the system will be manned daily, where transfers will take place via a Rigid Inflatable Boat (RIB) from Portaferry. During all operations with the system manned, the safety boat will be available for rapid egress of the crew. The RIB will also be on site during all maintenance operations to provide assistance in the event of any navigation problems. This follows from the practice adopted for operations off Lynmouth. The system will only operate in sufficient tidal flows as illustrated in Figure 2.5.

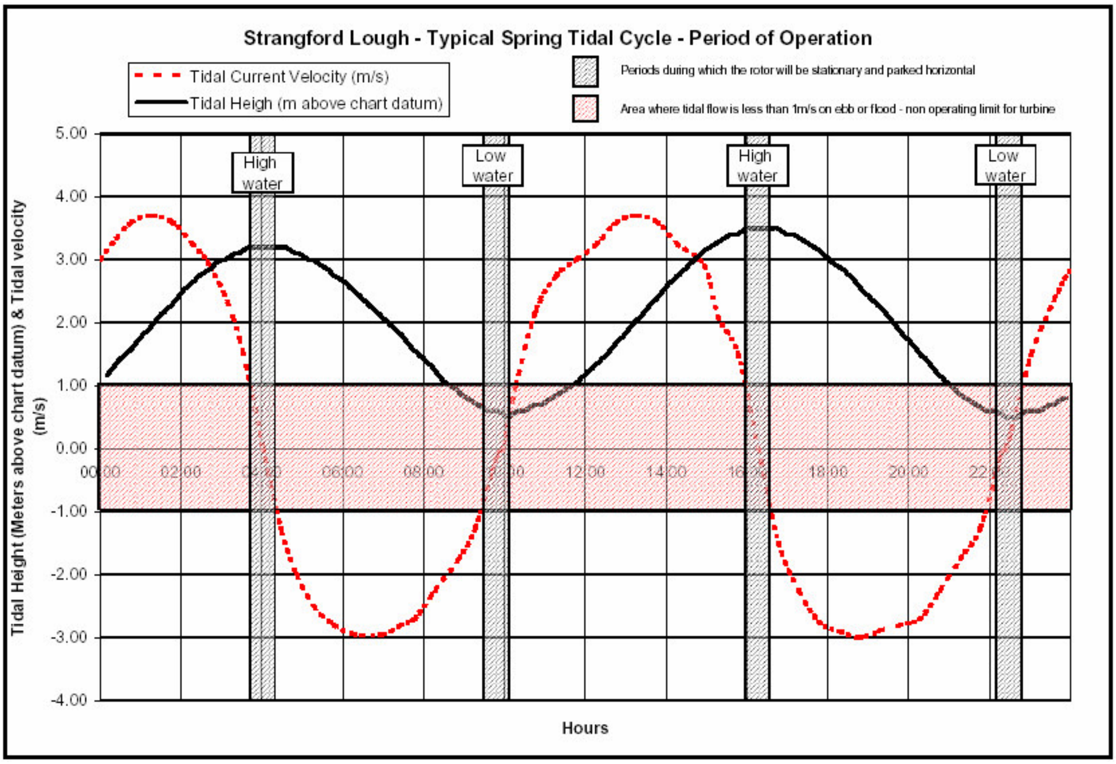


Figure 2.5 Predicted operation period of Seagen over a typical spring tidal cycle

It is proposed that a trained observer on platform for initial operating periods and to be retained until lack of observations or other evidence makes further continuous observations are no longer necessary, especially while the system is novel for local seals, who are likely to be curious about new features.

Throughout the commissioning phase the system will only be operated when personnel are present on the system even when in automatic mode. Even during the period where the remote or automatic mode of operation is being first tested (24 hour operation in Appendix 6) personnel will be present on the structure to ensure that the systems are operating correctly and to monitor the instrumentation.

From experience gained to date on the Seaflow system in Lynmouth, it is clear that there will not be a requirement for applying additional anti-fouling materials to the system *in situ*. The system will be anti-fouled during the manufacturing cycle and further treatments on site will not be necessary during the proposed installation period of 2-5 years.

The preferred antifoul for this project is a Teflon-based product that is non-leaching and works through physical properties as opposed to the presence of biocides.

A full environmental management plan for the operational phase of the turbine will be developed and agreed with the relevant regulators following submission of this ES once suitable contractors have been identified to carry out all technical operations.

2.6.2 Initial test programme

On completion of the commissioning phase and MCT's own testing, the Seagen system will undergo independent characterisation and type approval testing to verify performance. This work will be conducted in association with Queens University Belfast (QUB) and potentially the European Marine Energy Centre (EMEC), subject to agreement, and is currently proposed to be set up with Government support.

This schedule of work is expected to take up to 6 months, working alongside the proposed strategic environmental monitoring programme, and includes verification of the following:

- Optimisation of control system;
- Validation of the energy provided to the electrical grid;
- Validation of the energy extracted from the tidal stream;
- Key performance parameters of the system (coefficient of performance etc.); and
- Validation of performance predictions.

Most of this work will be conducted remotely from the control room that will be accommodated in the QUB Marine Research Centre in Portaferry.

The testing will necessitate the deployment of Acoustic Doppler Current Profiling (ADCP) meters upstream and downstream of the system, to measure the profile of the currents in real time through the entire water column. This is identical to the deployment methodology used during the Strangford Narrows tidal survey work conducted in the summer of 2004.

Based on the experience with Seaflow and the design of the Seagen machine, it is not expected that there will be a requirement to change any oils, hydraulic fluids and antifoulants during this phase of the project. During this phase the system may initially be started and shut down manually from the QUB control location or by an operator on the system itself. Towards the end of the initial test programme, fully automatic 24 hour operation may be implemented.

Seagen will be fitted with alarms that are triggered by any detectable faults on the SCADA (Supervisory Control and Data Acquisition) system and will shut down automatically should a fault arise. The SCADA system will then automatically communicate with the field support team to inform them of the system status. During automated operation the system will also be monitored by both MCT personnel and, it is proposed, site supervision personnel who will be on 24 hour call and capable of shutting the system down remotely (the expected surveillance provider is a local company based nearby in Larne with an international reputation for successfully monitoring renewable energy projects of all kinds in many parts of the world). In most cases any faults will be picked up by sensors built into the system and they will cause an automatic shut-down to take place. In the unlikely event that the system needs to be stopped in an emergency for a reason other than an automatically detectable fault this will be initiated through a 24 hour response telephone number and implemented remotely by B9 or MCT personnel.

2.6.3 Extended operation

Once the system has been characterised and deemed sufficiently reliable for continuous operation, it will then be put in fully automatic mode and run under all suitable tidal conditions 24 hours a day. The system will be continuously remotely monitored by both B9 (Larne) and MCT (Bristol), with a further monitoring facility at the MCT control room located in the QUB Portaferry Marine Research Centre. It will also be monitored by Northern Ireland Electricity who will be distributing the power produced.

After the system has met the project objectives and has been in place for sufficient duration to demonstrate reliability suitable for commercial application (expected to be between 2 and 5 years), the system can be decommissioned and the monopile will be removed completely from just below sea bed level.

2.6.4 Decommissioning process

The following process is envisaged for the decommissioning:

- The rotors and gearboxes will be removed using a multicat or similar small self-propelled barge prior to the jack up vessel entering the Narrows of Strangford Lough;
- The electrical grid will be disconnected at the substation and the system isolated electrically;
- All loose components that can be removed from the system by a small work boat or RIB will be taken ashore;
- The components and control room on top of the pile will be prepared for removal;
- A jack up barge will enter the Lough and position itself adjacent to the Seagen;
- The jack up barge will remove the Seagen control room, upper deck and other components and place it on the jack up’s deck;
- The jack up barge will remove the cross beam and place it on the jack up's deck;
- The jack up barge will support the weight of the pile with the crane;
- A operator will be lowered down the inside of the panel to attach a high pressure water cutting jet cutting device with the capacity to cut through steel;

- The pile will then be severed just below the sea bed surface (0.7 to 1.0m) with the remote controlled water jet cutting device;
- The jack up barge will then remove the pile;
- A diver will position a cap on the remnant of the pile below the sea bed level and the small volume left to sea bed will be allowed to backfill;
- The power cable to the system routed through the sea bed will either be terminated close to or below the sea bed surface, or if possible pulled back through the directionally drilled hole;
- The directionally drilled hole will be capped and sealed at the sewage farm end and allowed to naturally infill at the system end; and
- The substation will be dismantled and the affected area restored to its previous condition.

The decommissioning process will not involve the introduction of any construction materials into Strangford Narrows.

3 THE ENVIRONMENTAL ASSESSMENT PROCESS

This section should be read in conjunction with Appendix 7 and 8.

3.1 Environmental Impact Assessment

Environmental Impact Assessment (EIA) is a tool for systematically examining and assessing the impact and effects of a proposed development on the environment. The resulting Environmental Impact Statement (ES) typically contains the following information:

- A description of the **development proposal** and any alternative development options considered;
- A description of the **baseline** environment into which the development will be introduced;
- Prediction of **impacts** on that baseline and assessment of significance of subsequent effects.
- Prescription of **mitigation** measures to avoid, reduce or remedy such effects.
- A Non-Technical Summary (NTS).

In terms of the process, the following stages are typically included in EIA:

- Screening (i.e. determining whether a development proposal needs an EIA).
- Scoping (i.e. determining the issues that the EIA should address).
- Preparing an Environmental Impact Statement (i.e. establishing baseline data, evaluating impacts etc.).
- Submitting an ES and consulting the public and affected parties for their views.
- Reviewing and evaluating the ES to ensure it contains specified information.
- Deciding whether the development proposal should proceed.

In this case, following the preparation of a scoping report (Royal Haskoning, 2004b) the potential environmental impacts associated with the proposed deployment of marine current turbines in Strangford Lough were identified and a preliminary assessment carried out of those issues where it was considered that enough information existed. This assessment comprised a combination of consultation, data collection, site survey, experience of previous renewable energy projects, modelling, comparison with accepted standards and guidelines and review. This was an interim submission, and has been augmented and superseded by further development of this final ES as a result of feedback from stakeholders, regulators and advice from key experts in the areas highlighted through consultation as being of concern.

Table 3.1 summarises the approach taken by identifying a number of consecutive stages in the process.

Table 3.1 Summary of EIA methodology

Stage	Task	Aim/Objective	Work/Output (examples)
Scoping study	Scoping	To identify the potentially significant effects of the proposals (onsite and in the adjoining area).	Preliminary consultation with key consultees. Targets for specialist studies (e.g. noise, marine ecology).
EIA	Consultation	Consult with statutory and non-statutory organisations with an interest in the area.	Local knowledge and information.
	Primary data collection	To identify the baseline/ambient/background/ existing environment.	Biological surveys, archaeological studies, etc.
	Specialist studies	To further investigate those environmental parameters which may be subject to potentially significant effects.	Specialist report on the hydrodynamic and sedimentary regime.
	Impact assessment	To evaluate the baseline environment in terms of sensitivity To evaluate and predict the impact (i.e. magnitude) upon the baseline To assess the resultant effects of the above impacts (i.e. determine significance).	Series of significant adverse and beneficial impacts.
	Mitigation measures	To identify appropriate and practicable mitigation measures and enhancement measures.	The provision of solutions to adverse impacts. Feedback into the design process, as applicable.
	Environmental Statement (ES)	Production of the ES in accordance with the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 1999 (SR No. 73).	Environmental Statement

3.2 Identification of impacts

The potential environmental impacts identified associated with the construction, operational and decommissioning phases of the project were identified through:

- Observations on site;
- A review of the existing and survey data;
- Referral to key information sources; and
- Consultation with Regulators, stakeholders and the community through dissemination of the Scoping document and discussions with the relevant groups.

The potential impacts identified were then examined for their effect in the short term (up to 2 years), medium term (2 to 5 years) and long term (5 to 50 years). Medium-term and long-term impacts are identified as post-construction impacts, and it must be noted that the temporary nature of this proposal generally limits the impacts to the medium term.

3.3 Impact evaluation

An impact is determined based on the existing baseline environment and the alteration of any physical, chemical, biological or perceived characteristics of that environment. Where possible, beneficial and adverse impacts have been evaluated based on their potential scale/magnitude, longevity and significance. Where potential adverse impacts are identified, methods or actions to reduce or alleviate that impact are introduced.

Following the inclusion of mitigation, the impact is reassessed to determine the scale and magnitude of the impact (the 'residual impact'). The residual impact is that which is predicted to occur in the 'real life' scenario. Where mitigation measures are described, their implementation is the responsibility of the 'developer' and, in this case, MCT have committed to them explicitly in the form of a strategic environmental monitoring programme. Where impacts are considered to be irreversible, these have also been identified. Impacts have been split into those likely to arise during the construction, operation and decommissioning phases. Turbine construction and decommissioning phases consist of activities that are considered sufficiently similar to be considered in the same assessment, and this protocol has been followed throughout the impact assessment process.

Each impact is considered using the following criteria:

- Magnitude - the area/number of receptors to be affected by the impact within the local and regional context; and
- Duration - whether the impact is short-term or permanent.

3.4 Impact characteristics

Following the description of the impact, it can then be characterised in terms of its nature and magnitude or physical extent. In this ES the magnitude or physical extent of impacts has been quantified wherever possible. The nature of predicted impacts has been identified and described, as appropriate, using the following terms:

- Beneficial or adverse.
- Direct or indirect.
- Short, medium or long-term.
- Permanent or temporary.
- Reversible or irreversible.
- Cumulative (or *in combination* for features of European sites).

Where an impact can be quantified, thresholds are applied to determine the significance of an impact, unless otherwise stated. However, these thresholds are widely variable depending on the characteristic of the impact, for example an impact that is irreversible will have a far greater significance than an impact that is reversible, regardless of its magnitude. The area of search is defined as the whole of Strangford Lough unless stated otherwise, and the thresholds applied in this ES are:

- Negligible/indeterminable <1% of population/asset/resource
- Minor 1% to 5% of population/asset/resource
- Moderate 5% to 20% of population/asset/resource
- Major >20% of population/asset/resource

Where an impact cannot be quantified because of the nature or complexity of the impact, a subjective scale is used to determine its significance. Where qualitative descriptions of significance have been used, they have been defined and any uncertainty has been identified. The impact assessment seeks to classify the significance of qualitative effects on a seven point scale (from major adverse to major benefit). The magnitude of each proposed impact is compared with the sensitivity/recoverablity of the area and the importance of the individual assets. The magnitude of impact is characterised as high, medium or low for both adverse and beneficial impacts. The sensitivity of the features to proposed impacts is characterised on a five-point scale from very high to low. Table 3.2 presents the impact significance characterisation.

Table 3.2 Derivation of significance criteria from magnitude/value comparisons

Magnitude of Effects	**Receptor Sensitivity/Value of Feature**				
	Very High/ International /National	**High/ Regional/ County**	**Medium/ District**	**Low/ Local**	**Very Low/ Site-Specific**
High	Major	Major	Major	Moderate	Minor
Medium	Major	Major or Moderate	Moderate	Minor	Minor
Low	Moderate	Moderate or Minor	Minor	Minor or None	None

The basic definitions of significance (major, moderate and minor) are defined in Table 3.3.

In general terms, throughout the following sections it is assumed, unless otherwise stated, that impacts are:

- Short-term during the construction phase (i.e. 24 months).
- Long-term during the operational phase.
- Local rather than regional.
- Potentially reversible rather than irreversible.

Table 3.3 Terminology for classifying and defining environmental impacts

Impact	Definition
Negligible	The impact is not of concern
Minor adverse	The impact is undesirable but of limited concern
Moderate adverse	The impact gives rise to some concern but it is likely to be tolerable (depending on its scale and duration)
Major adverse	The impact gives rise to serious concern; it should be considered as unacceptable
Minor beneficial	The impact is of minor significance but has some environmental benefit
Moderate beneficial	The impact provides some gain to the environment
Major beneficial	The impact provides a significant positive gain

Where potentially significant adverse impacts have been identified, mitigating measures have been examined and recommended in order to reduce residual impacts, as far as possible, to environmentally acceptable levels.

The potential impacts on features protected under European legislation have also been considered and relevant information provided to inform any appropriate assessment of the likely effects on integrity of these features arising from the project.

3.5 Consultation

Consultation is an essential part of the EIA process. It is well understood and acknowledged that a well considered and implemented Consultation Strategy initiated at the start of EIA process is a vital tool in the successful development of a project. To this end Royal Haskoning and MCT have conducted extensive consultation, the primary aim of which being to inform, engage and resolve.

A list of stakeholders consulted during the scoping and ongoing environmental assessment phase of this project is included in Appendix 7.

Initial consultation was carried out based on the Environmental Scoping Report (Royal Haskoning, 2004b) and included formal and informal consultation with statutory consultees, local interest groups and interested parties, such as non-government organisations. Consultation identified a wide variety of relevant issues both directly and indirectly related to the proposal, including discussions over cable laying methodology and sediment transport.

3.6 Cumulative impacts

Cumulative impacts may arise from a combination of the effects of the proposed development and other projects. The proximity, nature and timing of initiatives need to be considered in the assessment of cumulative impacts. Other activities likely to be relevant in this case include existing marine activities such as fishing and navigation.

Key cumulative impacts which are likely to require assessment include:

- Physical obstacle and displacement effects on sea users, including fishermen and commercial and recreational navigation;
- Alterations to local hydrodynamics and sediment transport regimes;
- Effect on mobile marine fauna (e.g. mammals, larger fish); and
- Effect on the benthos.

These effects are considered further in Sections 7 and 8, and are not necessarily the same as *in combination* effects relating to features of European importance.

3.7 Monitoring

Where elements of uncertainly remain regarding impacts predicted through the EIA process a monitoring programme and period of review will be required. Environmental parameters which require construction or operational monitoring programmes are discussed in detail in Section 8.

A full Strategic Environmental Monitoring Programme has been developed in discussion with the relevant regulatory authorities in support of this proposal. This has been provided to these authorities and relevant non-governmental organisations for consultation. The monitoring programme is presented in Appendix 8. The monitoring programme should be regarded as under constant review, and this review is likely to continue into the commissioning phase of Seagen as more is learnt about the technology and its interaction with key ecological and wildlife features, then fed back into the monitoring and operational management process.

It is recognised that these monitoring commitments may become subsequent consent conditions. Whilst there is little scope for this option under the legislation regulating construction activities on the sea bed (Food and Environment Protection Act 1985 – FEPA) it may be possible that such conditions could form part of the sea bed lease required from The Crown Estate.

3.8 Mitigation measures

EC publication 'Managing Natura 2000 sites: the provisions of Article 6 of 'The Habitats' Directive 92/43/EEC' states:

> *As regards mitigation measures, these are measures aimed at minimising or even cancelling the negative impact of a plan or project, during or after its completion. Mitigation measures are an integral part of the specifications of a plan or project. They may be proposed by the plan or project proponent and/or required by the competent national authorities.*

Where appropriate and technically feasible, measures have been proposed in order to mitigate any negative impacts identified through the EIA process. These are mainly measures that will be in place during construction or commissioning and operation of Seagen. However, it is also proposed that an adaptive management approach will be taken to mitigation, involving the use of post-installation monitoring to inform ongoing management in a mitigatory feedback system.

4 SCOPING AND CONSULTATION

This section should be read in conjunction with Appendix 9 and 10.

4.1 Scoping

A scoping document was produced in June 2004 (Royal Haskoning, 2004b) and identified the range of potential impacts that might be anticipated as a result of installation and operation of the turbine. This is provided formed the basis of the impact assessment process alongside issues raised in consultation with key bodies such as EHS.

A summary of the issues raised during the scoping phase is provided in relation to the both the construction and operational phases is provided in Appendix 9. These issues have been considered in detail since the scoping phase and information on each issue is provided in this ES. Each additional report or work carried out in support of this proposal is provided as an Appendix to this ES.

4.2 Consultation

Extensive consultation has been carried out with statutory and non-statutory stakeholders, in particular with EHS Natural Heritage and Water Management Unit departments. Two key responses from EHS have been received which have influenced the content of this ES. These are the original scoping letter provided in October 2004 and comments on a preliminary ES submitted in February 2005 further to agreement with EHS that an initial view should be available before completion of the final ES. Relevant correspondence is provided in Appendix 10.

5 PLANS AND POLICIES

This section should be read in conjunction with Appendix 8.

5.1 Northern Ireland Energy Policy Framework

In 1991 the UK Government set out proposals for the restructuring of the electricity supply network in Northern Ireland. Through this the electricity supply industry was returned to private ownership and a system of competition was introduced. This involved moving away from Northern Ireland Electricity (a state owned vertically integrated national utility company) by privatising power stations and forming three individual companies. The remaining transmission and distribution portion of Northern Ireland Electricity was sold to shareholders intact in 1993. Electricity generation is reliant on four power stations at Ballylumford (owned by Premier Power Ltd), Kilroot, Belfast West (both owned by Nigen) and Coolkeeragh (in private ownership and management).

The Northern Ireland electricity supply system is regulated by the Electricity (NI) Order 1992 through licenses issued under the Order. Through the licensing system a framework for competition in supply and generation is provided which ensures security of supply, technical integrity of the electricity system, types of customer services and professional behaviour of licensees. Such licenses are currently only required for installations with output greater than 1MW. The Office for the Regulation of Electricity and Gas (OFREG) has been appointed by the UK Government to monitor compliance with licenses.

The energy sector as a whole faces many challenges in Northern Ireland and is considerably different from the situation ten years ago. The challenges include:

- bringing electricity prices down a level comparable with other parts of the UK and EU;
- opening the market for both gas and electricity to improve competition and prices;
- creating a diversity of energy sources and ensuring security of supply; and
- reducing emissions and introducing efficiency in relation to power generation and consumption.

The Strategic Energy Framework for Northern Ireland (2004) states that responding to the many and varied energy challenges ahead and minimising cost increases for consumers will be a key priority in the years to come. During the next three years the electricity industry will be exposed to increased competition in supply, which will result in more choice and reductions in cost over the long term. The electricity market is 36% open to competition with approximately 1000 large electricity consumers being in a position to shop around for supplies. With the recent EU Electricity Directive 2003/54/EC, the Northern Ireland electricity market as of 2004 is open to all non-domestic customers; however, full customer choice should be available by 2007.

5.2 Renewable energy in Northern Ireland

The renewable energy policy in Northern Ireland falls in line with that of the UK. Renewable energy is seen as making an increasing contribution to UK energy supplies and will assist the UK in meeting international and national targets for the reduction of greenhouse gas emissions. Consequently, targets have been set for 5% of licensed electricity to be produced from renewable sources by 2005 and 10% by 2010. Northern Ireland will contribute to reaching theses targets.

In 1992 the Department of Economic Development in Northern Ireland published a document entitled 'Energy in the 90's and beyond' which sets out a series of objectives. In particular, energy efficiency, clean production and use of energy, and diversification of supply coupled with the development of commercially viable renewable resources in Northern Ireland were considered to be crucial.

In 1999, a review of the Northern Ireland economy by the Economic Development Strategy Review Steering Group produced a document entitled 'Strategy 2010'. Within the strategy reference was made to developing an isle of Ireland energy market with targets for the utilisation of non-fossil fuels for electricity generation purposes. Through this a response was produced called 'Vision 2010 – Energy Action Plan'. It outlined that there would be consultation about sustained promotion of renewable energy after the UK National Review of New and Renewable Energy. It also made reference to renewable energy opening up business opportunities and improving regional economic prosperity.

In Northern Ireland, electricity from renewable sources is supplied to the grid via the Northern Ireland Non-Fossil Fuel Order and Northern Ireland Electricity plc's Eco Energy arrangements.

5.2.1 The Northern Ireland Non-Fossil Fuel Obligation (NFFO) Order

This was established as part of the 1989 Electricity Act. Originally the non fossil fuel levy was used to support the nuclear industry, however, in 1998 the subsidy stopped. The levy was continued and diverted to the development of renewable energy technology.

In 2000 the Government stated that there would be no further NFFO orders and that with future supporting arrangements there will be an obligation on electricity suppliers to contract (or 'buy-out' their obligation to contract) an increasing percentage of electricity from renewable sources. The Renewables Obligation will see 10% of the UK's electricity supply being met from renewable sources by 2010. In Northern Ireland, a target of at least 3% of total energy consumption by 2005 from renewables has been set in the immediate term. Through this, electricity supply companies are able to secure specified amounts of new generating capacity from non-fossil sources, which includes renewables. The renewables capacity is secured through contracts with renewable companies at premium rates. Electricity is sold under Northern Ireland's Non Fossil Fuel Obligation arrangements in which the UK government invites companies to bid for a long term contract to generate energy from renewable sources. Through this, the price is enhanced to encourage the development of new technologies.

The latest Northern Irish proposals are that legislation enabling Renewables Obligation Certificates (ROCs) will be effective in Northern Ireland from 1 April 2005. According to the Department for Enterprise, Trade and Investment Northern Ireland it is anticipated that this will result in the first ROCs from May 2005.

5.2.2 NIE's Eco Energy tariff

This tariff was introduced in October 1998 and offers consumers the opportunity to buy electricity produced through renewable energy technology. NIE is committed to matching Eco Energy users' consumption through providing an equal supply of 'green' electricity into the national grid. At present, consumers have options on the level of electricity supplied from renewable sources. The uptake of the Eco Energy Tariff incurs slightly higher average costs, however, the level of private consumers, businesses and public sectors institutions utilising this option is increasing and NIE have set a target of 25GWh per annum by 2005 under the current arrangements.

5.3 Licensing in the Strangford Lough marine environment

Under Northern Irish legislation, the development requires a FEPA (Part II) license from the Department of Environment (DoE) through EHS and consent to discharge aqueous effluent arising from the pile drilling process during construction, also from EHS, issued under the Water (Northern Ireland) Order 1999. At the time of writing it is understood that Electricity (Northern Ireland) Order 1992 may be under review and a separate license may be required in the future under this piece of legislation (see Section 5.1).

In light of the environmental significance and maritime uses in Strangford Lough, this project will have to take into consideration all relevant environmental and public health issues. As the licensing authority for Northern Ireland under the Food and Environment Protection Act, Part II, EHS will have regard to the following for licensing purpose:

FEPA Part II, section 8 (1):

> "…to protect the marine environment, the living resources it supports, human health: and to prevent interference with legitimate uses of the sea; and may have regard to other such matters as the authority considers relevant".

5.4 Sea bed lease

The sea bed in UK waters out to the 12nm limit is owned by the Crown, and its use is subject to obtaining a formal legal agreement from the Crown Estate. This agreement can contain any clauses deemed appropriate by the Crown Estate, and these conditions are often the subject of consultation with regulators and advisors. The novel nature of this proposal and its location within a European protected site means that there is little precedent on which to base any lease, as the issues raised have proved different to even those of the recent increase in development of offshore windfarms.

5.5 Strangford Lough environmental designations

Strangford Lough has various environmental designations in and around its area of geographical coverage. These will have to be borne in mind in relation to an application for a FEPA license. The following relate to the Lough:

5.5.1 Special Areas of Conservation

Special Areas of Conservation (SACs) are identified under the Conservation (Nature Habitats, etc.) Regulations (Northern Ireland) 1995 as amended (referred to as "the Habitats Regulations" throughout this report). SACs are protected sites under the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora ("the Habitats Directive") and form part of a network of important, high value conservation sites which contain species or habitats listed in Annex I or Annex II of the Directive. Northern Ireland now has 52 designated SACs, which includes Strangford Lough.

5.5.2 Special Protection Areas

Special Protection Areas (SPAs) are identified under the EU Council Directive on the Conservation of Wild Birds 79/409/EEC ("the Birds Directive"). All member states are required to identify areas of international importance for breeding, migrating and overwintering birds. Eleven SPAs have been established in Northern Ireland, including Strangford Lough.

5.5.3 Ramsar sites

Ramsar sites are wetlands of international importance designated under the Ramsar Convention. In the UK, the first Ramsar sites were designated in 1976. Since then, many more have been designated. The sites mainly concern areas which are important to waterbirds and Strangford Lough has achieved Ramsar designation.

5.5.4 Areas of Special Scientific Interest

Under the Amenity Lands Act (Northern Ireland) 1965 local planning authorities were required to make provision for areas of land of scientific interest which were not nature reserves, but were sufficiently important to merit special protection. The Planning Service of Department of Environment (Northern Ireland) was required by the Act to consult the Council for Nature Conservation and the Countryside on any development application falling within these Areas of Scientific Interest. The 1965 Act was updated and revised through the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985, which created the modern Areas of Special Scientific Interest (ASSIs) designation used today. Strangford Lough has been identified as an ASSI.

5.5.5 Marine Nature Reserve

Strangford Lough was designated as the UK's third Marine Nature Reserve (MNR) under the Wildlife and Countryside Act (1981), which serves to protect marine flora, fauna and geological features of natural significance within 3 miles of the coast under the Territorial Seas Act (1987), to the limits of UK territorial waters, including both the sea and the sea bed.

5.5.6 National Nature Reserves and Areas of Outstanding Natural Beauty

Strangford Lough is an Area of Outstanding Natural Beauty (AONB) which contains six National Nature Reserves (NNRs). These were set up under Nature Conservation and Amenity Lands (Northern Ireland) Order 1985. All NNRs are also ASSIs, discussed above.

5.5.7 EC Shellfish Waters Directive

The EC Shellfish Waters Directive (79/923/EEC) is an important piece of legislation, the purpose of which is to ensure a suitable environment for shellfish growth. The Directive was implemented administratively throughout the UK and in 1983 shellfish waters area was designated close to Mahee Island in Strangford Lough. In 1997 the Directive was transposed into legislation through the Surface Waters (Shellfish) (Classification) Regulations (NI) and took into consideration the EC Shellfish Hygiene Directive (91/492/EEC) to protect consumers of shellfish and the quality of shellfish populations. A further two shellfish water areas have been designated in 1999.

5.6 Assessment of plans and projects

It is important to note the relevance to this ES that the Strangford Lough SAC and SPA/ Ramsar designations have on the licensing procedure outlined in Section 5.3. As a 'plan or project' within a European marine site the development is subject to scrutiny and a test of 'likely significant effect' by EHS under Regulation 43(1) of the Habitats Regulations. If this test determines the proposal is likely to be significant in relation to the site's protected features an appropriate assessment must be undertaken by the Competent Authority to ensure that the site's ecological integrity is not compromised by the development. The EHS have produced operational guidance on how an appropriate assessment is judged in "The Habitats Regulations: a guide for competent authorities" published in 2002. In order to ensure that this can be carried out effectively information required to inform this process is provided in Section 8.10.

A significant element of this assessment process involves implementation of the precautionary principle in accordance with guidance from the European Commission (Communication on the Precautionary Principle, COM 2000) when sufficient information is not reasonably available, or uncertainty over likely impacts to protected features remains. Current thinking on practical and consistent application of the precautionary principle has moved on since the Habitats Regulations were transposed into UK legislation in recognition of the need to facilitate sustainable development (a specific objective enshrined within the Habitats Directive) as demonstrated by draft documents currently in preparation on behalf of members of SNIFFER, the Scottish and Northern Irish Forum for Environmental Research (SNIFFER *pers comm*).

To this end it is currently suggested by various NGOs and cross-sectoral stakeholder forums that an adaptive ongoing management approach should be available to developments of a novel nature for which the likely effects on internationally protected wildlife are uncertain. This does not obviate the need to carry out all reasonable investigations as part of this EIA process (see Section 8.12 for further information on the additional studies completed in support of this application) but it provides a route through which the inherent uncertainties associated with potential impacts of novel technology can be addressed.

The strategic environmental monitoring programme provided in Appendix 8, which includes a commitment by MCT Ltd to modify or cease operations in line with advice from the regulators through a recognised steering group, is submitted in line with this approach.

In practice this means that novel technologies such as Seagen, for which anticipated impacts on internationally protected features may retain a degree of uncertainty, should look to employ a system of monitoring and feedback so as to ensure that the integrity of these features remains intact, i.e. their conservation status does not become unfavourable as a result of the development. This will result in a situation where the requirements of Regulation 43(5) of the Habitats Regulations, i.e. that a Competent Authority can agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the European site, are met.

It is recognised that licensing through the FEPA process may not represent the best regulatory tool that could be used to ensure post-installation actions are carried out. It is therefore suggested that any conditions deemed necessary to ensure these actions take place form both conditions of the FEPA licence and part of the legal agreement drawn up under the sea bed lease from the Crown Estate, who also have responsibilities in relation to European protected sites.

6 INTRODUCTION TO BASELINE ENVIRONMENT AND IMPACT ASSESSMENT

The following sections provide detailed information on the environmental conditions and interests in the Strangford Narrows that are relevant to this proposal. Each section then includes an assessment of the environmental impacts that are thought likely to arise as a result of the construction, operation and decommissioning of Seagen. This includes consideration of features of Strangford Lough's European sites in Section 8.

Studies carried out either specifically to inform this EIA process or as part of wider investigations that bear direct relevance to this proposal are:

1. A site selection justification assessment;
2. Extensive consultation with statutory and non-statutory stakeholders and community consultation;
3. A desk-based study examining the patterns of water flow through a subtidal turbine;
4. A subtidal survey of the proposed turbine location to MNCR standards;
5. A post-site investigation subtidal survey to assess the impact of the jack-up barge;
6. A landscape impact assessment;
7. A navigation impact assessment (to be completed);
8. A geotechnical survey of sea bed conditions;
9. A geophysical survey of conditions in the Narrows (Titan Surveys, 2004);
10. Initiation of baseline data collection of marine mammal, basking shark and bird movements in the Narrows;
11. A desk study interpreting historical seal observation data collected around Strangford Lough;
12. An assessment of the anticipated operational underwater noise impacts arising from the turbine;
13. Review of relevant and available data sources; and
14. Development of a dedicated Strategic Environmental Monitoring Programme.

7 HYDROLOGY, GEOLOGY AND WATER QUALITY

This section should be read in conjunction with Appendix 2 – 4 and 11 – 16.

Strangford Lough Narrows is a relatively deep and steep-sided channel that connects Strangford Lough with the Irish Sea. Within the study area the channel width varies between 0.5 and 1km and water depths are typically between 25 and 40m. The bathymetry of the channel however varies considerably with many rocky outcrops along the flanks and an area with water depths of 45m (see Figure 2.1).

7.1 Physical environment and coastal processes

A desk study was prepared to provide information on tides, wave and wind conditions likely to be encountered in the Narrows. This report is provided as Appendix 11 and is summarised as follows.

7.1.1 Tidal and current flow conditions

Astronomical tide levels in Strangford Lough are summarised below:

Table 7.1 Tidal heights in the Strangford Narrows

Tidal position	Abbreviation	Height (metres above Chart Datum)
Highest Astronomical Tide	HAT	4.4
Lowest Astronomical Tide	LAT	0.1
Mean High Water Springs	MHWS	4.1
Mean High Water Neaps	MHWN	3.5
Mean Low Water Neaps	MLWN	1.1
Mean Low Water Springs	MLWS	0.5

Table 7.1 indicates that the mean spring and neap ranges at Strangford Lough are 3.6m and 2.4m respectively.

Tidal currents within the Narrows are strong, with flood flow directions between 320° and 335° N and the ebb flow between 135° and 165°N. ADCP data obtained during the site evaluation survey undertaken by Queens University indicates maximum spring flood tide flows of 7.8 knots (4m/s) and ebb flows of 7.2 knots (3.7m/s) in the channel off Rue Point. This data has been confirmed by the peak spring flows recorded in additional surveys undertaken in 2004 by Titan Surveys of 3.5m/s on the mid spring flood period. However, current speeds on a neap tide are considerably reduced and peak flows were recorded around 1.5m/s (Titan Surveys, 2004).

A full simulation of tidal conditions throughout the Strangford Lough system was carried out on behalf of MCT by RPS Kirk McClure Morton, using the MIKE21 HD and NHD flow model. This provided a 2-dimensional, depth-averaged model of conditions in the Lough and the Narrows. The model was also used as the base on which to predict the distribution of sediments released into the system during drilling operations on a 3-dimensional basis, and to assess the implications of energy extraction from the tidal system in the Narrows. The full report is provided in Appendix 12.

7.1.2 Wave conditions

The study area of the Narrows is relatively sheltered from waves generated in the Irish Sea, with the exception of waves from the south east which are able to travel directly up the channel. These waves and any generated locally within the Narrows are likely to be significantly affected by the strong tidal currents, although it is not possible to predict the impact of this in detail based on desk studies (Appendix 11). When waves oppose the tidal flows, the height will be increased and the length reduced and *vice versa* when the waves are travelling in the same direction as the tide. This effect is most marked at the mouth of the Lough where the Strangford ‘bar’ is created, composed of a series of standing waves. Consultation with Lough users has confirmed that large waves are rare further into the Narrows.

7.1.3 Coastal defences

Sea defences are present around the main body of the Lough, providing medium term protection of property and infrastructure from erosion. Limited coastal defence works have also been undertaken in the Strangford Narrows.

The favoured strategy, particularly in the Northern portion of the Lough appears to be the use of rock armour revetments. The development of coastal engineering works has had a history of altering small bays and areas of saltmarsh and tidal flats. These ‘hard’ structures have modified the physical processes within the Lough in localised areas and have led to changes in the habitats found there (Roberts *et al* 2004).

Impacts arising due to the presence of coastal defences are not considered to be relevant to this project as the proposed demonstration project does not have the potential to affect any of the existing coastal defences in the Lough and there will be no intertidal areas containing habitats that are impacted elsewhere in the Lough by coastal defences directly affected by the Seagen. Potential cumulative impacts with coastal defences are therefore not considered further in this document.

7.2 Geological conditions within the Narrows

Further to desk studies carried out in 2004, a geotechnical survey of two potential locations was completed by SeaCore Ltd in April 2005. An interpretive report of this work was completed by Royal Haskoning to validate the findings, and the full interpretive report is provided in Appendix 4. This section describes the geological conditions around the Strangford Narrows and the work undertaken during the geotechnical studies and assessment of the sites.

7.2.1 Geology of the Narrows

The regional memoir, *The Geology of Northern Ireland* (Mitchell, 2004), indicates that the geology on either side of the Strangford Narrows is comprised predominantly of rocks belonging to the Hawick Group, together with a narrow tract of Gala Group rocks surrounding a thin inlier of the Moffat Shale Group.

It is thought that the Narrows were formed during the late Palaeozoic Caledonian orogeny, which caused extensive faulting and intrusions of igneous rock trending from SE to NW. The turbidite beds have been deformed and upturned so that where they outcrop on the shores of Strangford Narrows, they are almost vertically bedded.

Late Palaeozoic intrusives consisting of lamprophyre dykes/sills were intruded during the Caledonian. The majority of the intrusions consist of vogesite and minette, and may be heavily altered to sericite (fine-grained muscovite), chlorite and carbonate.

The information available from the records at Strangford, Rue Point and Portaferry show that rock is shallow, buried beneath alluvial deposits consisting of loose silty sand and sandy gravel and soft silt, stiff glacial till containing cobbles and boulders, and medium dense fluvioglacial sand and gravel. Although no fault is shown in the geological maps of the region, it is generally thought that the basin of Strangford Lough is fault bounded, and that at least one fault provided a line of weakness along which erosion took place, creating the Narrows; the Lough's outfall to the sea (Mitchell, 2004).

7.2.2 Site inspection

A field inspection and sample collection at Rue Point on the shore opposite the proposed northern site was undertaken to provide information on the likely geology that would be present at the subtidal site.

Rue Point appears unique along the shores of the Narrows because it is composed of Quaternary sediments. The shape of the hill indicates that it is a drumlin. Indeed, many of the islands around the shores of Strangford Lough (to the north) are partially drowned drumlins. Ice striae suggest ice movement to the south-south east during their formation. The sediments of Rue Point are exposed along the shoreward side of the hill and comprise soft till with lenses of sand and gravel. The till is typically a clay-matrix supporting large numbers of pebbles and cobbles.

7.2.3 Sea bed mapping

Geophysical and ADCP surveys were carried out in Strangford Lough Narrows and reported in April 2004 (Appendix 15) for the purpose of providing more information on the proposed development area.

The side-scan sonar and underwater photograph results indicated a sea bed composed of bedrock outcrop (*Silurian turbidites*), pebble/cobbles or fields of sand waves/ megaripples. The asymmetry of the sand waves indicates a dominant sediment transport direction to the north-west, i.e. into Strangford Lough. However, the general dominance on the bed of coarse sediments or bedrock, and the patchy nature of the bedforms (and their small size), indicates that sand transport across the Narrows is minor. The strength of the tidal currents is likely to have removed much of the finer mobile sediment to leave a coarse lag or exposed rock.

Seismic profiling suggested that the cover (and complexity) of overburden on top of bedrock generally increases in thickness (up to 16 m) towards the south of the Narrows. The overburden is described as Quaternary sandy gravel or as chaotically bedded cobbles and pebbles within a sandy gravel matrix. Correlatives of these units were not found onshore during the site visit. The Quaternary sediments were thought to be possibly fluvioglacial in origin, although note that this was not supported by *in situ* investigations.

7.2.4 Geological conditions at the proposed installation location

The predicted geological conditions at the proposed site were confirmed by the construction of the two boreholes as reported in detail in Appendix 4, and were found to be comprised almost entirely of bedrock.

Superficial material was not encountered and glacial material was not positively identified at either of the borehole locations, having either never been deposited or having been subsequently removed by the high current regime operating through Strangford Narrows. The whole area has been subject to extensive glaciation in the recent past.

The encountered solid geological sequence based on pre–site investigation data was interpreted to comprise a sequence of mudstones, siltstones and subordinate sandstones, comprising a greywacke, which have been subject to deformation and low grade metamorphism (Jackson *et a*l, 1995, and Wilson, 1986). This material was interpreted to be of Silurian age (400Ma) and belong to the Wenlock Stage (Hawick Group) although previous work (Royal Haskoning, 2004c) has inferred the presence of material belonging to the Moffat Shale Group to the south of the investigated site.

Based on the nature of the recovered material it is probable that a variable cover of boulders and cobbles are present on the bed of Strangford Lough, with approximately 5.20m interpreted to be present at borehole 1 and 1.85m at borehole 2 (see Appendix 4). It should be noted that the stratigraphy varies considerably over the short distance between the boreholes due to the highly inclined nature of the bedding. Observed mineralisation may also affect the integrity of the material It should also be noted that areas interpreted to be associated with major faulting were not identified in either of the boreholes.

The geotechnical core surveys carried out at the final proposed construction location (Seacore, 2005) therefore confirmed the outcome of the desk survey, except that no sediments or glacial deposits were noted in the two specific survey areas. The top 1-2 metres of the sea bed is noted instead as being composed of heavily weathered mudstone and siltstone bedrock.

7.3 Water quality

The Strangford Lough SAC/SPA Management Scheme provides a useful description of the water quality of the Lough. It identifies the following as being the main anthropogenic inputs that have an effect upon the overall water quality:

- Effluent discharge;
- Organic waste;
- Fertiliser runoff;
- Bacteria;
- Hydrocarbons;
- Metals;
- Pesticides;
- Antifoulants; and
- Litter.

There are eight direct sewage outfalls around Strangford Lough. Treated sewage is also discharged into the Quoile. In general, the water quality of the Lough is considered to be

'Good', although there can be locally significant decreases in quality around outfalls or after storm events. Observations during the dive and intertidal surveys (see Section 8.2) at the proposed land fall site for the power cable indicated existing localised impacts, possibly arising from the discharge of inadequately treated sewage in the Narrows from the pumping station south of Strangford on the western shore.

Areas of the Lough are also subject to the requirements of the EC Shellfish Water's Directive which requires water quality suitable for shellfish production and harvesting. Neither of the two areas identified under this Directive affect the proposed development site directly.

Aspects of the Lough's water quality (i.e. salinity, temperature and chlorophyll-*a* content) are monitored throughout the year, with the results made available on the internet (http://www.afsni.ac.uk/Services/CoastalMonitoring/map.htm). Salinity in Strangford Lough ranges form approximately 32.5 to 34.5ppt. A modest seasonal effect on salinity has been recorded in the Lough, with salinities at the lower end of the range observed between September to March, with values rising to the highest observed levels by late July. In relation to chlorophyll-*a* concentrations, Strangford Lough typically exhibits a double 'spring' peak in phytoplankton growth and a brief 'autumn' growth period prior to increased nutrient levels during the winter season (Defra, 2000). In 1995 Defra conducted a study on the chlorophyll-*a* levels in Strangford Lough and showed that there was a marked difference in the seasonal cycle of dissolved inorganic nitrogen levels (Defra, 2000). The study showed that there is a large seasonal effect with maximum levels of nitrogen being found in the winter, diminishing to a minimum in the summer. It was also shown that nitrogen is the limiting nutrient in Strangford Lough.

Suspended sediment concentrations in the Narrows were monitored by QUB for a short period in order to provide an indication of levels likely to be encountered. This information is provided in Table 7.2.

Table 7.2 Sample suspended sediment loads in the Narrows

Date	Time	HW	Sediment load (mg/l)
15.12.04	0900	1515	7.08
17.12.04	1700	1653	4.03
21.12.04	1330	0859	3.19
22.12.04	1440	0953	15.11
10.01.05	1600	1227	20.54
12.01.05	1510	1403	32.66
13.01.05	1505	1451	19.66
17.01.05	1450	1523	19.32
20.01.05	1215	1514	16.35
21.01.05	1415	1014	15.80

Data provided by QUB (Appendix 13)

7.4 Potential construction period impacts and mitigation measures

7.4.1 Hydrodynamic regime

During construction a jack-up rig will be used to install the turbine over approximately one month. The presence of this large structure will not influence wave and tidal properties to any significant degree due to its open nature (i.e. waves and tidal currents would be able to continue to propagate through the water space occupied by the rig). Additionally, given the relatively short duration that the rig would be *in situ* of around one month, the potential for any modification of wave or current properties to have an influence on other associated parameters (e.g. sediment transport) is extremely low.

The presence of the jack-up rig in the water column will cause localised changes in flow patterns due to turbulence around the legs of the structure for the month of construction. As with any structure placed in a flow of water there will be a decrease in flow speed immediately downstream of each of the jack-up legs with acceleration of the flow on either side of the legs. This localised effect would occur throughout the water column. In the tidal conditions of the Narrows the influence of the jack-up structure legs on flow dynamics would largely be directionally balanced. This aspect is of importance with respect to the influence that the flow regime change may have (if any) on sediment accretion/erosion. However, this must be balanced against the natural turbulence in the water flow, especially closer to the sea bed, which is a characteristic of the Narrows. The natural variability was seen to fluctuate from 3.19 to 32.65mg/l between December 2004 and June 2005 (Appendix 13). The presence of natural sea bed formations, such as the ridges and gullies that run cross current, introduces significant turbulence to the water flow close to the sea bed with each tide.

Analysis of monitoring results from the existing marine current turbine off Lynmouth, alongside Computer Flow Dynamics (CFD) studies investigating the influence of a monopile structure on the flow regime in the surrounding water column, is presented in Appendix 14. This study identifies the key construction phase impacts arising from changes to the hydrodynamic regime as potential flow acceleration around the pile and support structure to speeds higher than those likely to occur naturally in the Narrows, which may lead to scour of an area 1.5-2m from the base on the sea bed (Appendix 14).

When considering potential scour impacts, the nature of the sea bed sediments is a key consideration. Bedrock, boulder and cobble sea beds such as those found in the proposed development site are highly resistant to the erosive effects of scour, and it is unlikely that any glacial material will be encountered in the vicinity of the monopile (Appendices 4 and 15). CFD modelling indicates that scour is likely to be limited to an area of within one and two times the diameter of the pile or jack-up leg. This provides a maximum area of impact on sea bed biota around the jack-up legs of $100m^2$ for the duration of the construction phase (one month). Due to the high recoverability potential of the main biotopes found in the area it is considered highly likely that the biota of the scoured areas will recover once the jack-up rig has been removed, as discussed in Section 8.11.1. This therefore represents a short term reversible adverse impact.

The residual impact of construction activities on the hydrodynamic regime is therefore characterised as **negligible to minor adverse**, with all impacts reversible over the short term.

7.4.2 Water quality

The potential implications of the overall operation of tidal current turbines on water quality are very limited in comparison with other forms of energy production (e.g. discharge of hot water from power stations). However, effects during the construction period are likely to be more significant due to the disruptive nature of some of the activities.

Directional drilling will be employed to install the cable required for connection to the electricity grid. This process will use a drilling mud during operations as discussed in Section 2.5. The impacts on water quality arising from this phase, which will last no more than two weeks, will be limited to the release of drilling materials after the drill has broken through the sea bed and the discharge of water used in the drilling process.

The release of drilling materials following breakthrough is likely to involve an initial release of around 1-2m^3 of water-based drilling mud. The entire cavity of the drilled hole will be filled with a mixture of sea water and drilling mud, the total volume of which is approximately 25m^3. This will contain around 2t of mud and the rest will be sea water. This mixture will be released into the Narrows by pumping clean seawater through the drilled hole. All of the muds proposed for use in this process are classed as non-toxic (see the Material Safety Data Sheets, Appendix 3); therefore there will be no chemical contamination of the water column. However it will involve the release of 2t of very fine mud which has the potential to smother sessile organisms.

The drill break through will be timed to coincide with peak tidal velocity on the ebb flow to ensure maximum dissipation and reduced sediment concentration of the drilling mud throughout the Narrows, and to ensure that the volume released on break through will be carried away from the main body of the Lough. The same approach will be taken to the process of clearing the cavity with sea water to ensure that none of the 2t of fine mud is released during the ebb tide, thereby avoiding any risk of affecting water quality in the main body of the Lough.

Used drilling mud will be collected from the mixture of abstracted sea water, drilling muds and drill cuttings on the land side of the operations and disposed of according to the appropriate licensing and waste disposal regulations. It is expected that this process will remove approximately 100% of all sediment from the water that is discharged back into the Narrows.

Directional drilling operations will therefore result in two separate releases of materials into the Narrows, neither of which will contain toxic compounds. The impacts will be limited to changes in suspended sediment content of water in the Narrows during ebb flows and the subsequent settlement of material. The implications of this on the biology of the Narrows are considered in Section 8.11.

The installation of the turbine will involve drilling a hole into the sea bed in which to place the turbine monopile followed by grouting of the pile into the drill socket. Both of these aspects of the construction process have the potential to influence water quality in the immediate vicinity of the turbine due to the potential release of materials into the water column. Mitigation through design has been applied by using a single pile for two turbines and using the minimum possible socket depth.

Drilling of the monopile hole into bedrock would be likely to result in the suspension and subsequent deposition of cuttings on the sea bed following mixing with seawater, with particle sizes of up to 50mm produced. The volume of sediment likely to be released over the approximately 28 hour drilling period, based on a socket dimension of between 3.1 and 3.25m diameter and drilling to a depth of 15-20m, is between 110m^3 and 170m^3 of sediment that would be released into the water column. Geotechnical investigations (Appendix 4) confirmed previous drilling experience with this rock type, which suggested that the predicted drilling residue size would be as shown in Table 7.3, therefore this particle size profile is considered most likely to represent the materials that will enter the Lough. The released sediment will be discharged from a pipe 5m below LAT under the jack-up barge and a particle size distribution based on the predictions provided in Table 7.3 was used for the purposes of plume modelling, with a maximum particle diameter of 3.5mm. In order to reduce the size of any particles released during drilling operations, thereby ensuring adequate dispersal and mitigating potential smothering impacts immediately around the discharge, drilling operations will employ a system of settling tanks on board the jack-up barge in order to ensure that a particle size is achieved that is consistent with those for which the modelling process has predicted negligible impacts (Appendix 12).

In order to assess the impact of the release of sediment into the Narrows from the pile drilling operations, plume analysis modelling has been undertaken over a period of 72 hours to determine the fate of the sediment released. Key results are included in Figure 7.1 and Figure 7.2 below and the full report is provided in Appendix 12. The modelling predicts that the release of sediment during the drilling process is highly unlikely to result in detectable levels of sediment being deposited in the Narrows or the main body of Strangford Lough after 72 hours. It also predicts that suspended sediment levels will be increased in the Narrows by an average of 1-2mg/l, amounts that would not result in an increase of total suspended sediment above those encountered under normal, natural fluctuations.

Essentially, this means that the solid particles contained in the drilling discharge will be very quickly dispersed due to the highly energetic and turbulent nature of water flows either side of slack water in the Narrows heading both into the main body of the Lough and out into the Irish Sea.

Table 7.3 Predicted particle size distribution of drill cuttings

Particle Size (microns)	<50	50 to 100	100 to 1000	>1000
% of particles	5	15	50	30

Source: Kirk McClure Morton (KMM)

In comparison, the sediment loading in the Strangford Lough Narrows during the storms in the winter of 2004/2005 was measured intermittently by QUB. These results indicated peak sediment loadings of 32mg/l, and an average loading of 15mg/l. A sample of the measurements is provided in Table 7.2 below. The full results are provided in Appendix 13. During drilling operations the particulate rock residue loading was modelled as 4kg/sec, to a total of 400t, which will be immediately diluted by the turbulent flow of water through the Narrows. Plume modelling suggests that the peak suspended sediment concentrations in the water column arising from the drilling operation will be less than 12 mg/l in the Narrows and 4 mg/l in the main body of the Lough. The average suspended sediment concentrations in the water column during the 72 hour simulation were generally less than 2 mg/l. This falls well within the natural variability encountered in the Narrows, and will last for less than the 72 hour modelling period.

The predicted dispersions of suspended sediments over a 72 hour period after drilling operations begin is illustrated in Figure 7.1, from which it can be seen that suspended sediments are only expected to be affected by up to 2mg/l as a result of the drilling operations.

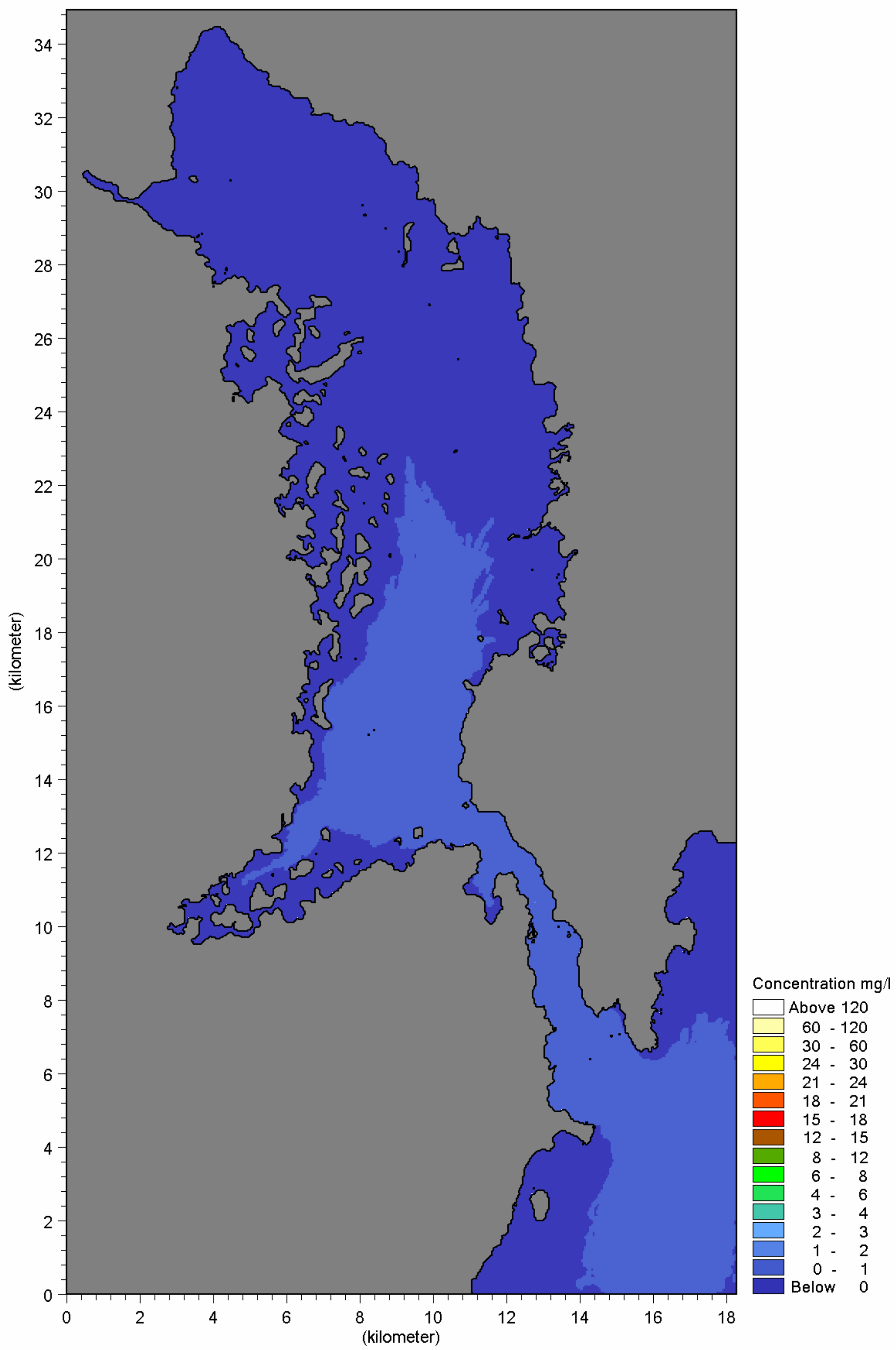


Figure 7.1 Predicted mean suspended sediment concentration envelope for the water column in Strangford Lough after 72 hours

It should be noted that the settling process proposed to ensure only fine particulate matter is discharged during the drilling process is expected to result in removal of approximately 50% of the total drilled material, which will be either reused or put to landfill. The modelled situation therefore represents a significant worst case scenario, and even at this level it predicts undetectable levels of change by the end of the model period further than 500m from the turbine and that suspended sediment loadings will be well within 'normal' limits. The material that is being released into the Narrows will also be composed of inert rock, therefore poses no contamination risk to biota in the area. This volume represents approximately 3% of the average amount of sediment transported through the Narrows on a spring tidal cycle (based on mean suspended sediment concentrations and Lough volume differences provided by QUB). As the drilling operation will continue for two full cycles it is therefore not considered necessary to carry out drilling works for the monopile installation on the ebb tide in order to avoid any introduction of materials into the main body of the Lough.

The maximum predicted deposition depths do not exceed 1mm anywhere outside the Narrows and these are considered likely to exist for only a very short period of time (around 30 minutes) around slack water, following which the material is quickly resuspended. The final deposition depths predicted at the end of the 72 hour modelling period after drilling operations is illustrated in Figure 7.2. This indicates that there is likely to be no measurable sediment deposition anywhere in the Narrows or the main body of Strangford Lough by at most 44 hours after drilling operations are complete.

The grouting operation to fix the turbine monopile into the drilled hole will involve the use of a cementitious grout comprising a mixture of cement and Pulverised Fuel Ash. Grouting will take place over a 6-12hr period and every attention will be made to ensure that no material is lost to the water column during this process, as detailed in the installation method statement. However, there is the potential for leakage to occur and given the caustic nature of cement (high alkalinity) there could be short term changes to water chemistry in the vicinity of the monopile.

Toxicity of the grout is considered to be ultimately low due to its reaction with water to form an inert, non-biodegradable solid. Its application through 'grout tubes' directly from within the pile once it is in place will minimise the surface area of the grout that comes into contact with the water, and the volume of grout administered will be monitored with precision to ensure only the exact amount required to fill the cavity (known volume) around the monopile will be used (Seacore *pers comm*). Environmental data sheets for the grout are provided in Appendix 2. The grouting process has been used historically for installing offshore wind turbine piles, the Lynmouth tidal turbine (Seaflow) and other piled structures. It is a well developed process with controlled procedures to ensure minimal loss of the grout to the environment.

The implications of this are difficult to determine with absolute certainty. However, given that the likely amount of any material released into the water column would be small and the high volume of mixing that would occur, release would be unlikely to have any significant effect on water chemistry and consequently any impact on biological processes.

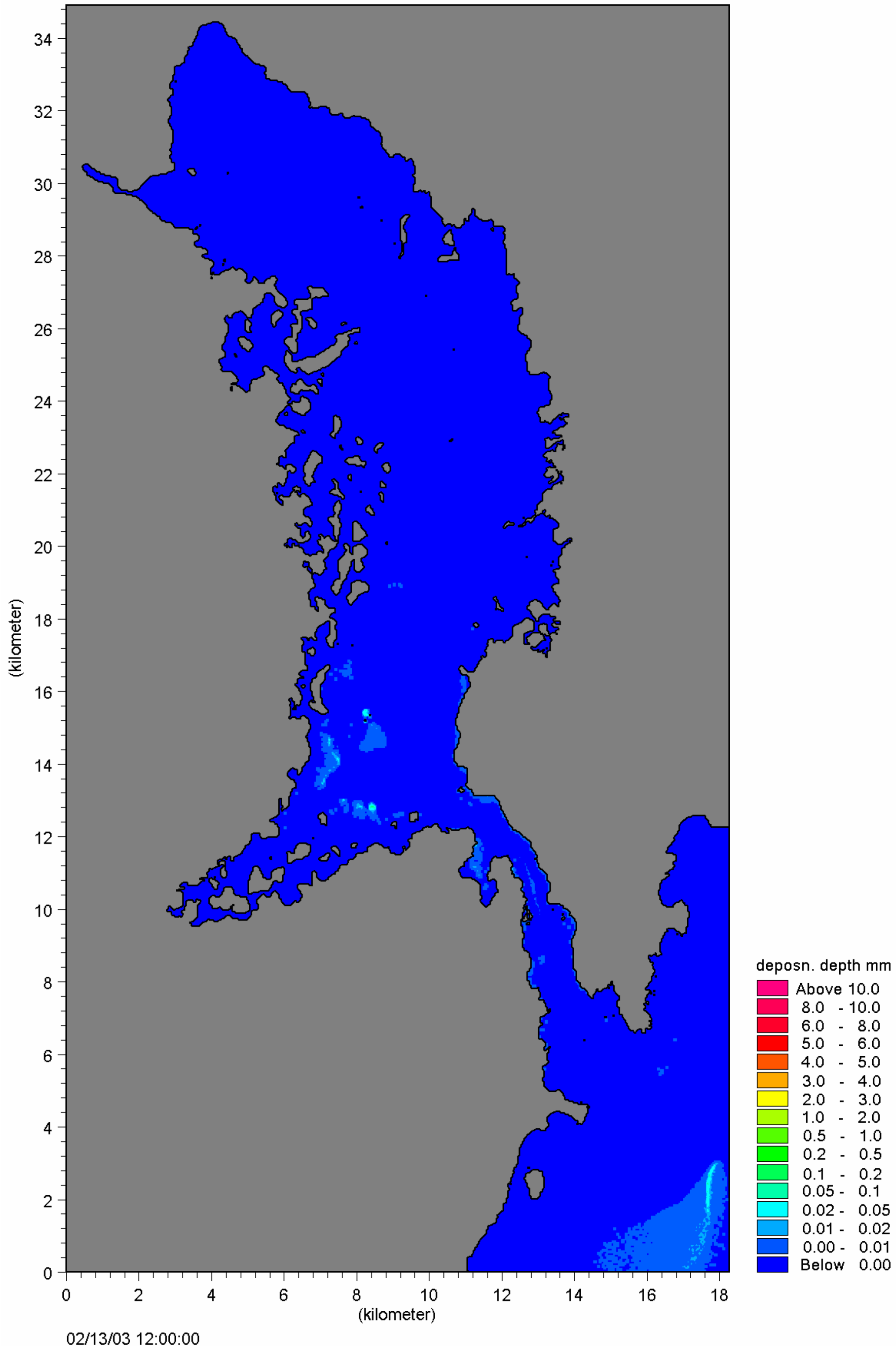


Figure 7.2 Predicted deposition depth of drilling residue at end of 72 hour modelling period

It is therefore proposed that a localised **minor adverse** impact is likely to be observed on water quality immediately around the monopile drilling discharge point for the duration of drilling (approximately 28 hours), i.e. two complete tidal cycles. This is likely to rapidly decrease to a **negligible** impact on water quality throughout the Narrows and into the main body of the Lough, even if discharged on the flood tide. The volume of material that will be discharged during the directional drilling process represents a significantly smaller volume of material (approximately 1/20th) than that modelled for the monopile drilling process. However, as the directional drilling process is considerably less sensitive to tidal conditions than work carried out from the jack-up barge, this discharge will be carried out only on ebb tides in order to avoid any doubt over potential impacts of release of drilling mud. The residual impact from directional drilling on water quality is therefore likely to be **negligible**.

Risk of accidental spillage

The construction phase will employ at least two small vessels and the *Excalibur* jack-up barge. These vessels will be working in a hazardous environment in areas of fast-moving water. The risk of accidental spillage of materials is therefore increased. The potential contaminants present on the jack-up barge include fuel oil, hydraulic oil and equipment lubricants. COSHH sheets are provided in Appendix 2.

In order to minimise the risk of accidental spillage, all staff involved in the drilling process will be fully briefed on the significance of the protected status of Strangford Lough. The storage of oils on the drilling barge is subject to normal maritime regulation and as such is considered adequate to minimise risk of spillage. Risk of spillage through collision of ancillary vessels with each other, the jack-up barge or the coastline will be minimised by employing fully qualified contract staff and avoiding working in extreme weather conditions. These staff and the jack-up barge operators are working to the Health & Safety Executive's Construction Design Management guidelines, thereby ensuring best practices to avoid spillage or other accident are employed. A full method statement including listings of relevant materials to be brought on site during construction is provided in Appendix 2.

Risk assessments will be undertaken for safety and environmental considerations and detailed method statements prepared to cater for the risks identified before deployment. Any specific requirements for operations at this site will be incorporated into these evaluations. The principle of minimisation of exposure will be adopted where technically feasible. This will include transferring adequate supplies of fuel oil in the jack-up main tanks, eliminating any requirement for fuel transfer on site.

EHS has taken non-statutory responsibility for shoreline cleanup in Northern Ireland, a role normally taken on by local authorities in the rest of the UK. In the event of accidental spillage the site staff should ensure that EHS and the Maritime & Coastguard Agency contacts are notified immediately. The MCA in Belfast can be contacted 24hrs on 0289 1463933. The MCA Counter Pollution Control team in Southampton can be contacted on 0238 0329407 during office hours.

Summary

The overall residual impact of construction and decommissioning operations on water quality is therefore characterised as **negligible** within the main body of Strangford Lough and most of the Narrows, and **minor adverse** during the periods of discharge at all states of tide immediately around or downstream of the monopile drilling discharge point. The strategic environmental monitoring programme provided in Appendix 8 includes assessments of impacts on water flow using ADCPs and ongoing benthic surveys to provide an indication of whether the predicted impacts to the hydrodynamic regime are accurate.

7.4.3 Geology

The background investigation work in support of the proposed turbine in Strangford Lough has resulted in the drilling of two 25m long geological cores, and the installation will involve the drilling of the 3.1-3.25m x 15-20m deep monopile socket and the drilling of a 500m x 18cm cable route. The impact of these works on the local geology, geological and geomorphologic features is considered to be broadly beneficial as it provides an understanding of the conditions underlying the Narrows. The impact of loss of these small amounts of geological integrity is considered negligible as the area shows broadly homogeneous geological conditions with occasional intrusions and no unusual features have been discovered in the proposed location.

The impact of the release of sediment from the installation of the turbine system into Strangford Lough has been discussed in relation to impacts on the natural heritage of the area in Section 8.

Given the relatively small footprint and already inaccessible nature of the geology in the area it is not considered that there will be any significant residual adverse impacts to geological interests. As **negligible** impacts are anticipated, geology and soil are not discussed further in this document.

7.5 Potential operational impacts and mitigation measures

7.5.1 Hydrodynamic regime

In a similar fashion to the masts used in offshore wind farms, the monopile structure of a marine current turbine will act as an obstruction to wave action that is likely to cause a localised disturbance to the wave field as it bypasses the structure. The near field effects of this have been modelled using Computer Flow Dynamics (CFD), the results of which are provided in Appendix 14. The far field effects of the turbine's likely impact on tidal flow velocity have also been examined using the MIKE321 HD model (Appendix 12).

Although a very slight decrease in wave energy may occur as a proportion of the wave's area comes into contact with the monopile structure, it is likely, given the ratio of the diameter of the pile structure to the width of the channel, that this effect will be negligible in the context of the existing energy environment. The proposed installation sites in the Narrows are generally very sheltered from wave action, a feature that was important in site selection, resulting in the marine biology of the Narrows predominantly reflecting the influence of the tidal regime. The wave studies undertaken for this project indicate that the wave climate found in Strangford Narrows is generally low, which further reduces the likely influence of the monopile on the wave climate. It is therefore considered unlikely that the operation of Seagen will have any discernable impact on the wave climate in the Narrows.

Analysis of monitoring results from the existing marine current turbine off Lynmouth, alongside CFD studies investigating the influence of the operational phase of a tidal turbine on the flow regime in the surrounding water column, is presented in Appendix 14. This study identified the key operational impacts arising from changes to the hydrodynamic regime as likely to be:

- Changes in water velocity induced by placing a solid structure in a lateral current; and

- Turbulence induced by the rotational motion of rotor blades.

The scoping consultation process has also highlighted the potential for an overall reduction in energy in the system to impact upon the hydrodynamic regime, with implications for ecological interests that may be sensitive to this parameter.

Influence of turbulence from turbine rotors
Observations from the Seaflow prototype and results of CFD suggest that the downstream influence (wake) of the entire structure is unlikely to cover an area greater than 1.5 times their diameter. This means that the downstream turbulence will not extend to sufficient depth to directly influence the hydrodynamic conditions encountered at the sea bed as long as the turbine is more than 4m above the sea bed level. This factor was built in as mitigation through design. It should also be borne in mind that the Narrows is already subject to significant chaotic turbulence due to ground conditions and the high tidal flow velocities.

Sea bed scour around monopile base
A consequence of near field effects on water flow around the pile is likely to be small-scale changes in patterns of sediment distribution (accretion/erosion) or scour of hard substrates due to changes in water flow speeds around the base known as the 'wake effect'. This has been discussed in Section 7.4.1. The potential for changes to sea bed communities as a result of the likely small change in current flow around the base of the monopile is, therefore, the same as that considered in the construction phase.

Effects of energy extraction
The rotating blades of the turbine are designed to extract energy from the flow of water. As the amount of water passing through the swept rotor area is the same as the amount leaving it, the water occupies a larger cross section behind the rotor, resulting in a decrease in flow speed down current of the turbine. It is estimated that the full turbine structure operating at full power would take approximately 0.56% of the total tidal energy passing through the Narrows (Appendix 12). This energy would normally be dissipated through friction against the sea bed, so it was considered necessary to investigate any likely changes to the speed of water flow arising from turbine operation (and the presence of a monopile structure) compared with the present situation.

Modelling results of the far field effects of energy extraction from the tidal regime are presented in Appendix 12. Figure 7.3 shows the mean velocity differential between the modelled tidal regime with an energy-extractor device analogous to a turbine in place, and that without, in the Narrows. Figure 7.4 illustrates this differential in the context of the whole of Strangford Lough. These model outputs indicate that the total hydraulic footprint of the turbine operating over a full spring tide cycle is unlikely to be measurable at distances greater than 500m from the rotors. Although the model was carried out with a depth averaged velocity profile (i.e. the predicted water velocities would be observed at any point in the water column from sea bed to surface), the results of this horizontal model can be considered alongside the observations from the Seaflow trial and CFD predictions (Appendix 14) indicating that turbulence arising from the rotors is unlikely to be observed at sea bed level. It follows that no impact pathway therefore exists for direct changes to biota as a result of changes in water flow. Even if this were not the case, the velocity differences away from the immediate area around the pile where scour is likely to occur are less than 1% of typical tidal velocities of 3.6m/s or more. This is considered to be an insignificant difference in the context of the range of speeds encountered throughout the Narrows and the short to medium term for which the turbine will be operational.

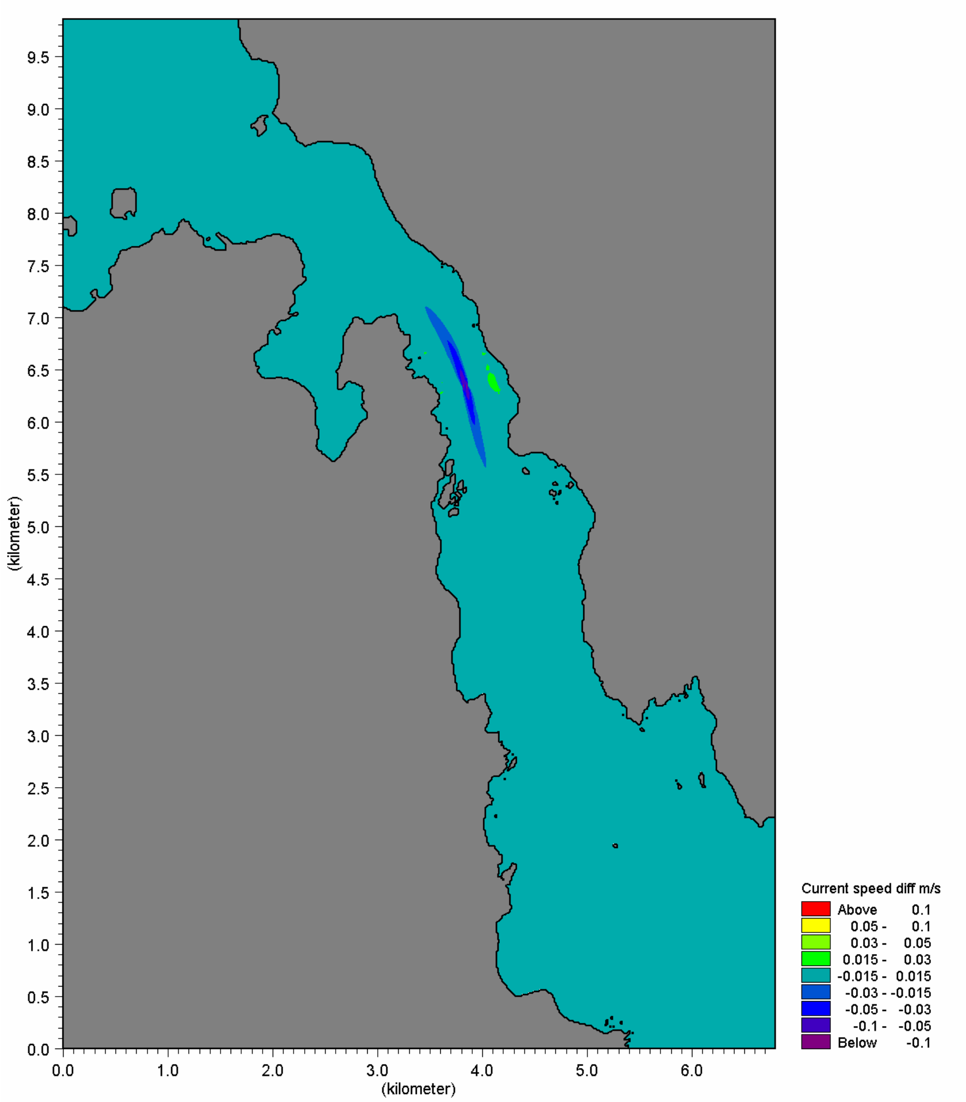


Figure 7.3 Velocity difference plot for Strangford Narrows illustrating extent and magnitude of energy extraction from turbines on tidal velocities

The potential for impacts of changes in water flow on sedimentation rates does extend to approximately 500m downstream of the turbine rotors, as the velocity differences shown in Figure 7.3 and Figure 7.4 are considered likely to be just enough to increase sedimentation rates in the areas of reduced water velocity. This velocity differential is not expected to be observed immediately above the sea bed as flows are unlikely to change uniformly throughout the water column according to observational data from Seaflow (the flows will, in reality, be highly turbulent given the naturally turbulent flow in the Narrows). Given that the velocity differentials predicted up to within a few metres of the monopile are less than 0.05m/s, it is considered highly unlikely that changes to the normal sedimentation regime will arise from operation of Seagen.

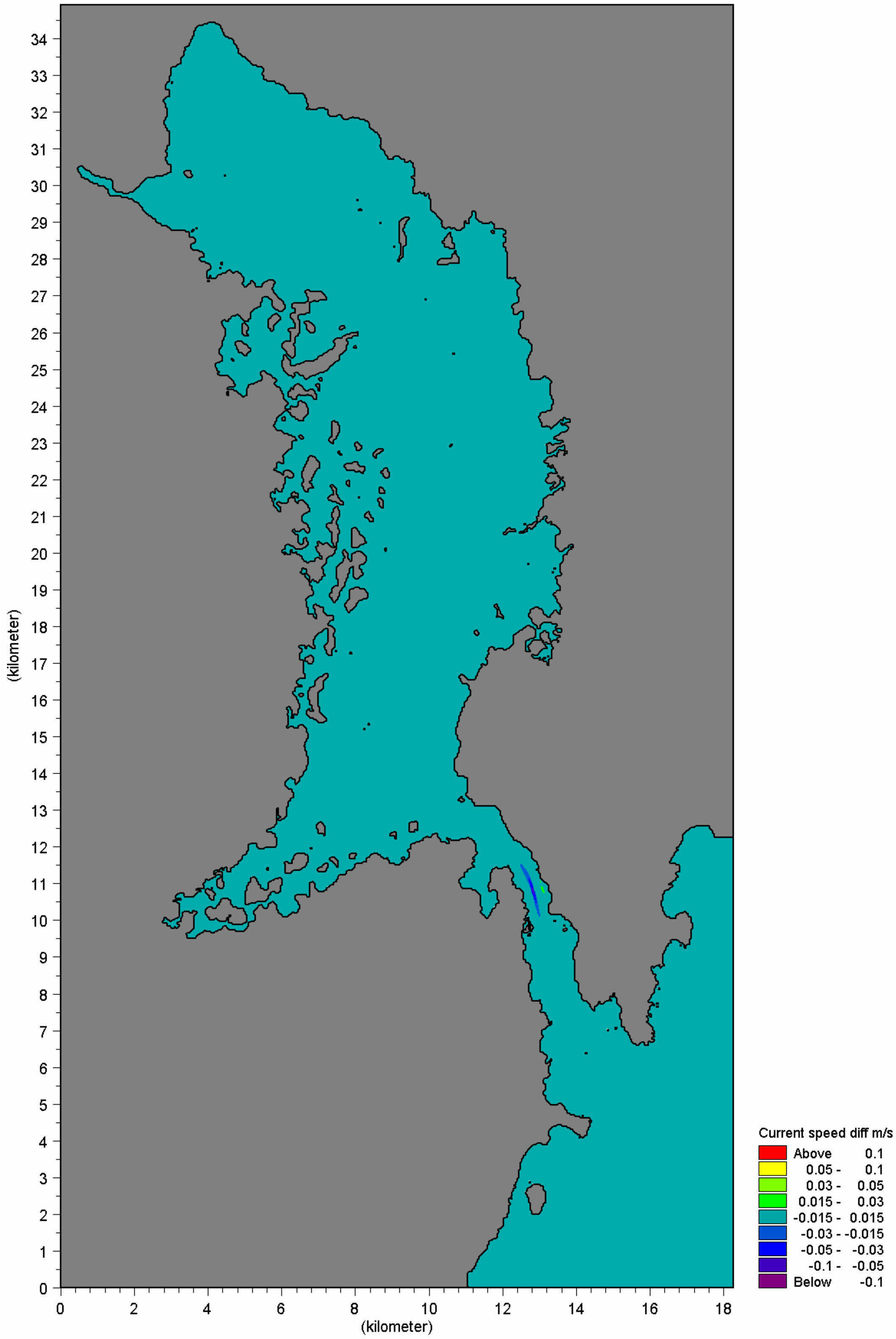


Figure 7.4 Velocity difference plot for Strangford Lough illustrating impact of energy extraction from turbines on tidal velocities

Summary

The impact of turbine operation of near field flows downstream of the rotors is likely to be **negligible**, based on CFD modelling and observations from the Seaflow prototype. The effect of the turbine operation on far field tidal velocities is also considered to be **negligible**, which means that the overall impact of energy extracted from the Narrows by the turbine will be **negligible**. The strategic environmental monitoring programme provided in Appendix 8 includes assessments of impacts on water flow using ADCPs and ongoing benthic surveys to provide an indication of whether the predicted impacts to the hydrodynamic regime are accurate.

7.5.2 Water quality

Operation of the Seagen turbine has the potential to result in several impacts on water quality as follows:

- Risk of accidental spillage or leakage of contaminants; and
- Cumulative impacts from antifoulants.

Risk of accidental leakage of contaminants

The moving turbine parts such as the gearbox and nacelle will require internal lubrication to reduce friction and ensure smooth operation. Suitable engineering methods will be used to prevent any leakage of lubricating compounds and oils (e.g. through the use of seals and sealants), although the potential does exist for the seepage of oil from the turbine if seal degradation occurs. However, such an occurrence is unlikely and the system will be continuously monitored using the SCADA system to ensure that the system fluid loss is detected and remedial action instigated. The system will be fitted with alarms and fluid level detection devices to ensure that any unforeseen system failure results in a rapid response and a negligible fluid loss into the environment. Fluid loss will also be limited or prevented through regular inspection and maintenance of the turbine.

The use of organic based oils within gearboxes has been adopted despite slightly poorer technical performance, using Exxon Mobil Polyolefins. However, a negative or neutral pressure setup will be employed where oils held behind the double seals in the gearbox will be operated at a lower or similar pressure to the surrounding sea water. Any leakage will therefore be into the turbine system rather than out of it, or will be very small. In addition, the lubrication system to be used has been changed from the Seaflow system, which employed an oil bath immersion system using around 200 litres of oil. Seagen will have a splash lubrication system that will use a total of just 70 litres of oil

The submersed gearbox is proposed to be equipped with redundant double seals to minimise any potential contamination of the gearbox by sea water. This will also act as an extra precautionary measure to minimise gearbox lubricant loss to the environment.

Risk of accidental spillage of contaminants

During the operational life of the turbine there will be periodic requirements for testing, monitoring and maintenance works to be undertaken. In order to facilitate maintenance, the design of the turbine enables the rotor blades to be raised and lifted clear of the water column. Maintenance is likely to involve the replacement of oils and lubricants.

During maintenance, the possibility exists for the accidental spillage of contaminants (oil, lubricants etc.) into the water column. To prevent spillage, or at least ensure that the potential for spillage is minimised as far as practically possible, best practice pollution prevention measures will be employed. These will be included in an Environmental Management System that will be produced in advance of the installation process. A procedures manual will be supplied to all staff operating on the development, to be agreed with the regulators, which will include first actions in the event of a spill and the

EMS best practice guidelines. In addition, to minimise the risk of release of lubricants into the surrounding water a service barge will be placed under the maintenance area to catch any spillage.

Use of antifoulants
The antifoul proposed for use on the whole turbine structure is Intersleek 737. This is in fact classed as a 'foul release' system, as it works through physical non-stick properties rather than biocidal ones. The material data sheets are provided in Appendix 16 along with a description of the product. It is considered that this represents the best environmental option and this will have no effect on water quality throughout the duration of this project.

The implications of these water quality impacts on nature conservation features are considered further in Section 8. The overall assessment of residual impacts to the Lough's water quality is characterised as **negligible**.

7.6 Construction and decommissioning impact assessment summary

Table 7.4 Classification of construction and decommissioning impacts

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Impact on wave climate in the Narrows	Negligible, localised	Short term, reversible	Negligible
Impact on the flow regime of Strangford Lough	Minor, localised	Short term, reversible	Minor Adverse
Release of additional suspended sediment into Strangford Lough	Minor, localised	Short term	Minor Adverse
Deposition of heavier particulates arising from drilling operations	Minor, localised	Short term	Minor Adverse
Release of contaminants during construction	Negligible, localised	Short term	Negligible
Impacts of construction activities on geology of the Narrows	Minor, localised	Long term	Negligible

Table 7.5 Construction and decommissioning: mitigation and monitoring

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring
Impact on wave climate in the Narrows	None required	None proposed
Impact on the flow regime of Strangford Lough	Ensure turbine is in sufficient water depth to allow 4-5m of sea bed clearance. Complete removal of monopile at decommissioning to ensure impacts are reversible.	Using benthic marine life as biological indicator of bottom current conditions, undertake regular dive surveys within a 1km x 500m box around the turbine. Post-decommissioning survey to determine recoverability of biotopes around monopile base.
Release of additional sediment into Strangford Lough	Minimise depth of pile socket. Mount two rotors on a single pile. Release sediment or drilling mud from directional drilling on ebb tide.	Post installation dive survey undertaken within 1 week and 10 weeks of installation. Using benthic marine life as biological indicator of sediment conditions, undertake regular dive surveys within a 1km x 500m box around the turbine and at two reference sites at the Northern end of the Narrows.
Release of contaminants during construction	Minimise quantity of grout utilised. Use low toxicity grout and avoid any release through feedback. Minimise surface area of grout exposed to the water.	Monitor 'curing' process of grout.

7.7 Operational impact assessment summary

Table 7.6 Classification of operational impacts

Potential Impact – Operational	Magnitude	Duration	Classification of residual or overall impact
Impact on wave climate in the Narrows	Negligible, Localised	Medium term	Negligible
Impact on flow regime of Strangford Lough	Minor, Localised	Medium term	Minor Adverse
Sea bed scour	Minor, localised	Medium term	Minor Adverse
Water quality	Negligible	Medium term	Negligible

Table 7.7 Operation: mitigation and monitoring

Potential Impact – Operational	Mitigation measures	Proposed monitoring
Impact on wave climate in the Narrows	None required	None proposed
Impact on the flow regime of Strangford Lough	None required	Undertake regular ADCP assessment of current footprint; 4 times per year post installation. Using benthic marine life as biological indicator of bottom current conditions, undertake regular dive surveys within a 1km x 500m box around the turbine (minimum 4 times per year).

8 ECOLOGY AND NATURE CONSERVATION

This section should be read in conjunction with Appendix 2-3, 5-6, 8, 12, 14 and 17-21.

8.1 Designations and non-statutory conservation

Strangford Lough supports a wide range of marine habitats and communities, with over 2,000 recorded species (www.ehsni.gov.uk). It is important for marine invertebrates, algae and saltmarsh plants, for wintering and breeding wetland birds, and for marine mammals. This variety and richness of habitats and species has led to the Lough receiving a number of designations for nature conservation. These designations are summarised below.

Strangford Lough was recognised as an SAC in May 2005 and is also identified as an SPA and a Ramsar site, as it is considered to be Northern Ireland's most important coastal site for wintering waterfowl, and important for breeding terns. Sites designated under the Habitats and Birds Directives (and the Ramsar convention) form a network of protected sites across the European Union known as the Natura 2000 network. The Natura interests in and around Strangford Lough are summarised in Table 8.1.

Table 8.1 Summary of Natura features in Strangford Lough

SAC Feature	Global Assessment
Annex I or II feature or species	
Large shallow inlet and bay	A
Coastal Lagoons	B
Mudflats and sandflats not covered by seawater at low tide	B
Reefs	B
Common seal *Phoca vitulina*	C
Annual vegetation of drift lines	C
Salicornia and other annuals colonizing mud and sand	C
Atlantic salt meadows (*Glauco-Puccinelietalia maritimae*)	C
Perennial vegetation of stony banks	C
SPA Feature	**Timing**
Arctic tern *Sterna paradisaea*	Breeding season
Common tern *S. hirundo*	Breeding season
Sandwich tern *S. sandvicensis*	Breeding season
Bar-tailed godwit *Limosa lapponica*	Over winter
Golden plover *Pluvialis apricaria*	Over winter
Knot *Calidris canutus*	Over winter
Light-bellied brent goose *Branta bernicla hrota*	Over winter
Redshank *Tringa totanus*	Over winter
Shelduck *Tadorna tadorna*	Over winter

The global assessment for an SAC is an expert judgement of the overall value of the site in a European context for the conservation of the relevant Annex I habitat. It provides an integrated assessment of the other selection criteria, and may also take into account other relevant factors, such as ecological relationships between different habitats and species. As an overall index of the site's conservation value, particular attention has been paid to the global assessment. Sites have been graded A, B or C, as described in the Natura standard data form (European Commission DGXI 1995). In the UK, these gradings have been interpreted as follows:

- A: Sites holding outstanding examples of the habitat or species in a European context.
- B: Sites holding excellent stands of habitats or populations of species, significantly above the threshold for SSSI/ASSI notification but of somewhat lower value than grade A sites.
- C: Examples of habitats or species which are of at least national interest (i.e. usually above the threshold for SSSI/ASSI notification on terrestrial sites) but not significantly above this. These habitats are not the primary reason for SACs being selected.

There is, therefore, a distinction between the principal features for which sites have been selected (those graded A or B) and those which are only of secondary interest (those graded C). This is a useful distinction but it is important to note that all three grades represent qualifying SAC interest features.

8.1.1 Strangford Lough SAC

Strangford Lough was accepted as an SAC under the Habitats Directive in May 2005. The SAC includes all of the subtidal area of the Lough and its foreshore up to the landward boundary of the Strangford Lough, Killard and Ballyquintin Point Areas of Special Scientific Interest (ASSI). The site's seaward boundary runs across the Narrows in a straight line between Killard Point and Ballyquintin Point. Figure 8.1 shows the SAC boundary in Strangford Lough.

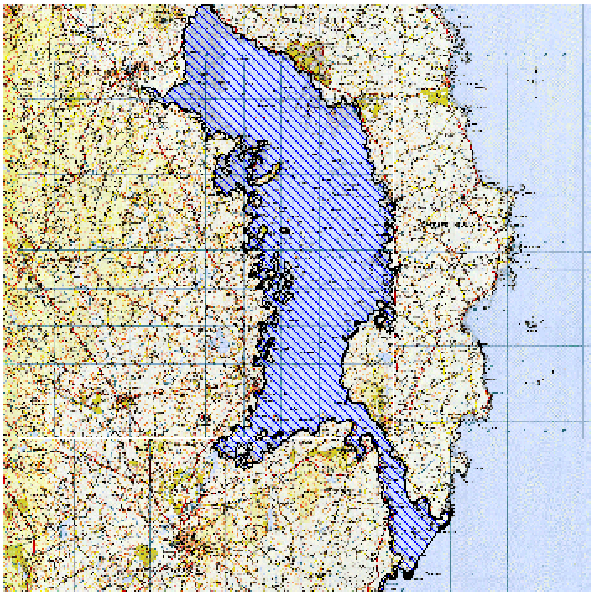


Figure 8.1 Map of SAC boundary in Strangford Lough

(From NBN gateway, www.searchnbn.net)

The features for which the SAC has been designated are officially recorded by the JNCC as follows:

- ***Large shallow inlets and bays*** – *With a wide range of tidal stream strengths and depths, there is a remarkable marine fauna within Strangford Lough and it is one of the most diverse sea Loughs in the UK. The communities present range from the very rich high-energy communities near the mouth, to communities in extreme shelter where fine muds support burrowing brittlestars, Dublin Bay prawn Nephrops* *norvegicus, and a rich community associated with horse mussels Modiolus modiolus (Brown et al, 1997), the intertidal boulder reef shores around Strangford are extremely species rich and the intertidal mudflat areas of the north of the site support luxuriant sea grass beds.*

- ***Coastal lagoons** – These are classed as a priority habitat under the Habitats Directive. The 'Dorn' is a silled lagoon on the eastern side of Strangford Lough in Northern Ireland. The Dorn, from the Gaelic word for 'narrow channel', refers specifically to the channel which connects several exceptionally sheltered bays to the main area of the Lough. Near the mouth, rock barriers or sills hold back water as the tide falls, creating saltwater rapids, unique in Ireland. In the area of the Dorn rapids, abundant growths of sea anemones, sponges and ascidians clothe the rock and boulders. Several of the animals found in the area of the rapids normally occur in relatively deep water. These include the featherstar Antedon bifida, purple sun-star Solaster endeca, sting winkle Ocenebra erinacea, king scallop Pecten maximus and light-bulb sea-squirt Clavelina lepadiformis. The main trough of the Dorn supports a dense forest of sugar kelp Laminaria saccharina and sea-oak Halidrys siliquosa. The gravelly-sand bottom has unusually dense colonies of peacock worm Sabella pavonina and sand gaper Mya arenaria, with occasional native oysters Ostrea edulis. The channel immediately above the sill has fast tidal streams without turbulence, enabling sponges to grow to exceptional proportions. The sheltered marine 'ponds' feeding the Dorn feature beds of common eelgrass Zostera marina and the green alga Codium fragile ssp. tomentosoides. (Brown et al, 1997).*

- ***Mudflats and sandflats not covered by seawater at low tide** - The intertidal mudflats and sandflats in the north of Strangford Lough represent the largest single continuous area of such habitat in Northern Ireland. There are very extensive areas of muddy sand from Newtownards to Ardmillan Bay in the west and to Greyabbey in the east. The habitat also occurs in the south-west reaches of the Lough along the northern shore of Lecale. The northern flats support luxuriant beds of the eelgrasses Zostera noltii and Z. angustifolia. Common eelgrass Z. marina and tasselled pondweed Rupia maritima are also present the latter being widespread but quite local in its distribution. Many of the invertebrate species present in moods also occur in muddy sand. However, lugworm Arenicola marina and nereid worms are generally dominant, along with bivalve molluscs such as Angulus tenuis, Mya arenaria and Cerastoderma edule (Brown et al, 1997).*

- ***Reefs** - Reefs in Strangford Lough vary from tide-swept bedrock and large boulders in the main channel of the Narrows, through sand-scoured bedrock and boulders at mouth of the Narrows, to more sheltered bedrock and boulders in the main central portion of the Lough and in parts of the intertidal. Beds of horse mussels M. modiolus form extensive biogenic reefs within the central portion of the Lough. However, recent survey work has suggested that the quality of these beds has rapidly declined and their status is at this time unclear. Within the Narrows there is a range of tidal current conditions and habitats. Tidal streams range from moderate to extreme and habitats are predominantly rocky with bedrock, boulder and mobile cobble habitats occurring within the Narrows. The marine communities in the Narrows reflect this diversity of conditions and habitats, stable bedrock and boulder reefs are entirely clothed in suspension-feeding species, notably the soft coral dead-men's fingers Alcyonium digitatum, sponges, especially Pachymatisma johnstonia and the rock-boring Cliona celata (which in some areas may reach massive proportions), ascidians, particularly Dendrodoa grossularia and Corella parallelogramma, and sea-anemones including Metridium senile. Very large boulders strew much of the bed of the Narrows, and are subject to strong tidal streams. These boulders support encrusting sponges, such as Myxilla incrustans and Esperiopsis fucorum, with abundant hydroids, especially Tubularia indivisa, and Sertularia argentea and sea anemones, including Sagartia elegans, Corynactis viridis and Actinothoe sphyrodeta. Coarse sand scours rock* *surfaces at the sides and either end of the Narrows. Here the characteristic species is the bryozoans Flustra foliacea.*

Massive boulders (glacial erratics or the cores of eroded drumlins) occur on the shore and form rocky islands known as 'pladdies'. Whilst Silurian rocks predominate, there is sandstone at Mountstewart and limestone at Limestone Rock. The fauna and flora associated with these outcrops are dependent on the rock type, the angle of bedding-plane and degree of weathering, the position on the shore, and the degree of exposure to currents and waves.

Source www.jncc.gov.uk

The key features of international importance found in the 15,398ha Strangford Lough SAC are summarised in Table 8.2 below.

Table 8.2 Marine SAC features summary data

Feature	Estimated Size/extent/population	Subfeature
Large shallow inlet and bay	15,090 ha (all sub-features)	Subtidal sand and gravel communities
		Subtidal fine sand and mud communities
		Tide swept communities
Coastal Lagoons*	45 ha	Tide swept communities
Mudflats and sandflats not covered by seawater at low tide	2,000 ha (all sub-features)	Intertidal sand and gravel communities
		Intertidal fine sand and mud communities
		Zostera beds
Reefs	5,000 ha (all sub-features)	Subtidal rock and boulder communities
		Subtidal rocky reef communities
		Intertidal rock and boulder communities
		Modiolus modiolus beds – biogenic reefs
Common seal *Phoca vitulina*	210 individuals	n/a

* Priority habitats under the EC Habitats Directive
Figures supplied by Department of Environment, Northern Ireland or sourced from Natura 2000 data form

Annex I habitats that are present within the SAC, but are not a primary reason for its designation or (significantly) within the development area, include:

- Annual vegetation of drift lines;
- *Salicornia* and other annuals colonising mud and sand;
- Atlantic salt meadows (*Glauco-Puccinelietalia maritimae*); and
- Perennial vegetation of stony banks.

The Annex II species common seal *Phoca vitulina* is also present throughout the Lough, but is similarly not a primary reason for the designation of the site.

8.1.2 Strangford Lough SPA

Strangford Lough qualifies as an SPA under the Birds Directive. The SPA boundary is concurrent with that of the SAC, but also includes the freshwater dominated area of the Quoile Pondage National Nature Reserve (NNR).

Strangford Lough is Northern Ireland's most important site for wintering waterfowl due to its extensive areas of mud, sandflats and eelgrass beds, which in turn provide valuable food resources for waterbirds in the form shellfish and other invertebrates. The Lough qualifies as an SPA under Article 4.1 of the Birds Directive by supporting populations of European importance of the following species listed in Annex I of the Directive:

During the breeding season;

- Arctic Tern *Sterna paradisaea*, 210 pairs, representing at least 8.4% of the breeding population in Ireland (5 year peak mean, 1992/3-1996/7);

- Common Tern *S. hirundo*, 603 pairs, representing at least 19.5% of the breeding population in Ireland (5 year peak mean, 1992/3-1996/7); and

- Sandwich Tern *S. sandvicensis*, 593 pairs, representing at least 13.5% of the breeding population in Ireland (5 year peak mean, 1992/3-1996/7).

Whilst many of the key tern breeding sites are some of the islands in the main body of the Lough, terns also breed on the small islets in the Narrows. The important sites close to the proposed turbine include Granagh Bay and Swan Island off Strangford village.

Over winter;

- Bar-tailed Godwit *Limosa lapponica*, 882 individuals, representing at least 5.0% of the wintering population in Ireland (5 year peak mean 1991/2 - 1995/6); and

- Golden Plover *Pluvialis apricaria*, 6,526 individuals, representing at least 3.3% of the wintering population in Ireland (5 year peak mean 1991/2 - 1995/6).

This site also qualifies under Article 4.2 of the Birds Directive by supporting populations of European importance of the following migratory species:

Over winter;

- Knot *Calidris canutus*, 8,723 individuals, representing at least 2.5% of the wintering Northeastern Canada/Greenland/Iceland/Northwestern Europe population (5 year peak mean, 1992/3-1996/7);

- Light-bellied Brent Goose *Branta bernicla hrota*, 10,527 individuals, representing at least 52.6% of the wintering Canada/Ireland population (5 year peak mean, 1992/3-1996/7);

- Redshank *Tringa totanus*, 3,176 individuals, representing at least 2.1% of the wintering Eastern Atlantic - wintering population (5 year peak mean, 1992/3-1996/7); and

- Shelduck *Tadorna tadorna*, 3,871 individuals, representing at least 1.3% of the wintering Northwestern Europe population (5 year peak mean 1991/2 - 1995/6).

The Lough also qualifies as a “Wetland of International Importance” under Article 4.2 of the Birds Directive by regularly supporting a wildfowl assemblage of over 20,000 individuals.

Whist over wintering wildfowl and waders are regularly observed in the Narrows area, and the SPA designation encloses the entire Lough, areas of key importance to wildfowl and waders are generally recognised to be to the north of Strangford Lough Narrows.

8.1.3 Strangford Lough Ramsar site

Strangford Lough qualifies as a “Wetland of International Importance” under the Ramsar convention on *Wetlands of International Importance,* especially as waterfowl habitat. The following descriptions are taken from the EHS website:

The site qualifies under Criterion 1 by virtue of supporting a variety of important wetland features. Areas of fringing saltmarsh and freshwater habitats support a diversity of wetland plant species. Strangford Lough supports one of the most extensive saltmarsh areas in Northern Ireland.

The site qualifies under Criterion 2a by supporting an important assemblage of vulnerable and endangered wetland plants and animal species. These include a number of marine sponges, marine hydroids, marine molluscs and sea urchins which are restricted to Strangford Lough in Northern Ireland or, in some cases unknown or very rare elsewhere in the British Isles. The mudflats support luxuriant beds of eelgrass; Zostera noltii, Zostera angustifolia, Zostera marina and Ruppia maritima are all present, with the latter being widespread but quite local in its distribution. Such extensive ‘beds’ are rare in the British Isles.

The mammal fauna includes Common Seal Phoca vitulina, Grey Seal Halichoerus grypus and Otter Lutra lutra. Strangford Lough is the most important breeding site in Northern Ireland for the Common Seal.

…the site qualifies under Criterion 3a by regularly supporting over 20,000 waterfowl in winter. The five year winter peak mean for the period 1992/93 to 1996/97 was approximately 70,200 waterfowl, comprising 48,700 waders and 21,500 wildfowl.

The following nationally important species contribute to the overall population of over-wintering waterfowl: Bar-tailed Godwit Limosa lapponica (the five year peak mean for the period 1992/93 to 1996/97 was 1,058 which comprises 6% of the all-Ireland population), Black-tailed Godwit L. limosa 138 (1.5%), Coot Fulica atra 410 (1.6%), Curlew Numenius arquata 1,980 (2.3%), Dunlin Calidris alpina 6,900 (5.5%), Eider Somateria mollissima 33 (1.%), Gadwall Anas strepera 110 (18.3%), Great-crested Grebe Podiceps cristatus 94 (3.1%), Greylag Goose Anser anser 420 (10.5%), Greenshank Tringa nebularia 57 (6.3%), Goldeneye Bucephala clangula 298 (2.7%), Golden Plover Pluvialis apricaria 8,277 (4.1%), Grey Plover 284 (7.1%), Lapwing Vanellus vanellus 9,108 (3.6%), Mallard Anas platyrhynchos 1,562 (3.1%), Mute Swan 129 (2.4%), Oystercatcher Haematopus ostralegus 8,248 (16.5%), Pintail Anas acuta 214 (3.6%), Red-breasted Merganser Mergus serrator 338 (16.9%), Ringed Plover Charadrius hiaticula 305 (2.4%), Shelduck Tadorna tadorna 2,358 (33.7%), Shoveler Anas clypeata 140 (2.2%), Teal 1,662 (2.6%), Turnstone 350 (1.6%) and Wigeon Anas penelope 1,975 (1.6%).

The site qualifies under Criterion 3c by regularly supporting, in winter, internationally important numbers of the following species: Light-bellied Brent Geese Branta bernicla hrota (the five year peak mean for the period 1992/93 to 1996/97 was 10,527 which comprises 52.6% of the international population), Knot Calidris canutus 8,723 (2.5%) and Redshank Tringa totanus 3,176 (2.1%).

The site also qualifies under Criterion 3c by regularly supporting internationally important breeding populations of both Sandwich Tern Sterna sandvicensis and Common Tern Sterna hirundo. The five year means for the period 1993 to 1997 are: Sandwich Tern - 593 pairs, which is 1.2% of international population (13.5% of the all-Ireland population), and Common Tern - 603 pairs, which is 1.2% of the international population (22.3% of the all-Ireland population). The site also supports nationally important numbers of Arctic Tern Sterna paradisaea. The five year mean for the period 1993 to 1997 is 210 pairs (8% of the all-Ireland population).

8.1.4 Areas of Special Scientific Interest

In Northern Ireland ASSIs are the equivalent of the English, Welsh and Scottish designation Site of Special Scientific Interest (SSSI). These sites are designated under the Nature Conservation and Amenity Lands (Northern Ireland) Order (1985). ASSIs are identified as being of the highest conservation value. They have well-defined boundaries and by and large remain in private ownership. The ASSIs designated in and around the proposed development site at Strangford Lough are Strangford Lough (parts 1, 2 and 3), maps of which are provided in Figure 8.2 to Figure 8.4. The area most likely to be affected by the development is Strangford Lough ASSI Part 2.

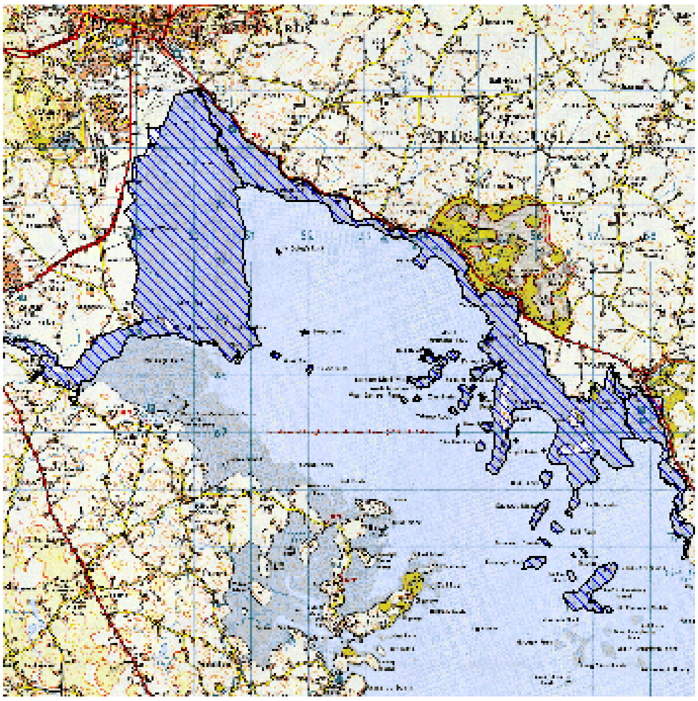


Figure 8.2 Map of Strangford Lough ASSI Part 1

From NBN gateway, www.searchnbn.net

Figure 8.3 Map of Strangford Lough ASSI Part 2

From NBN gateway, www.searchnbn.net

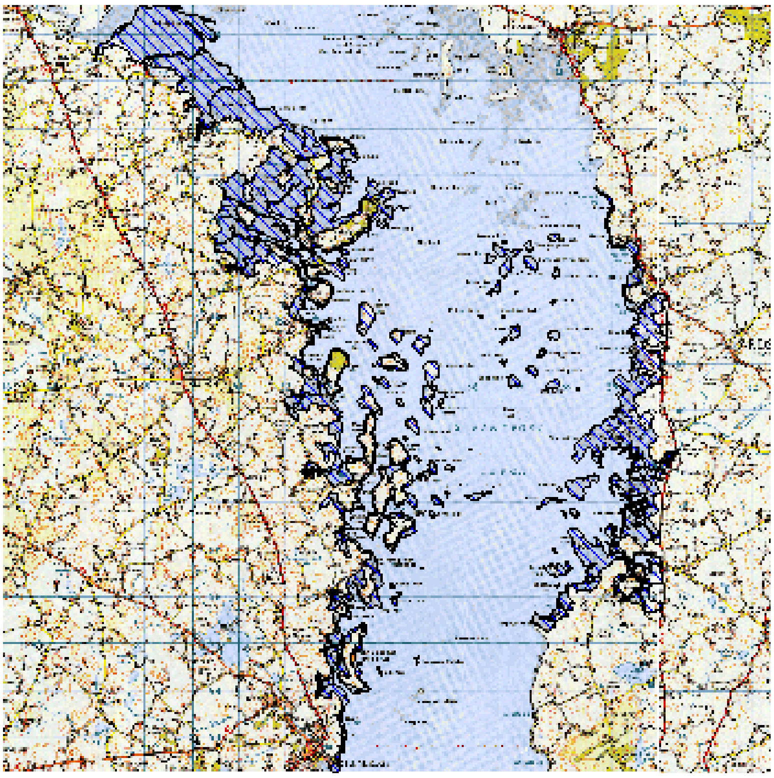


Figure 8.4 Map of Strangford Lough ASSI Part 3

From NBN gateway, www.searchnbn.net

According to the ASSI site citations for Strangford Lough, parts 1, 2 and 3:

The upper part of Strangford Lough, in ASSI Part 1, includes extensive mudflats and also sandflats, saltmarsh and rocky intertidal habitat. The mudflats support luxuriant beds of Zostera (eelgrass). The intertidal mudflats (particularly the Zostera beds) are of great importance as feeding areas for wintering wildfowl and waders. The sandflats and mudflats are especially productive in terms of invertebrate fauna.

The Lough overall supports internationally important numbers of wintering waterfowl and waders, most of which favour the mud flat of the Part 1 area. Furthermore, the relatively extensive areas of estuarine saltmarsh, with its typical assemblage of saltmarsh plants and communities at and around the mouth of the Comber River, are a rare habitat in Northern Ireland.

Within Strangford Lough ASSI Part 1 only, small areas of rocky intertidal habitat occur. However, off South Island, at or around the extreme limit of low water spring tides, is a habitat which is unique within Northern Ireland. This is an unusually stable intertidal habitat consisting of cobbles interspersed with occasional larger boulders lightly but firmly embedded in coarse sand and gravel. In this habitat, there are exceptional growths of many sponge (Porifera) and sea-squirt (Tunicata) species, interspersed with various tube-dwelling worms (Annelida). The diversity of the associated herbivores and detritivores is considerable.

The Part 2 area contains representative areas of a large number of intertidal habitats ranging from soft mudflats to steeply faced bedrock. The principal physical factor influencing these various tidal habitats is the exceptional flow of water through the Tidal Narrows and this gives rise to an extremely diverse flora and fauna. A considerable number of species exhibit the 'emergence phenomenon' where, typically, sublittoral organisms are found living on the shore.

Large numbers of filter feeding organisms take advantage of the high plankton turnover provided by the exceptional water movement and many phyla are represented. The diversity of sea anemones, in particular, is extremely high.

The various sediments range from soft mudflats around Castle Island and Gores Island, through muddy sand as at Bar Hall Bay, to clean sandy bays such as at Kilclief Bay and Mill Quarter Bay. The soft mud flats support a variety of burrowing organisms, whilst the sandy shore at Kilclief Bay supports very dense populations of various deep burrowing organisms.

There are a number of sheltered boulder shores which all have very species rich flora and fauna, particularly the shore around Ballyhenry Island. Granagh Bay on the east coast of the Narrows is extremely interesting with a complete range of substrates occurring within a relatively confined area. At the northern end of Marlfield Bay there is an area of uniformly sloping bedrock which is an uncommon physical feature in the Lough. The classical zonation pattern of intertidal algae and under canopy fauna can be seen here.

Areas of fringing saltmarsh are important in this location because of the diversity of plant species found and the rarity of this habitat in Northern Ireland. A typical assemblage of saltmarsh plants occurs at these sites. In places, there are natural transitions from mudflat and saltmarsh to freshwater fen, maritime heath and scrub, particularly at Bar Hall Bay.

The Part 3 area is an integral part of the Lough as a whole. It contains a great diversity of intertidal habitats, with The Dorn being an area of exceptional note. Extensive mudflats, saltmarsh and other types of shoreline habitat occur, including The Dorn NNR, a unique and exceptionally important site for intertidal flora and fauna.

Extensive areas of mudflats are found on both the east and west shores of the Lough. The mudflats in the sheltered areas around Black Neb have large concentrations of Dwarf Eelgrass (Zostera noltii). The mudflats are rich in invertebrate fauna and provide important feeding grounds for large numbers of wading birds and wildfowl.

The fauna of the upper shore around Saltwater Bridge and Ardmillan Bay reflect a degree of estuarine influence. This type of habitat, with freshwater influence, is rare within Strangford Lough.

The under-boulder and cobble fauna in Strangford Lough Part 3 is particularly well represented at a number of sites where the boulder zone extends to the extreme low water spring tide mark.
(Source www.ehsni.gov.uk)

8.1.5 Strangford Lough Marine Nature Reserve

Strangford Lough was designated as Northern Ireland's first Marine Nature Reserve under the Nature Conservation and Amenity Lands (NI) Order 1985. The reserve includes all the waters, sea bed and shores (up to high water mark mean tide) of Strangford Lough itself plus those of an area around the mouth of the Lough, extending north to Kearney Village, south to Sheepland Harbour and offshore for a distance of ¼ to ½ a nautical mile.

The decision to designate was based on extensive surveys of Northern Ireland's seashore and coastal sea bed which confirmed the importance of the Lough and adjacent coastal waters for marine life. The designation provides for the conservation of the flora, fauna, landforms and other features of scientific interest and for study of these features.

8.1.6 National Nature Reserves

A nature reserve is defined as an area of importance for flora, fauna or features of geological or other special interest, which are reserved and managed for conservation and to provide special opportunities for study or research. Environment and Heritage Service declares nature reserves under the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985. To date, 47 nature reserves have been declared in Northern Ireland. There are seven NNRs relevant to the proposed site at the Narrows, Strangford Lough:

- North Strangford Lough;
- The Dorn;
- Granagh Bay;
- Ballyquintin Point;
- Killard;
- CLoughy Rocks; and
- Quoile Pondage.

All are under the ownership of EHS, except North Strangford Lough, which is owned by the National Trust.

8.1.7 Northern Ireland Biodiversity Strategy

In Northern Ireland, the UK Biodiversity Action Plan is implemented by the Northern Ireland Biodiversity Group in the form of the Northern Ireland Biodiversity Strategy. This strategy facilitates the implementation of the UK Biodiversity Action Plan at a Northern Ireland level for those habitats and species that are important in Northern Ireland. Of the forty priority habitats identified in Northern Ireland, the following are found in and around Strangford Lough. Those present at the proposed development location are marked *.

- Mudflats;
- Seagrass beds;
- Tidal rapids*;
- Maerl beds;
- Littoral sediment;
- Inshore sublittoral rock*; and
- Horse Mussel beds.

Individual species that occur in the Lough are also subject to the Strategy, including Oyster *Ostrea edulis* and the seaweed *Ascophyllum nodosum var mackii*.

The local Biodiversity Action Plan habitats and species listed above are included as key features within the SAC and ASSI designations. They are not considered further here.

8.2 Benthic biology of the Strangford Narrows and proposed turbine site

Strangford Lough provides a mosaic of marine habitats that are subject to varying physical conditions and, therefore, support a diverse faunal and floral assemblage. The sea bed of the Narrows is characterised by rocky outcrops of bedrock and boulders, densely covered in ascidians and hydroids. Due to the powerful currents, only certain highly adapted species are able to colonise and thrive in the Narrows. Those that do, have access to a rich food supply coming in from the Irish Sea and in some areas of particularly suitable substrate and current conditions are able to grow to a size unattainable in less favourable conditions. These species include the Elephant's Ear sponge *Pachymatisma johnstonia*, the giant Boring sponge *Clione cellata* and the soft coral, Dead Man's Fingers *Alcyonium digitatum* (Brown, 1990).

In order to provide a robust baseline against which the potential impact of the turbine on benthic communities could be assessed, a series of 14 transect sites were surveyed. The dive sites were chosen to reflect the two possible turbine locations that are under consideration, as well as a site where the jack-up rig may need to jack its legs down between tides during installation and 11 other control sites to provide context. The context sites were selected from areas of relatively similar depth and tidal exposure as the turbine site to allow the variation in current swept biotopes to be assessed. A further sublittoral biotope survey was carried out following the site investigation works to assess the impact of jack-up barge legs that enabled an independent marine surveyor to verify the first biotope assessment.

Larger boulders, bedrock ridges and exposed bedrock encountered during the dive survey supported a faunal turf with similar biota at each of the sites surveyed. The turf was dominated by the hydroids *Sertularia argentea* and *Tubularia indivisa*, with the sponges *Esperiopsis fucorum, Halichondria panacea* also present and the barnacle *Balanus crenatus* present in places. The anthozoans present were limited to the anemones *Urticina felina* and *Sagartia elegans*, with some patches of soft coral *Alcyonidium digitatum* also present. Mobile fauna included caprellids on the hydroids; the crabs *Pagurus bernhardus*, *Cancer pagurus*, *Hyas coarctatus* and *Liocarcinus puber*; the dogwhelk *Nucella lapillus*; and the starfish *Asterias rubens*. The faunal turf was also noted to support large numbers of caprellid amphipods. A detailed report of the dive survey undertaken as part of this EIA is included in Appendix 17.

8.2.1 Biotope assignment and assessment

The current (Connor *et al.*, 2004) and older (Connor *et al.*, 1997) versions of the UK biotope classification were used to classify the biotopes encountered. The two biotopes provisionally assigned to the current swept faunal crust encountered in Strangford, based on the most recent (2004) classification, are:

CR.HCR.FaT.BalTub; and
CR.HCR.FaT.CTub.Adig.

These biotopes are described as occurring "typically on upward-facing, extremely tide-swept, circalittoral bedrock, boulders and cobbles".

The difference between the two biotopes is largely due to increasing degree of tidal current and a consequential fall in species richness from **CR.HCR.FaT.BalTub** to **CR.HCR.FaT.CTub.Adig.**

Distribution data for biotopes in the British Isles is not widely available using the 2004 classification, however, a conversion table produced by JNCC to accompany the 2004 classification allows the assignment of equivalent 1997 biotopes, for which distribution data can be obtained. The following biotopes are indicated using that table:

CR.ECR.BS.BalTub;
CR.ECR.BS.BalHpan; and
CR.ECR.Alc.AlcTub.

Of these biotopes, **CR.ECR.BS.BalHpan** is found in areas of variable or low salinity and, therefore, is not applicable to Strangford Lough Narrows. The other two biotopes are both limited in distribution to areas of strong tidal current, with one, **CR.ECR.Alc.AlcTub,** being uncommon but widely distributed in areas of strong tidal current, including the Pentland Firth, Strangford Lough Narrows and Kyle Rhea. Within the context of Strangford Lough Narrows, survey dives completed as part of investigation carried out for this project indicate the presence of one biotope provisionally assigned the 1997 code **CR.ECR.Alc.AlcTub**. The second biotope, **CR.ECR.BS.BalTub**, is restricted to sites with extremely strong tidal currents, and has been recorded in only two other major locations, the Menai Strait and the Coryvreckan whirlpool.

Generally, it is concluded that the benthic ecology within the areas surveyed is represented by hardy species adapted to survive in the harsh tide swept conditions and the MarLIN recoverability work suggests that these are species which will re-colonise and recover rapidly from any habitat disturbance.

8.3 Other benthic SAC features of Strangford Lough

In order to ensure full consideration is given to internationally protected features of the Strangford SAC it is necessary to consider the potential impacts of this proposal on features outside the immediate study area. Figure 8.5 shows a high level overview of the Lough and its subtidal communities.

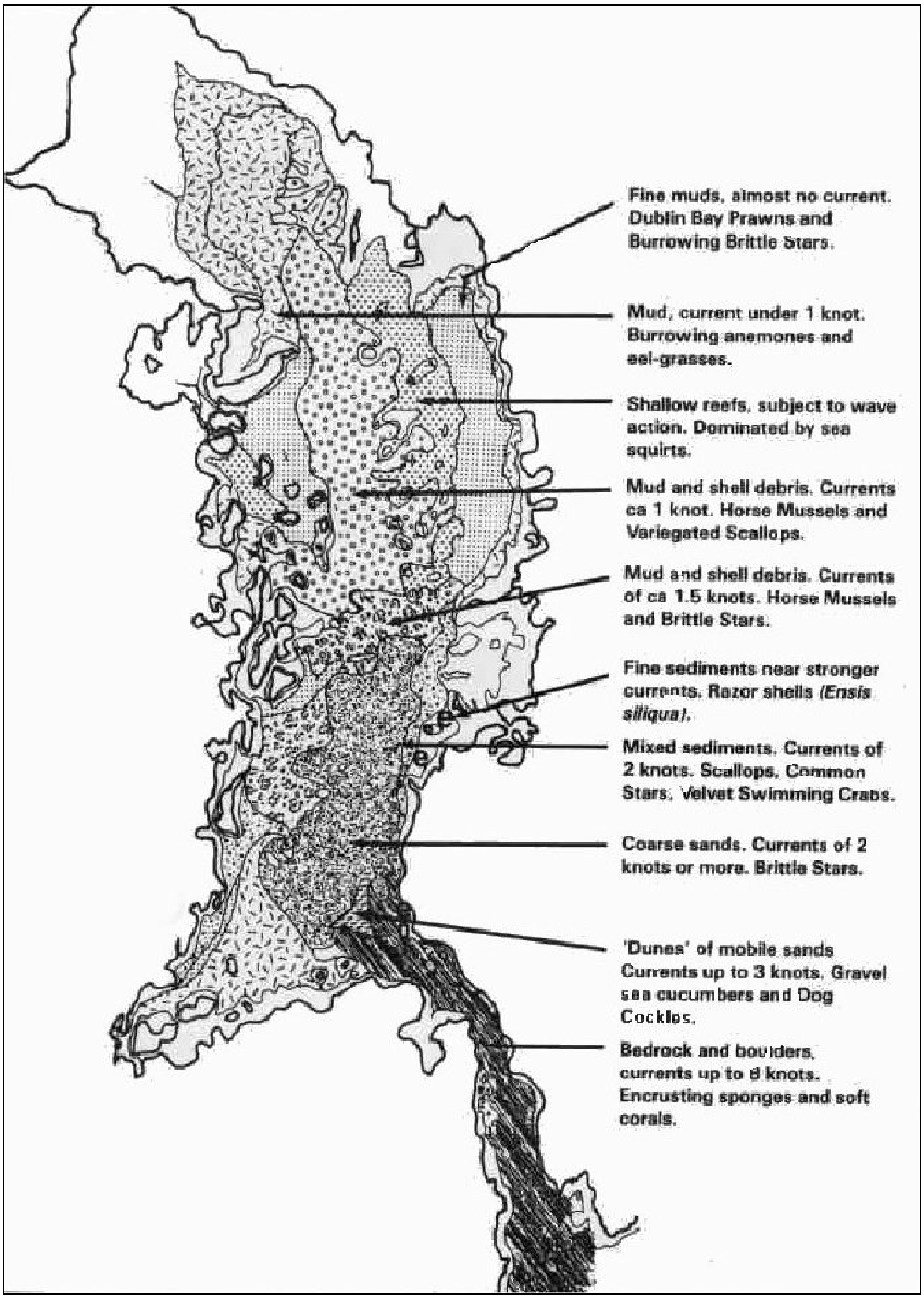


Figure 8.5 Subtidal Faunal Communities of Strangford Lough (After Brown, 1990)

The benthic habitats for which Strangford Lough has been identified include various sub-features of reefs and large shallow inlets or bays as follows:

Sub-features of large shallow inlets or bays:

- Subtidal sand and gravel communities
- Subtidal fine sand and mud communities

Sub-features of reefs:

- *Modiolus modiolus* beds
- Subtidal rock and boulder communities
- Subtidal rocky reef communities

The reef sub-features present in the Narrows that relate predominantly to subtidal rock and boulder communities have been discussed in Section 8.2.

8.3.1 Intertidal rock and boulder communities

It is recognised that removal of energy from the overall system and changes to sedimentation as a result of impacts to the hydrodynamic regime as discussed in Section 7 represents a potential route through which intertidal habitats may be affected. However, it must be noted that the proposed turbine would be in place for only 2-5 years, a time period over which it is considered highly unlikely that any detectable change is likely to occur in relation to intertidal habitats. When also considering the tiny fraction of overall energy removed from the system as a result of the turbine activity it is reasonable to conclude that there will be no significant, long-term irreversible damage, or even change, to intertidal habitats as a result of this proposal. This is supported by modelling results in Appendix 12. Intertidal habitats are therefore not considered further in detail as the presence of an impact pathway is not reasonably demonstrable.

The reef sub-features 'subtidal rock and boulder communities' are predominantly found in the Narrows and as such are considered in more detail in Section 8.2.

8.3.2 Subtidal sand and gravel communities

This sub-feature relates mainly to very coarse sands at each end of the Narrows. These substrates are formed into sand waves or mega-ripples running perpendicular to the tidal flows. Such areas tend to be lower in diversity than more sheltered locations due to their mobility, supporting species such as the Dog Cockle (*Glycymeris glycymeris*) and Purple Heart urchin (*Spatangus purpureus*) off Ballyquintin Point (Strangford Lough Management Scheme, 2001). In currents of around 2kn coarse sands and cobbles are found, and cleaner sands are present in the mouths to open bays such as Granagh Bay. There are also small areas of maerl found off Audleys Road and Ballydorn.

8.3.3 Subtidal fine sand and mud communities

This sub-feature is found in areas of lower tidal and wave energy than the cleaner sand and gravel communities. The habitat varies from clean rippled sand through to fine mud depending on the degree of exposure. These varied habitats support a range of species including commercially important Dublin Bay prawn (*Nephrops norvegicus*) in fine mud and King Scallop (*Pecten maximus*) in areas of finer sand. These sub-features tend to be found away from the centre of the Lough, where the fine mud is considered as part of the biogenic reef sub-feature.

8.3.4 *Modiolus modiolus* beds

Strangford Lough contains biogenic reef structures formed by the Horse mussel *Modiolus modiolus* in three main forms. The fully developed climax community, is found in very sheltered parts of the Lough along with the Variable (*Chlamys varia*) and Queen (*Aequipecten* opercularis) scallops as co-dominant species; a community that is influenced by slightly higher water movement is found in the central to south-western part of the Lough where the co-dominant species is replaced by Brittle star (*Ophiothrix fragilis*) and *Ophiocomina nigra*; and sparser communities are found around the fringes of these areas with smaller numbers of clumping *Modiolus*.

These biogenic reefs support a high diversity of species, mainly either epifauna or mobile fauna that are able to colonise or use the hard substrate for protection and feeding. The most recent assessment of the condition of Modiolus beds concludes that the sub-feature is no longer in favourable conservation status in the Lough (Roberts *et al.*, 2004 and Roberts, 2003). It is also considered that the *Modiolus* beds showed no sign of recovery as a result of changes in management since 1993, and that the loss of extent of the biogenic reef amounted to around 3.7km^2, over 90% of the original resource.

The MarLIN sensitivity table for *Modiolus* beds is provided in Table 8.3.

Table 8.3 Sensitivity of *Modiolus modiolus* beds to selected occurrences that could arise from development in the marine environment

	Intolerance	Recoverability	Sensitivity
Physical Factors			
Smothering	Intermediate	Low	
Increase in suspended sediment	Low	Immediate	Not sensitive
Decrease in suspended sediment	Low	Immediate	Not sensitive
Increase in water flow rate	Intermediate	Low	
Decrease in water flow rate	Intermediate	Low	
Increase in turbidity	Low		
Decrease in turbidity	Tolerant*	Not Relevant	Not sensitive*
Chemical Factors			
Synthetic compound contamination	Intermediate	Low	
Heavy metal contamination	Low		
Hydrocarbon contamination	Low		
Biological Factors			
Introduction of microbial pathogens/parasites	Low		

From www.marlin.ac.uk

It is important to note that *Modiolus* beds are considered as sensitive to changes in patterns of sedimentation as this can result in smothering of the mussels themselves, which are normally associated with more energetic situations.

8.3.5 Subtidal rocky reef communities

This sub-feature is found in areas of reduced but still fast tidal flow, mainly along the sides of the Narrows and near each end of the Narrows. Characteristically robust species of algae, coral and encrusting algae and epifauna such as the Lemon sea-mat

(*Flustra foliacea*) are found on raised cobble ‘pladdies’ and rock scoured by sand abrasion. Shallower areas support algae characteristic of moderate exposure such as Oarweed (*Laminaria digitata*) and Cuvie (*L. hyperborea*).

8.4 Fisheries

The main fishery in the Narrows involves creel fishing for lobster and crabs. Creel fishing for *Nephrops* has also taken place in Strangford Lough. Sensitivity maps produced by the various Fisheries Agencies with support from other industry bodies (Coull *et al*., 1998) indicate that sprat *Sprattus sprattus* may spawn in the Lough during May to August.

Although it is recognised that the study area has the potential to act as a spawning area for this species, it is important to note that, for sprat, spawning occurs in nearshore areas throughout the UK. Therefore, although spawning does occur in Strangford Lough, this area only constitutes a very small proportion of the total spawning area of the species.

The range of species of shellfish present within the study area is likely to be typical of similar areas in this part of the UK. Based upon previous studies carried out in Strangford Lough, it is possible to determine the range of shellfish species that are present. These include:

- Lobster (*Homarus gammarus*);
- Prawns (*Nehrops*);
- Crabs (*Cancer, Necora, Carcinus*);
- Horse mussels;
- Scallops Pecten maximus and Aequipecten opercularis
- Dog cockle Glycymeris glycymeris; and
- Curled octopus *Eledone cirrhosa*.

Advice from the Department of Culture, Arts and Leisure suggests that sea trout (*Salmo trutta*) are likely to pass through the Narrows and there is an interest in developing a leisure fishery based around the sea trout in Strangford Lough. It should also be noted that there has been recent effort put into reinstating the flat oyster (*Ostrea edulis*) fisheries. There is also an oyster farm producing pacific oysters (*Crassostrea gigas*) utilising a number of sites in the Lough.

8.5 Marine mammals

Strangford Lough is recognised as hosting an important common seal population, although this is not the primary reason for which the Lough has been identified as an SAC. It also hosts grey seals, and sightings of various cetaceans have been recorded over the years, in particular harbour porpoise.

8.5.1 Seals

Two species of seal are known to inhabit or visit Strangford Lough; the common (or harbour) seal *Phoca vitulina* and the grey seal *Halichoerus grypus*. Limited information on the distribution of these species is available in observational records going back to the 1970s (EHS *pers comm*). A review of this data has been completed in order to inform this impact assessment and is presented in Appendix 18. Furthermore, a total of three months real time observational data has been gathered over the spring and early summer of this year in order to provide an indication of seal behaviour in and use of the

Narrows as part of the baseline studies providing reference for the environmental monitoring programme. A summary of the review of historical data is provided below.

1. The number of harbour seals in the Lough has declined in recent years, but there are still about 200 adults and subadults assembling in the Lough during the June/July breeding season, representing a significant decline from around 800 in the 1980s, and about 20–30 pups born each year. This decline is thought to be continuing. The number of grey seals in the Lough during the October peak breeding season has increased in recent years to nearly 80 adults and subadults and 30–40 pups [this figure is thought to be an overestimate, although could represent an underestimate of adult numbers or adult to sub-adult ratios]. Most (60–80%) of the harbour seals pups and almost all of the grey seal pups are born in the main body of the Lough, north of the Narrows. Breeding adults must therefore pass through the Narrows on their way to and from the sea, and weaned newborn pups must pass through the Narrows on their first journey to sea from their natal site, and on subsequent journeys. Seals are sometimes seen riding the fast current in the centre of the Narrows channel, in towards the main body of the Lough on the flooding tide and out on the ebb.

2. At present population levels, at least about 100 adult or subadult harbour seals and about 20 pups using the northern part of the Lough would be expected to travel in and out of the Lough via the Narrows during the summer season. Preliminary tracking studies suggest these seals may only go in and out of the Lough 2–3 times each season (resulting in a minimum of about 300 adult and 60 pup 'seal trips'). Preliminary tracking studies may suggest that harbour seals hauling out at the mouth of the Lough are not enter the northern part of the Lough at all [although this is based on a very small sample size of two individuals (Sue Wilson *pers comm*)].

3. At present population levels, at least about 30 adult and subadult grey seals would be expected to pass in and out of the Lough, at least at the beginning and end of the autumn breeding season, and at least about 20 newly weaned pups would be expected to pass through the Narrows while leaving the Lough. Seals of both species and all ages use the north of the Lough in smaller numbers outside the breeding season and therefore would be expected to make use of the Narrows channel en route in and out. In the winter months a greater proportion of the harbour seal population uses the haul-out sites in the Narrows.

The Strangford Lough common seal populations are likely to be part of a wider south west Scotland population (SMRU *pers comm*), although there is little published evidence to support this at this time. The reasons for the decline in numbers are not known, although investigations currently centre on loss of food resources and disturbance from general increased levels of disturbance to their breeding or haul out sites (Sue Wilson and Judith Montgomery Watson *pers comm*). It is likely that the Strangford Lough common seals are part of the greater population in south western Scotland, although there has been no empirical research carried out to provide evidence of this assertion. Influx and export of animals to this population appears to happen regularly (SMRU, *pers comm*). The main contributor to improving understanding of the seal populations in Strangford Lough is the EHS through their existing SAC monitoring programme, although significant contributions would appear to be made by volunteers and NGOs such as the National Trust's Strangford Lough wildlife schemes.

Seals are thought to use the Narrows as an access route to the main body of Strangford Lough and islands within the Narrows for hauling out and breeding (Appendix 18). Haul out sites at the mouth of the Lough are thought to attract predominantly grey seals. Haul out sites in the mid Narrows include Cloghy Rocks NNR and Granagh Bay NNR. Both of these islands are important common seal haul out sites but also host grey seals. The area known as Yellow Rocks around to the North of Castle Hill, at Ardkeen, is known to be a favoured, secluded pupping area for common seals.

Foraging behaviour by seals is relatively poorly studied, although it is generally thought that short dives to less than 100m depth are made. It is known that seals utilise a number of senses to detect their environment and to enable them to hunt in often low visibility conditions. Seals are known to rely on eyesight as well as their vibrissae to detect vibrations and touch at close range. However, recent research work has suggested that detecting of sound or pressure changes may play an important role in assisting seals to sense their environment and to hunt efficiently. Initial research undertaken by the Sea Mammal Research Unit (SMRU, *pers comm*) suggests that seals may rely upon a form of passive sonar through which they sense the environment and form sound 'maps' of their sea bed surroundings, whilst relying on vision and vibrissae for 'close work' associated with hunting.

Seals are known to habituate to stimuli or other activities in their environment, for example in relation to potential predators as confirmed by Deecke et al. (2002). It is logical to extrapolate this to physical features of common seals' local environment, and in the Strangford Narrows seals must have become accustomed to water based disturbance such as the Strangford-Portaferry ferry. There is a paucity of research on which to base a judgement as to how long such habituation has taken.

Common seals are likely to be most sensitive to direct disturbance during the breeding season in June and July (EHS *pers comm*) as it is this time of year that most time is spent hauled out before pups are weaned. Grey seals breed between September and November and spend more time hauled out as their pups enter the water closer to weaning than common seal pups.

8.5.2 Cetaceans

Cetaceans (whales, dolphins and porpoise) are reported in Strangford Lough on a regular but infrequent basis. According to non-effort limited observations by National Trust staff the harbour porpoise *Phocoena phocoena* is the most frequent can often be seen foraging for fish throughout the Lough. Anecdotal observations suggest that a weak variable front line in the Lough between Ballyhenry Island and Dunyneil Island is an area where porpoise have been sighted by yachtsmen and other Lough users. A less common visitor to the Lough is the bottlenose dolphin *Tursiops truncatus*. Pilot whales *Globicephala melaena* have been seen at the Lough entrance. Whilst the killer whale *Orcinus orca* is also occasionally sighted within the Lough itself, the last documented sighting was 1982. Subsequently, two killer whales have stranded in Northern Ireland, one in Rathlin Island and another in Belfast Lough (CEDAR http://www.habitas.org.uk).

8.6 Basking sharks and elasmobranchs

Basking sharks are the largest fish in UK waters and the second largest in the world. In the UK they have been recorded mainly in surface waters from April to September. The basking shark is thought to be oviparous, but the life cycle is poorly known. The basking shark is protected in waters around Great Britain under Schedule 5 of the Wildlife and Countryside Act (1981) and further protected from disturbance and harassment under the Countryside and Rights of Way Act (2000) around England and Wales. This level of protection has not yet been adopted into Northern Irish legislation. The basking shark's global status is assessed as vulnerable in the 2004 IUCN Red list.

Basking sharks have historically been recorded in Strangford Lough. The Marine Conservation Society (MCS) have confirmed this is likely to still be the case and recently reported that Strangford Lough may be a hotspot for basking sharks (MCS *pers comm*, data from 2003). Whilst this report is based on non effort limited sightings the observations are broadly supported by anecdotal reports collected during our consultations. It is likely that low numbers of basking sharks visit the Lough most years, although the sightings data indicates that most of these visits are to the Lough entrance, downstream of the proposed turbine location (Figure 8.6).

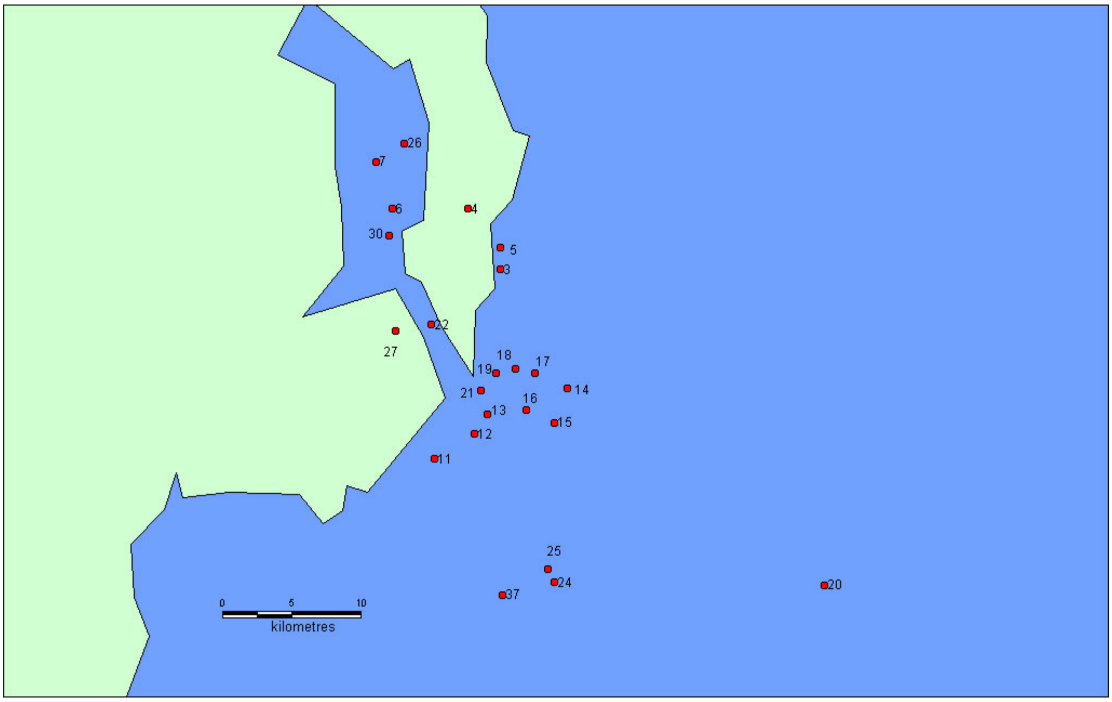


Figure 8.6 Basking shark sightings reported to the Marine Conservation Society between 1987 and 2002 from waters around Strangford Lough

(Source: MCS)

Elasmobranchs have traditionally been a much sought after, over-exploited commercial fish. MCS reported in 2002 that all flat-bodied elasmobranchs over 120cm have disappeared from the Irish Sea, with the cause of this decline being attributed to likely unsustainable fishing pressure.

Elasmobranchs are known to have electroreceptive organs and to utilise electric fields for prey detection, orientation and navigation. Gill and Taylor (Countryside Council for Wales, 2001) reported on the potential effects of electromagnetic fields generated by cabling between offshore wind turbines (and to land for grid connection) upon elasmobranch fishes and recommended that further studies would be required on work of this kind. The Crown Estates research programme, known as COWRIE, has resulted in completion of a phase 1 report that examines the fields generated by subsea cables and Phase 2 of this research is currently under way, expected to report in 2005.

8.7 Otters

EHS have recently published a report reassessing otter numbers in Northern Ireland (EHS, 2004). Otters were not recorded along coastal stretches of Antrim and Down, but were found along the Ards Peninsula and Strangford Lough.

Positive signs of otter activity were found at eight locations around Strangford Lough during 2002, some of these being in the Narrows area. It is, therefore, assumed that otters are active throughout the Narrows.

8.8 Ornithology

As mentioned in Section 8.1 Strangford Lough has been designated as both an SPA and a Ramsar site for a number of bird species. Aside from the species for which the SPA has been designated, the Lough also supports a wide range of other species, often associated with the open sea, which exploit its rich food supply and sheltered conditions. There are likely to be numerous bird species that use or pass through the Narrows, although no data currently exists to characterise this (RSPB and National Trust *pers comm*).

Species that use various methods of diving to feed are considered to be the most important group of birds in relation to this proposal due to the sub-surface activity of tidal turbines. The main species reported to use the proposed site of the area of the turbines include:

- Terns (Sandwich, Common and Arctic)
- Gannet *Sula bassana*;
- Cormorant *Phalacrocorax carbo*;
- Shag *P. aristotelis*;
- Red-breasted merganser *Mergus serrator*;
- Black guillemot *Cepphus grille*;
- Razorbill *Alca torda*; and
- Common guillemot *Uria aalge*.

It is proposed that key species requiring further consideration in this ES are Sandwich, Common and Arctic terns due to their nationally and internationally important breeding populations over the summer months and anecdotal evidence that they are the main species feeding in the Narrows. The National Trust monitors breeding colonies of terns in the Lough and report that no colonies are present south of Swan Island near Strangford Harbour. There is a paucity of data on numbers feeding in the Narrows, so it is assumed that the area is well used, based on anecdotal observations and the initial results of baseline observations carried out in support of this proposal. Terns are plunge divers, feeding on small fish such as sand eels within depths normally of 1-3m (Cramp, 1985).

Whilst the majority of Gannet feeding activity is likely to be found closer to Killard Point it is possible that they feed further up the Narrows, closer to the proposed turbine location, although it is considered unlikely that this will be in significant numbers (RSPB *pers comm*). Cormorants and shag are regularly seen passing through the Narrows. Gannets and Cormorants are therefore also given consideration as two deeper-diving species present in the Narrows that could be considered as representative of the most likely species to be affected by the presence of a turbine. Gannets are known to dive up to 15m and Cormorants between 3 and 9m (Cramp, 1985).

8.9 Alien species

8.9.1 *Sargassum muticum*

Sargassum muticum, commonly known as wire weed, strangle weed or 'Jap' weed, is a perennial brown seaweed that grows just below the low water mark in the shallow sublittoral or in areas of standing water on the lower shore, such as channels, pools and lagoons. *S. muticum* was first identified and recorded growing in Strangford Lough in mid-March 1995. Four annual studies were commissioned (1995-1998) by EHS to investigate the distribution, status and management implications of the introduction of *S. muticum* to Strangford Lough (Davison, 1998). Additionally, there were concerns that the introduction of this species would displace other native species. The introduction of *S. muticum* can have a number of other implications that relate to the amenity, recreational and commercial uses of coastal areas.

8.9.2 *Spartina anglica*

Spartina anglica is a stout, rhizomatous salt marsh grass that spreads by clonal growth, often forming extensive meadows. *Spartina* was deliberately introduced into the Lough in the 1940s, in an attempt to stabilise a causeway. In 1997 *Spartina* covered over 30ha of Strangford Lough. Measures have been employed to control the spread of *Spartina*, however fears that this operation might be having an adverse affect on farmed shellfish and the *Modiolus* beds have led to the suspension of the spraying operation. As a result, the grass has recolonised and *Spartina* continues to spread within the Lough (SLECI Work package 10, 2004).

8.10 Impact assessment for key ecological features within Strangford Lough, including Natura features

The purpose of this section of the ES is to assess the potential impacts of the proposed Seagen development upon the key ecological and nature conservation interests of the Strangford Narrows. It is also necessary to ensure that sufficient information is available to determine whether the development is likely to have a significant effect on the SAC and SPA features of the Lough, and, if such effects are considered likely, to assist the Competent Authority in carrying out an assessment of the potential impacts arising from the development on Natura 2000 interests within Strangford Lough.

Included within this section are assessments relating to each of the Natura 2000 features and the impacts predicted of the installation, operation and decommissioning of Seagen. The issue of whether Seagen will adversely affect the integrity of the European sites with respect to each relevant feature is considered, and these assessments are summarised in Appendix 19 of this report. It is anticipated that this will form the basis on which any appropriate assessment is carried out by the Competent Authority under Regulation 43(1) of the Habitats Regulations in line with advice on Article 6 of the Habitats Directive.

In each of the ES sections below the predicted impacts are discussed more fully, mitigation measures suggested where appropriate and assessment and monitoring regimes proposed.

8.11 Potential construction and decommissioning period impacts and mitigation measures

8.11.1 Benthic habitats and species in the Narrows

Installation of the turbine monopile will require the use of a jack-up barge to provide a safe working platform and a sufficiently large vessel from which to drill the pile foundations (see Appendix 2 for full description). The barge will utilise up to eight jack-up legs which, once held in the correct position by tugs, will be lowered onto the sea bed. The platform will then be jacked up and drilling operations commenced. Each of the rig's eight legs has a diameter of 1.8m but the observed area of impact during post-site investigation surveys was consistently around 4m diameter. Taking a 4m diameter circle as a precautionary impact zone for each leg, this gives a minimum area of impact of approximately $100m^2$. The depth of water in which the legs will be deployed will allow a full drop to the bottom. As set out in the method statement, it is considered that very little lateral movement from the legs is likely. In addition, the legs are pointed, thereby further reducing the likely contact area. This has been validated by dive surveys carried out following the Site Investigation work which also employed the jack-up barge, in which impact zones of three legs were located, measured as approximately 4m diameter, and it was found that no lateral movement or scraping occurred along the sea bed (Appendix 5).

From the dive survey undertaken as part of the initial investigations, the preferred turbine site in the Narrows shown in Figure 2.1 is colonised by a hydroid and sponge turf typically comprising *Tubularia indivisa,* along with the sponge *Esperiopsis fucorum,* hydroids *Sertularia argentea* and the anemones *Urticina felina, Corynactis viridis* and *Sagartia elegans*. These are common and widely distributed species characteristic of high energy, tide swept sites. Neither the full subtidal dive surveys nor the post-site investigation works surveys recorded the presumably long lived massive form sponges that are noted in some areas of the Narrows. It seems likely that the peak current in the areas most favoured for the turbine installation do not favour the growth of these large sponges. A report of the full benthic dive surveys is provided in Appendix 17 and the post-site investigation survey in Appendix 5.

To consider the sensitivity of the biotopes present, the protocols and advice available from MarLIN (Marine Life Network) has been used. The MarLIN sensitivity assessment allows a comparative assessment to be made of the sensitivity and recoverability of marine biotopes. Biotopes are considered representative if they are functionally similar, occur in similar environmental conditions and/or the same species are used to indicate biotope sensitivity.

The 'sensitivity' of the biotope(s) to certain occurrences found in the Narrows is represented by the biotope IR.AlcByH (*Alcyonium digitatum* with a bryozoan, hydroid and ascidian turf on moderately exposed vertical infralittoral rock) on the MarLIN website. Those likely impacts of the site investigation works that are relevant are shown in Table 8.4 below, along with their sensitivity.

Table 8.4 Sensitivity of IR.AlcByH to selected occurrences that could arise from development in the marine environment

	Intolerance	Recoverability	Sensitivity	Species Richness
Physical factor				
Substratum loss	High	High	Moderate	Major decline
Smothering	Intermediate	High	Low	Decline
Increase in suspended sediment	Low	Very high	Very low	No change
Noise	Tolerant	Not relevant	Tolerant	Not relevant
Visual presence	Tolerant	Not relevant	Tolerant	Not relevant
Abrasion and physical disturbance	High	High	Moderate	Major decline
Displacement	High	High	Moderate	Major decline
Chemical factor				
Synthetic compound contamination	Intermediate	High	Low	Decline
Heavy metal contamination	Low	High	Low	No Change
Biological factor				
Introduction of non-native species	Tolerant	Not relevant	Tolerant	Not relevant

From www.marlin.ac.uk

From the above table it can be seen that the likelihood of the tide swept communities recovering quickly once the jack up rig is removed is considered to be very high. Although a species richness decline may be apparent in the short term, the communities in this area are dominated by species that are likely to recover quickly once the disturbance is removed. From observations on the post-site investigation dive survey it was also noted that the leg impact zones are broadly similar to the localised areas of scour that occur naturally throughout this biotope as a result of tidal action.

Direct loss of habitat

Drilling the pile socket will result in the loss of a circle of habitat 3.1-3.25m across. On decommissioning, the pile will be cut below sea bed level and removed, leaving a circular dish which will fill with mobile cobbles and gravel. This will result in the loss of a small area of subtidal habitat. Typically, the area involved for a single turbine would be approximately $12m^2$. In the context of the biotopes present around the proposed installation location this represents a negligible loss of habitat.

Impacts arising from placing of jack-up barge legs on the sea bed are considered to be very short-term and recoverable, therefore it is not appropriate to consider this loss of habitat cumulatively. Based on experience from post-site investigation works surveys (Appendix 5) it is anticipated that approximately $100m^2$ of sublittoral habitat will be temporarily, reversibly affected by placing of the jack-up legs on the sea bed.

Given the small area of the expected footprint of installation operations, the rapid recovery that can be expected and the presence of similarly scoured areas in the vicinity of the surveyed area it is judged that use of the drilling rig at the proposed site in Strangford Narrows will not have a significant impact on the integrity of the SAC feature. Additionally, as the structure proposed for the Strangford location is itself temporary and will be removed in 2-5 years, the MarLIN sensitivity and recoverability assessment undertaken suggests that this loss of habitat will very rapidly recover once the monopile is removed through recolonisation by the relatively robust hydroids and sponges found around the installation location. The environmental impact is considered to be localised and reversible, therefore the residual impact is **negligible**.

Release of particulates during drilling
The release of particulates during installation of the monopile and directional drilling and the potential impact on water quality are discussed in Section 7. A maximum of 160m^3 of solid material would be released during the monopile drilling process if all solids were included in the discharge. This will be mitigated by the use of settlement tanks to remve all particles greater than 3.5mm in diameter, a process that is expected to remove approximately 50% of the drill cuttings (Seacore *pers comm*). In addition, 25m^3 of aqueous drilled material containing approximately 2t of drilling mud will be discharged during the directional drilling process for electric connection cable installation. These operations may impact upon the benthic fauna of the Narrows by direct smothering or through an increase in the suspended solids loading of the water with consequent decrease in light penetration. The potential for smothering of organisms/ communities in the vicinity of the turbine site depends on the dispersion characteristics of the sediment or drill cuttings (e.g. current velocity, position of point of discharge in the water column). A full report investigating these impacts using 3-dimensional modelling is provided in Appendix 12.

It is important to bear in mind the existing levels of suspended sediment in the Narrows when considering the potential impacts of sediment released from drilling operations. QUB data indicates that there is significantly greater transfer of sediment through the Narrows in comparison with the amount of solids that will be released during drilling operations, as illustrated in Table 7.2. The finer drill cuttings will be released into a high energy turbulent tidal system, facilitating excellent dispersion. Modelling studies indicate that the impact of any resulting layer of sediment deposited in the Lough would be un-measurable (Appendix 12). It is therefore considered highly unlikely that any changes to the sediment character will occur as a result of changes in the hydrodynamic regime due to the short construction phase, therefore the release of particulate matter during drilling will have a **negligible** effect on the benthic habitats and species in the Narrows.

Risk of pollution incident during installation
The risk of spillage of contaminants during the installation and directional drilling process has been considered in Section 7.4.2. The potential for any pollution arising from accidental spillage has been identified and mitigation measures put in place.

8.11.2 Other benthic SAC features

It is important to recognise fully that the *Modiolus* beds for which Strangford Lough has been recognised as internationally important are currently considered to be in unfavourable conservation status. It is therefore logical to scrutinise any plan or project proposed that has the potential to further influence these features of interest.

It is concluded in Section 7.4.2 that the construction phase for the proposed turbine will not have a significant effect on the sedimentation regime of the Lough on the basis that all large fractions of drill arisings will be contained and the remaining fraction will be completely dispersed (Appendix 12). This means that there is no anticipated mechanism through which either the *Modiolus* beds or the subtidal sand and gravel or subtidal fine sand and mud communities could be affected by construction activities.

The potential for changes in the hydrodynamic regime arising from the presence of the jack-up barge in the Narrows for approximately one month to affect the *Modiolus* beds, the subtidal gravel and sand or the subtidal fine sand and mud communities is also considered in Appendix 12 to represent an un-measurable difference in existing to predicted water velocities outside a zone of 500m from the turbine. The risk that this will cause long term adverse impacts is therefore considered to be so remote that no further investigation is necessary.

These impacts will be localised and temporary. Given the predicted negligible impacts it is not considered necessary for drilling activities to be undertaken only on the ebb tide. The overall impact to benthic SAC features outside the Narrows from construction and decommissioning is therefore characterised as **negligible**.

8.11.3 Fish resources

It is possible that construction of the proposed turbine could impact upon fish populations in the following ways:

- Loss of feeding habitat
- Increased suspended sediment concentrations during construction, leading to short-term impaired respiratory or reproductive function or disruption to migration/ spawning; and
- Noise and vibration effects causing physiological damage or affecting fish behaviour.

Direct loss of feeding habitat
As discussed previously, the area of sea bed directly impacted by the installation of a monopile is relatively small in comparison with the extensive areas of habitat that would remain at approximately $12m^2$. It should be noted that an increased area will be affected by the current effects of scour around the base of the monopile, and this is considered as an operational impact. For bottom-feeding fish, which are opportunistic feeders, the overall significance of the loss of a small area of foraging habitat such as this is considered to be **negligible**.

Changes in suspended sediments
All construction works that will give rise to release of particulates will take place on the ebb tide. Appendix 12 provides evidence that the sedimentation regime will not be significantly affected by the installation procedures or construction activities. The actual release of particulate material is estimated to be around 200t, based on a predicted reduction of material to be discharged by around 50% through removal of all particulates larger than XXX 3.5mm diameter and disposal to landfill (Seacore *pers comm*). This will take place over a maximum period of 28 hours. In order to avoid a clear impact pathway on trout, *Salmo trutta*, a species of importance highlighted during the consultation process, the construction phase will be carried out in February-March, avoiding the main run later in the year. Without this pathway the impact is classified as **negligible**.

Disturbance due to noise and vibration

It is possible that approximately 15 minutes of hammering will be required to bed the drilling head as part of the construction process. This is considered unlikely to be required, and depends on the precise sea bed characteristics encountered when the installation operations actually commence. However it is necessary to consider the impacts of this process if hammering activities are required. This is a very low energy process in comparison with impact piling, and will employ soft start practices to allow any mobile species to move away from the source before the main hammering is carried out.

Underwater noise is also likely to be generated during the drilling process. This will last for a maximum of 28 hours. All particulate fractions of greater than 3.5mm diameter will be removed from the discharge, and this is expected to result in removal of approximately 50% of solids from the total process (Seacore *pers comm*).

Many fish species are sensitive to vibration and noise vibration underwater (Appendix 20). This acute ‘hearing’, principally through their lateral line and other specialised structures, allows many species of fish to build up a detailed ‘sound picture’ of their environment. As with cetaceans and seals, production of any loud noise has the potential to cause damage or disturbance to pelagic and bottom-dwelling fish species present in the construction area, depending on the volume and frequency at which this noise is produced at source and the degree to which the noise is muted through transmission loss through water in that location.

It is possible that fish would move from areas during noise generating operations such as hammering or drilling. Due to the extremely short duration and low power rating of this activity that it will take place outside the sea trout run, this impact is characterised as small scale, temporary, and therefore **negligible**.

8.11.4 Marine mammals – pinnipeds

The construction of relatively large man-made structures in the marine environment may have a number of potentially adverse effects on seals. These include:

- Acoustic disturbance during construction;
- Risk of collision with construction machinery and installed structures; and
- The potential impact of contamination of marine waters with pollutants.

Acoustic disturbance
Many marine mammals actively use sound as a means of locating prey and for navigation. High energy intense sound, such as explosions, can cause permanent damage to the auditory organs of marine mammals in close proximity or a shift in hearing thresholds. Activities which cause concern relating to noise impacts in the marine environment have traditionally been based around the use of seismic and sonar equipment, explosions and the use of ‘noisy’ marine construction techniques such as impact piling. The proposed development is not expected to result in high intensity noise generation of this magnitude.

Noise signals and the pressure waves created during construction would be generated from a number of sources, notably high energy hammering and the drilling operation, and potentially from the positioning of the rig and general construction activity on board the jack-up rig. The principle source of anthropogenic low-frequency ocean noise in the marine environment tends to be shipping. The noise environment is Strangford Narrows is not affected by such commercial traffic. However, the Strangford ferry and turbulence from water movements through the Narrows, including features such as the Routen Wheel whirlpool, have been identified as significant noise sources (Appendix 20).

As discussed previously, it is possible that a short period (around 15 minutes) of hammering will be required to drive the drilling head into the surface layers of the sea bed, depending on the ground conditions encountered on the day. This is likely to be the loudest sound generated, but remains well below the power output that would be expected to cause physiological damage to seals (SubAcoustech *pers comm*).

The presence of a jack-up rig during the construction period would introduce new and novel obstructions into the water column of the Narrows (i.e. the legs of the structure). It is possible that the presence of the rig and its associated support vessel movement and activities may disturb seals in this area of the Narrows. Operations will therefore be carried out over the shortest possible period and be timed to avoid sensitive times of year such as common seal pupping season, i.e. June-July inclusive.

The temporary and relatively low levels of noise expected during construction are not, therefore, anticipated to pose a risk to seals either resident in or visiting Strangford Lough. Mitigation applied to construction activities results in characterisation of the residual impact due to noise and disturbance to seals during the construction phase as temporary and localised. As this will take place in an area relatively well used by common seals it represents **minor adverse** impact, although this assessment relates to the short term localised disturbance of marine mammals and is not likely to result in an adverse effect on the integrity of the SAC feature.

Risk of collision with construction machinery
The construction process will involve the positioning of a jack-up barge over the drilling location using two tugs, followed by small vessel movements to and from the barge for the duration of its stay (approximately 1 month). This will occur in February-March in order to avoid the common and grey seal pupping season (and the sea trout run), a period when general use of the Narrows by boat traffic will be low as it is outside the main summer season (Appendix 21).

It is considered highly unlikely that seals will collide with any of the static structures such as jack-up legs used in the construction process. The risk of collision by randomly moving vessels exists, although it is also considered to be very small as the Narrows is already used by numerous recreational vessel, so seals are expected to be used to their activity. In order to reduce this risk it is proposed that vessel movements follow standard routes and are undertaken at slack water wherever possible. In recognition of the need to minimise disturbance, no unnecessary boat movements will be permitted to the south of the monopile location.

The residual impact of potential collision with construction machinery on seals is therefore characterised as **negligible**.

Accidental release of contaminants
The potential for accidental release of contaminants such as hydraulic oils that could affect seals directly, or their haul out sites has been discussed in Section 7. The issues and mitigation measures are equally applicable here.

The potential impact accidental spillage of contaminants on seals is considered as a significant hazard but with a very low risk of occurrence. This will be further reduced through the implementation of guidance (CIRIA, 2002), therefore the residual impact is characterised as **negligible**.

8.11.5 Cetaceans

The construction of relatively large man-made structures in the marine environment may have a number of potentially adverse effects on cetaceans. These include:

- Acoustic disturbance during construction;
- Risk of collision with construction machinery and installed structures; and
- The potential impact of contamination of marine waters with pollutants.

Acoustic disturbance
Many marine mammals actively use sound as a means of locating prey and for navigation. High energy, intense sound such as explosions can cause permanent damage to the auditory organs of marine mammals in close proximity or a shift in hearing thresholds. Activities which cause concern relating to noise impacts in the marine environment have traditionally been based around the use of seismic and sonar equipment, explosions and the use of 'noisy' marine construction techniques such as extended impact piling. The proposed development is not expected to result in high intensity noise generation of this magnitude.

Acoustic disturbance in the marine environment is the most important cause of behavioural disturbance in cetaceans because they use acoustics to navigate, locate prey and maintain social contact. Because sound is effectively conducted in water and can be heard over large distances, it is difficult to avoid the propagation of noise generated underwater. Loud, low frequency sounds can travel considerable distances, while higher frequency tones dissipate rapidly and do not travel as far.

As discussed previously, it is possible that a short period (around 15 minutes) of hammering will be required to drive the drilling head into the surface layers of the sea bed, depending on the ground conditions encountered on the day. This is likely to be the loudest sound generated during construction, but is unlikely to exceed the power output that would be expected to cause physiological damage to cetaceans. An environmental observer will be placed on board the drilling rig during the drilling operations with the authority to halt operations if cetaceans are observed in the area immediately prior to hammering operations. Drilling operations produce significantly lower noise outputs therefore no mitigation is proposed during drilling.

The presence of a jack-up rig during the construction period would introduce new and novel obstructions into the water column of the Narrows (i.e. the legs of the structure). It is possible that the presence of the rig and its associated support vessel movement and activities may disturb cetaceans in this area of the Narrows. The short duration of operations will minimise impact on cetacean's normal behaviour.

The residual impact of construction noise and disturbance on cetaceans is characterised as negligible based on the relatively low noise levels likely to be generated and the short duration of activities. A **minor adverse** impact is suggested if a short burst of hammering is required to position the drill head.

Risk of collision with construction machinery
It is considered highly unlikely that cetaceans will collide with static structures associated with construction. The risk of collision by randomly moving vessels exists, although it is also considered to be very small. In order to reduce this risk it is proposed that vessel

movements follow standard routes and are undertaken at slack water wherever possible. The residual impact is therefore characterised as **negligible**.

Accidental release of contaminants
It is likely that cetaceans would exhibit an avoidance reaction to any accidental spillages that would remove them from the risk area. This impact is low risk and would be temporary, therefore the residual impact is characterised as **negligible**.

8.11.6 Basking shark

The risk to basking sharks during construction arises manly from increased activities and general disturbance. Given the rare, although regular, sightings of basking sharks in the main body of Strangford Lough it is considered that impacts on basking shark transiting the Narrows as a result of construction activities is unlikely to have a significant impact on either the individual involved or UK populations, based on the static nature of the monopile to be constructed. In addition, the observer on board the jack-up rig will have the authority to halt hammering operations if a basking shark is sighted in the area. The residual impact is therefore characterised as **negligible**.

8.11.7 Otters

The presence of a jack-up rig during the construction period would introduce new and novel obstructions into the water column of the Narrows (i.e. the legs of the structure). It is considered unlikely that the presence of the rig and its associated support vessel movement and activities will disturb otters in this area of the Narrows given the existing levels of boating activity in the area. The short duration of installation will minimise the impact of the construction process.

In addition, activities above low water on the shore may result in minor disturbance to otters, although the directional drilling process will predominantly take place well away from the intertidal. The shore works will be preceded by a visual inspection prior to placing seawater pump pipes on the shore to ensure no obvious holts or spraint are present that could indicate the requirement for a licence. If such a walkover does discover holts or spraint an appropriate licence will be sought.

The residual impact on otters is therefore characterised as **negligible** due to the short duration of activities.

8.11.8 Ornithology

The potential impact of construction on ornithological interests is likely to be limited to those species that utilise the area for feeding. The most likely route by which birds could be affected by construction activity is disturbance (human activity and noise).

Disturbance
Although likely to last less than one month (for the installation of a single turbine) the construction process has the potential to cause disturbance to birds within the immediate area of the construction site. The main sources of disturbance would come from human activity and increased noise levels. Movements of additional boat traffic may lead to the localised disruption of feeding behaviour for the short duration of the construction period.

Human activity and noise would be of greater concern if the installation site was to be situated close to habitats that support relatively high numbers of breeding birds, such as intertidal mudflats or offshore, unpopulated islands. In this case, the construction phase will take place just before the main breeding season. The nearest significant SAC feature is a colony of breeding terns on Swan Island, near Strangford village. It is considered that this is sufficiently far from the construction activities to determine that no significant effect on this feature is likely.

Whilst precise data on use of the proposed turbine location and adjacent area to indicate exactly which species use the area is not available, it is considered likely that the area will be used by a range of feeding species in addition to terns. These may include gannets, and are likely to include guillemots, cormorants and shag, sea ducks, occasional divers and gulls. Given the localised nature of the work and its timing outside the main breeding season the lack of specific data is not considered necessary for impact assessment. However, it should be noted that baseline data is currently being collected that will contribute to understanding of the operational impacts of the turbine structure.

There will be a short term loss of a small area used for feeding whilst the jack-up rig is in position for approximately one month. Given the tiny surface area this represents in comparison with the rest of the available feeding area of the Narrows and the relatively short duration of activities outside the main breeding season this is not considered likely to be significant.

The directional drilling techniques to be used to install the cable (by drilling from the land through rock to the monopile) will avoid any disturbance of the seashore habitats. Impacts near to the intertidal area will be restricted to a short term (2 week period) disturbance due to the presence of the drilling team, vehicles and equipment at the existing sewage farm location. This will occur in March, outside the main wintering period.

The residual impact on birds using the Narrows from the construction phase is characterised as **negligible** due to the localised and temporary nature of disturbance.

8.11.9 Alien species

Introduction of alien species during installation
In order to minimise the risk of invasive marine alien species being transported into Strangford Lough in association with the jack up rig operations, the rig will be jacked out of the water as it prepared for both the Strangford Lough Site Investigation project and for the installation of the monopile and turbines. In this process the rig body will be exposed to the air for a minimum of 2 days. When in transit the legs will also be in the ‘up’ position and, therefore, exposed to the air for a minimum of 2 days during the tow to Strangford Lough. No ballast water will be exchanged or discharged within 3nm of the entrance to the Narrows.

The rig *Excalibur* will also be mobilised from a period of time in nearby Belfast Lough before coming to Strangford. Coupled with normal hull antifouling procedures, the likelihood of alien translocation is reduced to a very low risk, therefore represents a **negligible** impact.

8.12 Operational period impacts and mitigation

Operation of any developmental technology brings with it inherent uncertainties, both in terms of technical performance, and the way in which the technology interacts with or impacts upon its surrounding environment. Despite an extensive set of survey work, modelling and interpretational desk studies and consultation with UK experts and academics uncertainty remains in relation to the likelihood and magnitude of operational impacts on key features, in particular seals and cetaceans. This uncertainty has been confirmed by the leading sea mammal specialists at the SMRU as unlikely to be clarified by any studies other than a close examination of the interaction with sea mammals (and other mobile species) of a turbine *in situ*.

This section of the ES aims to provide a reasoned and scientifically justified argument to characterise the risk of impacts arising as a result of turbine operation on features for which uncertainty remains. These uncertainties have particular relevance to features of Strangford Lough protected under the Habitats Regulations, and result in the application of the precautionary principle, as discussed in Section 5.6.

In order to reduce the risk associated with these uncertainties as far as possible additional work carried out to inform this section of the EIA has included:

1. Extensive consultation with statutory and non-statutory stakeholders and academic experts
2. A desk-based study examining the patterns of water flow through a subtidal turbine
3. A subtidal survey of the proposed turbine location to MNCR standards
4. A post-site investigation subtidal survey to assess the impact of the jack-up barge
5. Initiation of baseline data collection of marine mammal, basking shark and bird movements in the Narrows
6. A desk study interpreting historical seal observation data collected around Strangford Lough
7. An assessment of the anticipated operational underwater noise impacts arising from the turbine
8. Development of a dedicated strategic environmental monitoring programme

8.12.1 Benthic Biology of the Narrows

There is potential for the operation of an energy extracting turbine and for the presence of a monopile structure in an area of fast flowing water to affect surrounding benthic biota through changes to the hydrodynamic regime. It is most likely that impacts will arise from localised scour around the base of the monopile and through any effects of turbulence on the sea bed. There is also the remote possibility that a net reduction in energy of the tidal flow in and out of the Lough through the Narrows as a result of energy extraction through the turbine could affect both adjacent habitats and those in the main body of the Lough.

It is also possible that impacts arising from changes in water quality discussed in Section 7 could affect adjacent habitats.

Alteration of subtidal habitats and species due to scour around the monopile
The impacts of changes in flow behaviour on the hydrodynamic regime were discussed in Section 7. This identified a likely increase in flow velocity around the monopile during periods of tidal flow. This is likely to cause scouring at the base of the pile which will result in a change to the benthic communities present. However, the footprint of the scour effect is likely to be limited to a few meters surrounding the pile base, approximately 20-30m^2. This represents a **negligible** impact on the benthos of the

Narrows due to its reversible nature, the presence of other naturally scoured sea bed features (Appendices 5 and 17) and the small size of the impacted area.

Alteration of subtidal habitats and species due to reduction in tidal energy
As explained in the previous section, physical parameters such as current flow and wave energy would be unlikely to be affected to any detectable degree. Modelling studies indicate that subtle changes to the benthic biology which may arise from the action of the turbine extract energy from the Narrows is highly unlikely, given the small proportion of energy removed (Appendix 12) and the limit of flow impacts of rotors to an area above the sea bed (Appendix 14).

For all of the benthic communities encountered in the Narrows these minute changes in flow dynamics and associated sediment transport (if any change in this parameter at all) are likely to fall within the range of physical conditions typically supporting these communities/organisms and within the spectrum of velocities naturally encountered at the same location. The short duration (maximum five years) of this commissioning process means that any changes likely to arise in the biology of the Narrows as a result of energy extraction are highly unlikely. This is therefore likely to have a **negligible** impact.

Alteration of benthic habitats and species due to downstream turbulence
Modelling of near-field turbulence (Appendix 12) was carried out using a solid blocked area to approximate to the turbine rotor. This indicates that the turbulence created downstream of the rotors during maximum tidal flow will dissipate within approximately 200m of the turbine, being unmeasurable beyond 500m, and the rotor height above the sea bed is sufficient to ensure that the influence of this turbulence will not be observed at the sea bed (Appendix 14). The residual impact is therefore characterised as **negligible**.

Alteration of benthic habitats and species in the Narrows due to net decrease in energy
The net energy flux in the Narrows has been modelled for both spring and neap tide conditions. This indicates that the proportion of energy extracted by the turbine will be 0.56%. Over the course of 2 to a maximum of 5 years, the results of tidal velocity difference modelling indicates that this is a negligible amount (Appendix 12). Given this small loss of energy from the system and the short time period over which it will come into effect it is highly unlikely that any impact will be observable or even arise in benthic habitats in the Narrows. The residual impact is therefore characterised as **negligible**.

Impacts on benthic habitats in the Narrows arising from changes in water quality
There are two potential pathways through which changes in water quality arising from the turbine could impact upon the benthic habitats found in the Strangford Narrows. Use of antifouling on the structure could result in subtle impacts to biota structure or function, or the area could be affected as a result of accidental spillage of contaminants.

The preferred antifoulants product is Intersleek 737 and this has been discussed in Section 7.5.2. Table 8.4 provides the MarLIN sensitivity matrix of the surrogate for the biotope most commonly found in the Narrows. This indicates that the biotope is relatively robust when faced with synthetic compound contamination. In addition, the small amounts of copper introduced to the system over the maximum five year operating period are negligible when compared with the number of antifouled yacht hulls already using the area. Any observable impacts are likely to be in the form of a reduction in species richness. As an essential element, copper is readily accumulated by plants and animals. Bioconcentration factors ranging from 100 to 26,000 have been recorded for various aquatic species. However, whole-body concentrations tend to decrease with increasing trophic level. It is believed copper is regulated or immobilised in many species and is not biomagnified in food chains to any significant extent (www.ukmarinesacs.org).

The risk of accidental spillage of contaminants such as hydraulic or fuel oils is likely to be significantly lower during the operational phase than the construction phase. The most likely source of such contaminants is from the lubricating materials used in the turbine. The turbine has been designed to ensure the full five year life can be expected from all sealed joints, and experience with the Seaflow turbine off Lynmouth has not indicated any problems to date. In addition the SCADA system monitors lubricant levels and provides an early warning system to implement remedial measures in the event of accidental losses. The risk of spillage is therefore considered to be low, although the hazard posed by such an event could be moderate to high, depending on the species. The risk of contamination is managed by ensuring that the system is known to the Coastguard and EHS, so that in the event of accident a swift response is possible using existing emergency procedures. Servicing will employ a drip-collection barge below the system.

The overall impact of changes in water quality to benthic habitats is therefore considered to be **negligible**, although a small risk of a moderate adverse impact from accidental spillage must be taken into account.

8.12.2 Combined impacts on benthic habitats in the Narrows

The total area of benthic habitat likely to be directly affected in the Narrows by this proposal is as follows:

Jack-up barge: leg impacts from site investigation work[1]	75m2
Jack-up barge: leg impacts from installation process	100m^2
Jack-up barge: leg impacts from decommissioning	100m^2
Temporary (medium term) loss of habitat due to monopile structure	10m^2
Alteration of habitat around monopile through scour	30m^2
Total area affected over 2-5 years	**315m^2**

It must be noted that the approximate figure calculated for the total area of sea bed habitat likely to be affected by the presence of Seagen, taking into account all work phases, is misleading in that there will be up to five years in between the construction and decommissioning phases. The dominant biotope in the Narrows has been recognised as relatively robust and contains species that are able to recolonise substrates quickly after scour or abrasion. It is therefore highly likely that the areas impacted during the construction and site investigation phases will have recovered by the time decommissioning commences, even if this is within two years.

Impacts due to changes in water quality are considered negligible, therefore the combined impact of all work phases on benthic habitats in the Narrows is expected to be temporary, localised, small scale adverse. In the context of the conservation objectives for this feature these impacts are unlikely to give rise to deviation in the presence of characteristic biotopes identified during the baseline surveys. The residual impact is therefore characterised as **negligible**.

8.12.3 Other benthic SAC features

Impacts arising from changes in the hydrodynamic regime

[1] Note that this impact has been confirmed by post-site investigation work survey

In addition to the near-field effect discussed above there is potential for the operation of an energy extracting turbine to affect benthic biota in a wider area through changes to the hydrodynamic regime. The consultation process has highlighted the possibility that a net reduction in energy of the tidal flow in and out of the Lough through the Narrows as a result of energy extraction by the turbine could potentially affect habitats in the main body of the Lough.

It is concluded in Section 7 that the turbine operation will not have a significant effect on the hydrodynamic regime of the Lough on the basis that the overall reduction in energy is a minute and undetectable fraction of the total energy flux in and out of the Narrows, the impact would be observed only over a period of 2-5 years then removed, and the zone of turbulence during operations will be imperceptible beyond 500m downstream of the turbine rotors.

The tiny fraction of energy that will be extracted from the tidal system, combined with the short duration of turbine operation, even assuming the rotors are working during all suitable tidal flows, represents a temporary and extremely low magnitude impact. Relating this directly to the *Modiolus* beds, such impacts should be compared with individuals' longevity and reproduction rates. Even if such factors were of sufficient magnitude to adversely affect SAC communities in the main body of Strangford Lough the turbine would have to be operated over enough time for any possible subtle effects to be manifest.

It is thought that horse mussels live for between 20 and 100 years and have a generation time of 5-10 years (www.marlin.ac.uk). In this context even the full 5 year commissioning period would be unlikely to represent a sufficient period of time to have either a significant impact on the existing population structure or extent, or on this population's regenerative ability.

The overall impact is therefore characterised as **negligible**.

Impacts arising from changes in water quality
It is important to recognise fully that the *Modiolus* beds for which Strangford Lough has been recognised as internationally important are currently considered to be in unfavourable conservation status. It is therefore logical to scrutinise any plan or project proposed that has the potential to influence these features of interest.

Impacts identified in Section 8.12.1 apply equally to benthic SAC features in the main body of the Lough. In particular, *Modiolus* beds are noted as being at low risk of damage from contamination by heavy metals (www.marlin.ac.uk). It is therefore considered that the main water quality impacts likely to arise from use of antifoulants will pose a **negligible** risk of adverse impacts to *Modiolus* beds.

8.12.4 Fish resources

It is possible that this proposal could affect natural fish resources in a number of ways, including:

- Direct loss of habitat (spawning) and food resources from installation of turbine foundations;
- Potential alterations to the sediment composition due to changes in the current and wave regime and the influence that this may have on feeding and spawning habitat;

- Effects of physical obstruction and noise on fish, particularly during spawning, nursery or migratory periods; and
- Potential contamination of the water column, sediments and marine organisms (i.e. potential prey items) from accidental release of cementing/grouting materials and/or release of existing sediment bound contaminants.

Ongoing loss of feeding habitat
As discussed previously, the area of sea bed directly impacted by the installation of a monopile is relatively small (approximately 12m^2, although an increased area will be affected by the current effects of scour around the turbine pile) in comparison with the extensive areas of habitat that would remain. For bottom-feeding fish, which are opportunistic feeders, the overall significance of the loss of a small area of foraging habitat such as this is considered to be **negligible**.

Potential alterations to the sediment composition and associated communities due to changes in the current and wave regime
As discussed in Sections 7.4 and 7.5, and in more detail in Annex 5, changes in wave and current conditions and knock-on effects on sediment transport are likely to be negligible and, if they do occur, would be confined to small areas within a few metres of the base of the turbine monopile where scour effects may be expected. As such, although some change in sediment characteristics and by inference infaunal communities that fish may prey on is expected, it is likely that this would be on such a small scale as to be insignificant. The residual impact is therefore characterised as **negligible**.

Physical obstruction
Given the manoeuvrability of fish it is considered highly unlikely that any collisions will occur whilst the turbine is in operation. Spawning and nursing ground in Strangford lie outside the Narrows.

Noise and vibration effects
The potential for disturbance to fish populations due to noise and vibration effects during operation of a turbine cannot be predicted with 100% certainty. However, there is a body of research available on which to base informed assessments (Appendix 20). A further study has been carried out in support of this application to examine the likely effects of noise generated by the turbine in the Narrows. This is provided in Appendix 20.

There are no active noise emitting devices associated with current turbines and noise generated is created by the rotor blades moving through the water and the movement of the internal machinery coupled to the rotors. The high current speeds and general water turbulence that these structures operate in gives rise to significant levels of background noise during periods of tidal flow, as observed during baseline surveys (Appendix 20). It is therefore considered that the additional sonic disturbance to fish created by the turning of the rotor blades in the water is highly unlikely to be significantly above the general background noise, in fact the design of the rotors means that these levels will be significantly lower as the sources of noise represent losses in efficiency of power generation.

The analysis of underwater noise produced by the Seaflow system already in place off Lynmouth (Appendix 20) has been extrapolated to predict the noise generated by gearing and other moving parts in the twin Seagen turbine. Avoidance reactions of fish for which reliable audiograms are currently available, including dab and sea trout. The sound generated by Seagen will be audible in a broadly spherical zone due to the homogeneity of conditions in the Narrows at depths of 4m and more below sea level, which will be present over the noise sources at all times. The analysis concludes that this is likely to give rise to a mild aversion reaction from all fish species examined over a range of a few metres during periods of power generation.

Fish species are expected to be capable of avoiding the rotors due to their manoeuvrability and the mild aversion in the immediate vicinity of the turbine likely to arise from noise generation. These noise levels are not sufficient to cause any physiological damage and are sufficiently localised through attenuation in the water column as to represent an insignificant barrier to transit through the Narrows. The residual impact is therefore characterised as **negligible**, and this will not change as a result of modifications to the sound frequency peaks proposed to mitigate impacts on cetaceans (see Section 8.12.6).

8.12.5 Marine mammals - pinnipeds

There are two key potential impacts to seals that may arise as a result of operating Seagen. There is the possibility that a rotor may strike a seal that happens to pass through the sweep area. This has implications for the resident population through potential impacts on reproductive ability by removal of mature adults, or pups, if a strike were to result in mortality. It is also possible that operation could cause a barrier effect as a result of either noise or physical obstruction that either reduces or stops the transit of seals through the Narrows, in between the Irish Sea and key haul out, pupping, lactating and nursing sites in the main body of Strangford Lough. This has implications for the broader population through changes in site fidelity, although it should be noted that the recovery that has been seen around Scottish coasts following the Phocine Distemper Virus outbreak has not been seen in Strangford Lough. It is possible that this reflects an inherently lower suitability of the site for supporting common seals. Both of these potential impacts have implications for the condition of the common seal SAC feature under the Habitats Regulations, as an ongoing reduction in common seal numbers currently thought to be occurring to less than a critical threshold defined by EHS as 200 adults would cause the feature to be defined as being in unfavourable conservation status.

It is very difficult to predict the likely effect that a marine current turbine will have on seals as there are little or no previous investigations of their possible interactions with these types of structures. Some inference can be obtained from previous experience with offshore wind farms and these have been reviewed by a number of authors (most recently Dolman *et al.*, 2003). The approach taken in the EIA process has been to reduce levels of uncertainty through informed targeted studies and interpretation of research. However, advice from the UK's leading experts in seal behaviour and population studies (SMRU *pers comm*) has confirmed that it is impossible to predict the likely behavioural response of seals to this novel technology. It is therefore important to recognise that no amount of research into seal behaviour or usage of the Narrows would result in a situation where the uncertainty over behavioural response is removed.

Observations collected from ongoing baseline surveillance and interpretation of historical observation data (Appendix 18) indicate that seals may use both the rapid moving central areas of the Narrows and the slower moving counter tide areas towards the shore during periods of tidal flow. This may be either foraging activity or to move between the main Lough and haul outs in the Narrows at Granagh Bay and Cloghy Rocks and possible feeding areas in the Irish Sea (SMRU *pers comm*). This means that the whole of the Narrows is likely to be used up to the near shore shallows. The baseline observation studies, forming part of the proposed strategic environmental monitoring programme (Appendix 8) were initiated in April 2005.

It is anticipated that any FEPA license granted for this project will stipulate that this baseline be completed to provide at least 8 months data prior to installation and the results and conclusions being agreed with EHS. It is important to note that this information will provide a baseline against which the results of ongoing monitoring and surveillance can be assessed, and would not provide additional information relevant to determining impacts and outcomes of this development. The data collected will provide an indication of the numbers of seals transiting the Narrows and their behaviour on the sea surface. Whilst uncertainty remains over the likely behavioural response of seals to the turbine it is considered that information over and above that obtained from interpretation of the historic observations (Appendix 18) will not result in a reduction of this uncertainty. It is considered unfeasible for such investigations to be made that would clarify this point to a level that would satisfy the requirements of the Habitats Regulations (to demonstrate that no adverse effect on integrity of the feature is likely to occur) as it can only be investigated once a developmental turbine is *in situ* (SMRU *pers comm*). It is for this reason that an adaptive management approach is proposed (see below).

Noise disturbance
Sub surface noise emitted by the developmental turbine is likely to result in two impacts. It may alert acoustically aware species of the turbine's presence, and cause varying degrees of avoidance at various distances as a function of the species' hearing sensitivity and the frequencies to which the hearing is targeted.

Appendix 20 provides a detailed analysis of the predicted underwater noise levels that will be emitted during periods of power generation by Seagen and the following assessment is based on this report. It is important to note that noise will only be emitted from Seagen during periods of tidal flow greater than 1m/s (1.9kn) and when the commissioning process allows, as illustrated in Figure 2.5. The likely percentage of operating time during the 2-5 year commissioning process is predicted in Appendix 6, illustrating that there will be no activity during common seal pupping, that there will not be maximum utilisation until at earliest year two of commissioning, in addition to the fact that there will be regular periods of zero activity around each slack water (likely to be approximately 45-60 minutes based on observations during dive surveys) and longer periods during intermittent maintenance or other testing times.

It is thought unlikely that any fatalities or physiological damage will occur to any species, including seals, as a result of noise emissions from operating Seagen. During periods of operation a mild aversion reaction from common and grey seals due to noise levels is expected out to a distance of 10m from the source, based on the 15m predicted in Appendix 20 with a corresponding reduction in distance as a result of proposed modifications (c.f. mitigation for cetaceans). This mild aversion reaction is predicted based on the audiograms currently available for common seals, with grey seals showing slightly less sensitivity, and is based on aversion to noise levels that are 'unpleasant' (see Appendix 20). This aversion reaction is therefore not predicted purely as a result of seals modifying their behaviour to a new feature, and outside these mild aversion distances the behavioural reaction cannot be predicted other than to note that the zone of acoustic detection by seals is likely to extend beyond the zone of 'mild aversion'. These sources are the turbine nacelles which will be located at the centre of each rotor, i.e. approximately 10m either side of the monopile 11m below LAT. This will result in a spherical zone of 'mild aversion' influence affecting an area of the Narrows 30m wide, as illustrated in Figure 8.7.

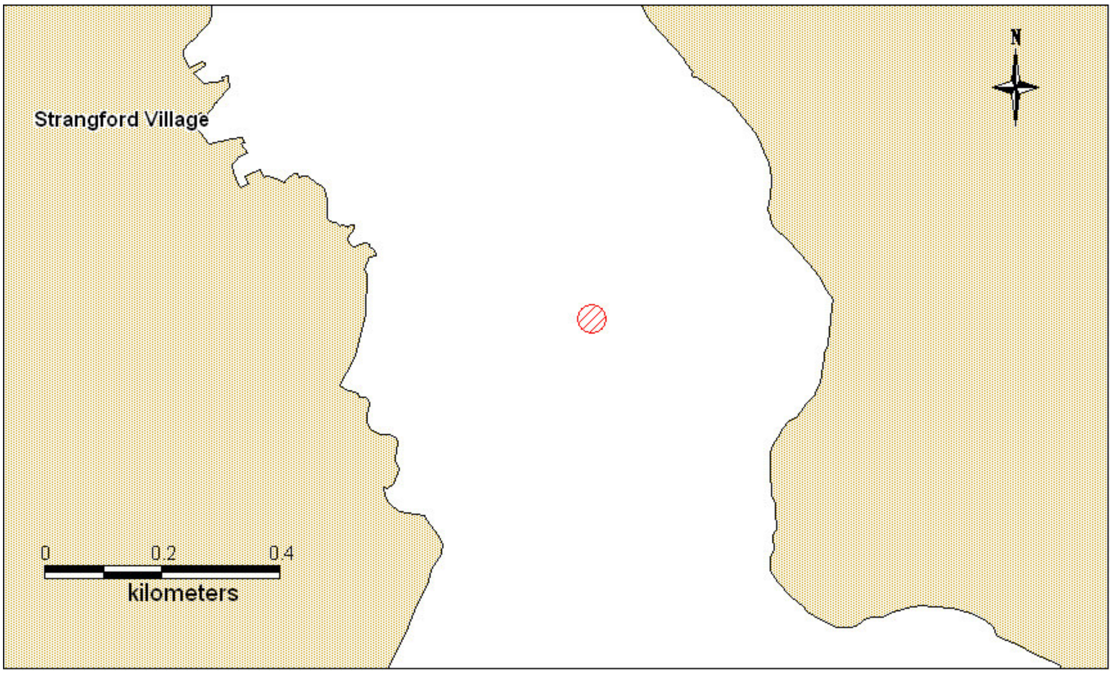


Figure 8.7 Predicted zone of 'mild aversion' in common seals due to noise levels around Seagen

The noise signature of Seagen is likely to have significant similarities to the Strangford-Portaferry ferry, although there are some differences in the predicted frequencies of peaks. Anecdotal observations (Sue Wilson *pers comm*) indicate that seals are rarely seen approaching close to the ferry. It is therefore possible to predict that seals are unlikely to exhibit an acute avoidance reaction as a result of noise, based on these similarities. However, the potential for the effect of these noise sources to impact movements *in combination* with each other cannot be predicted.

There are therefore uncertainties surrounding the likely impacts of noise underwater noise generated during the operation of Seagen on seals. It can be concluded that seals will not be physiologically damaged by this noise, that the noise levels are sufficiently high to guarantee at least awareness (or a mild aversion reaction) to the generators when operating at a range of up to 15m, and that the sound profile is likely to show similarities to that of the local ferry which is currently thought to be avoided by seals. In order to clarify whether this will result in an overall avoidance of the Narrows it is proposed that a monitoring and surveillance programme is implemented to include remote tagging studies both pre- and post-installation, examining site fidelity issues, and behavioural assessments are carried out using sonar and low light cameras. Details on these elements of the proposed strategic environmental monitoring programme are provided in Appendix 8.

In conjunction with agreed adaptive management of the commissioning process as discussed in Section 5.6 it is concluded that the residual impact of noise, including the potential barrier effect on both common and grey seals using the Strangford Narrows is **uncertain**, although the relatively small zone of mild aversion of the turbines when in operation, the intermittent nature of operation during tidal flows of at least 1m/s and the temporary nature of the installation as a whole is considered unlikely to result in a significant reduction in use of the Narrows by seals.

In addition, the adaptive management strategy proposed in conjunction with the strategic environmental monitoring programme will ensure that the common seal feature of the Strangford Lough SAC is not adversely affected as a result of noise generated during turbine operation by identifying impacts and providing a mechanism to feed this information back into the management of Seagen. Although the potential impacts are currently classified as uncertain, in order to reduce the overall risk of impacts to the common seal SAC feature the turbine will not be operated during the pupping season (June-July inclusive).

Collision

The potential for collision between marine mammals and structures in water is difficult to predict. In the case of EIAs for offshore windfarm developments, concerns have been raised about installation noise and vibration, habitat loss and disturbance, but collision with large static objects such as piles is not considered as an issue, as sea mammals are able to sense and avoid similar naturally occurring obstructions. However, the movement of water driven blades rotating at approximately 12 rpm (with a tip velocity typically of about 10 to 12m/s) raises a number of novel questions whose assessment with respect to this project remain ongoing.

Predictions of collision risk for marine turbines have to weigh the probability of a collision occurring (based on the small area swept by the rotating blades) against the natural curiosity of seals. This approach immediately complicates any possible prediction due to the fact that curiosity on the part of the animal implies that it is aware of the turbine and that instinctive avoidance of collision is likely. Seals are able to detect noise the vibrations caused by movement detected through vibrissae (whiskers) when under water, as well as having good underwater eyesight. Recently the possible importance of passive sonar to seals in detecting their wider environment has been discussed but remains largely undefined (SMRU *pers comm*).

The possibility of adapting a simplistic model developed by Scottish Natural Heritage to predict the potential risk of bird strike when passing through commercial scale windfarms to this case has been investigated. The results of this process are not presented as part of this EIA as these investigations highlighted assumptions that no avoiding action would be taken in the vicinity of moving rotors, and shortfalls in the inclusion of an understanding of fluid dynamics and the way fluids move through a rotating turbine (see Appendix 14). Although cognisance has been given to the statistical risk of striking an inanimate object below, the use of such predictions is considered to be of limited value in assessing the real risk of collision posed by this technology, particularly when considering the acknowledged lack of ability to predict behavioural response (SMRU *pers comm*).

Interpretation of historic observational data indicates that the total number of transits by common seals of the Narrows during the summer months, when such activities are more frequent than in winter, is likely to be in the order of 400 (Appendix 18). However, despite the use of this dataset, some of which extends to the mid 1970s, it is thought that this represents an underestimate (SMRU *pers comm*). Confidence in the assumptions of numbers of feeding trips by common seals from the main body of Strangford Lough through the Narrows is also relatively low due to the very small tagging study sample number (two individuals).

Awareness of their surroundings combined with their natural agility in this environment suggests that seals should be able to avoid collision with the monopile and the turbine rotors. However, the high levels of by-catch of seals in set fishing nets, especially those located in new positions suggests the issue may be more complex, although nets are likely to be less visible to active or passive sonar and underwater eyesight. If passive sonar does play a significant, even a dominant role in the ability of seals to detect their environment then in a tidal area such a Strangford Narrows the ability of seals travelling down tide towards the rotors to detect them at distance is largely unknown, although it is reasonable to assume that no creature is likely to swim at high speed if totally lacking any "visibility" of solid immobile obstructions. The noise that is predicted will be emitted by the turbine will be approximately spherical (Appendix 20) therefore the seal will have at least one clear indication of its presence. It is also likely that seals will learn about the presence of Seagen, although the results of this learning in terms of their behaviour are impossible to predict.

The proximity of the Granagh Bay and Cloghy Rocks common seal breeding colonies increases the risk of young and juvenile seals being exposed to the blades. Research into seal entanglement (principally in relation to in fishing gear) suggests that younger seals are most susceptible to such fatal curiosity, although as mentioned previously nets are less "visible" and are in fact specifically designed to trap swimming wildlife whereas the proposed turbine is not built in a form which could enclose or trap any passing marine creatures. As mentioned above the turbine will therefore not be operated during the common seal pupping season of June-July inclusive.

The speeds of the Seagen turbine rotors are low compared with devices such as ship propellers or wind turbines tip velocities. The rotor speed is not only in the region of double the burst swimming speed of many mobile marine species (i.e. 10 or 12m/s at the tip). Even in the unlikely situation that no avoiding action was attempted any such collision would tend to be at a shallow angle due to way water flows through the rotors (see Appendix 14) and therefore less likely to result in serious impact. However, to ensure a precautionary approach it is assumed that a full strike by the rotor runs a high risk of causing damage to a seal that would result in fatality. This is based on veterinary pathologist opinion (Glasgow University *pers com*) that the bruising and haemorrhaging caused by a full blow could lead to complications and secondary infection, or reduced ability to feed, rather than immediate death. It is therefore considered that any strike from the turbine rotors on seals is unacceptable. This is important when considering the adaptive management approach to impact uncertainties below.

The acoustic 'visibility' of turbine rotors to seals is considered to be high, based on the zone of influence arising from the noise profile relevant to seals discussed above and in Appendix 20. The turbine blades will be a light colour as a result of the Intersleek 737 antifoul paint. It is therefore considered that they will be visually obvious to seals. It is uncertain whether this is likely to be beneficial through increasing the seals' level of awareness of moving parts or detrimental by attracting foraging or juvenile seals.

The key points in relation to the statistical potential for collision of inanimate objects with the rotors can be summarised as follows (see Appendix 14):

- The water flow through the turbine blades follows a helical path through the rotor such that any passive neutrally buoyant object will follow a path aligned with the rotor blades rather than across them;
- As a result the passage of unobstructed water between blades will be over 6m across between the 50% and 100% radius positions whereas the solid "target" of oncoming rotor blade is in the order of 0.2 to 0.3m;
- Larger objects will be at more risk of impact, but an object of 0.5m girth would only have approximately a 1 in 8 chance of even touching a rotor blade if arriving in the rotor 'stream tube' randomly;

- As a result of the way in which water anticipates the turbine rotors and its flow direction changes to run across the rotors, most such impacts would tend to be a glancing blow[1] at a maximum velocity of about 12m/s near the rotor tips, although it is recognised that such an occurrence will be considered unacceptable if picked up in post-installation monitoring; and
- The zone of influence of noise generated by the turbine in operation has the potential to elicit a mild avoidance reaction within 15m of the noise source.

However, as mentioned this omits the inclusion of any behavioural response that may be observed by live animals.

Summary
In conclusion, following investigation of the likely result of seals becoming entrained in the turbine flow and consultation with seal experts both within Northern Ireland and the SMRU, there remains significant uncertainty regarding the potential impact of the turbine on marine mammals. It seems likely that a detailed assessment of the potential impact will not emerge until a test turbine array can be installed and fully monitored.

The likelihood that the Seagen rotors will collide with any seal is therefore considered **uncertain** due to uncertainties over the behavioural response, although it can be predicted that seals will be aware of the rotors from at least 15m and probably further through acoustic stimuli. Detailed modelling of the statistical probability of collision with the rotors is likely to be misleading and has not been attempted here in recognition of the potential for a behavioural response, either avoidance or attraction. This behavioural response may result in a localised avoidance of the danger, or an overall avoidance or 'barrier' effect to seals using the Narrows, although this risk also remains **uncertain**. The chance of serious injury arising from a strike with the rotors is considered to be low due to the way in which water flows past the rotor surface, but if a full blow was to occur it is considered likely to result in serious injury to seals that could lead to fatality. Juveniles are considered more likely to be attracted to or at risk of collision with the rotors due to their slower swimming speeds, therefore the turbine will not be operated during the common seal pupping period.

It is recognised that these uncertainties justify the application of the precautionary principle to this application, in particular when considering potential impacts to the common seal SAC feature. In order to reduce the risk of harm to seals, in particular commons seals, to a level at which this proposal can be considered as unlikely to adversely affect the integrity of this SAC feature, it is proposed that an adaptive management approach be taken to the precautionary principle. This is discussed in more detail in Section 5.6, and a proposed monitoring programme to determine whether seals are either struck or displaced by the turbine operation is provided in Appendix 8. However in summary the use of adaptive management means the implementation of a detailed targeted monitoring programme to address or continually observe areas for which uncertainty has invoked the precautionary principle. The programme in this instance includes measures to assess whether seals are either being struck or deterred from use of the area as a result of turbine operation. The results of this monitoring are fed back directly into the management of the project in order to allow adaptation or cessation of activities if necessary.

As a result of this firm commitment to alter or cease operations where technically feasible in accordance with advice from the strategic environmental monitoring programme

[1] 'glancing' refers to a situation where not all of the kinetic energy present in the rotors is transferred during the collision, with the object struck tangentially

steering group, the impact of this proposal on seals is unlikely to be significantly adverse. The integrity of the SAC feature will not therefore be compromised as a result of this proposal.

8.12.6 Cetaceans

The main cetacean species of concern in Strangford Lough is considered to be harbour porpoise, as these are the most common species sighted in the area. Cetaceans maintain an awareness of their surroundings through the use of echolocation. As small cetaceans often travel without using active sonar but rely on their passive sonar abilities then their ability to detect the turbines turning down tide of them is unknown. The spherical acoustic zone of influence (Appendix 20) is likely to provide an indication of the turbine's presence both up- and downstream during operation.

The potential impacts on cetaceans arising from operation of Seagen are the same as those considered in Section 8.12.5 for seals. The main difference between seals and harbour porpoise relates to the predicted perceived noise levels generated during turbine operation and the presence of significantly fewer animals in the Narrows. The noise assessment provided in Appendix 20 predicted that a mild avoidance reaction would be seen in harbour porpoise up to 108m from source due to the difference in the frequencies to which they are sensitive, and due to their overall sensitivity to acoustic volume, based on audiograms for harbour porpoise. It was noted that this sensitivity is primarily a result of noise that will be generated at a frequency of around 5kHz. The source of this noise has been identified as generator inverters and these components will be acoustically isolated to provide a 10-12dB reduction in noise generation. The resultant predicted zone of mild avoidance reaction is therefore reduced to approximately 40m from source.

The impact of a mild avoidance reaction in harbour porpoise of 108m initially identified would effectively cover the whole of the area of the Narrows likely to be used by harbour porpoise or other cetaceans, who are unlikely to swim in areas of less than 5-8m depth. However, alterations to the design of electronics within the turbine is predicted to mitigate this impact with a resulting decrease in this predicted avoidance zone to approximately 50m (SubAcoustech *pers comm*). This is illustrated in Figure 8.8.

Whilst it is impossible to accurately predict the behavioural response to the turbine without *in situ* investigations, it is considered that the risk of harm to cetaceans through collision is low due to their manoeuvrability and the fact that they will be aware of the turbine acoustically. The risk of cetaceans avoiding the area altogether remains **uncertain** due to uncertainties over the behavioural response, although it must be recognised that there is potential for intermittent avoidance of the centre of the Narrows as a result of noise generation. This uncertainty does not have implications for the integrity of Strangford Lough SAC, but as cetaceans are a European protected species a similar approach of adaptive management is proposed.

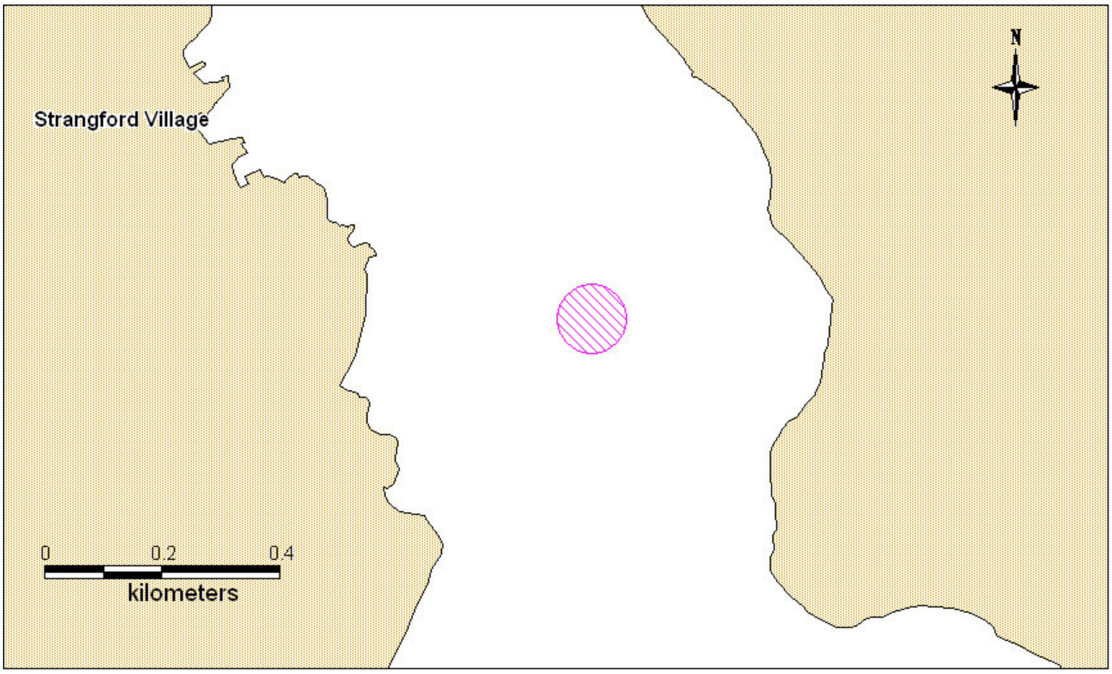


Figure 8.8 **Predicted zone of 'mild aversion' in harbour porpoise due to noise around Seagen**

8.12.7 Basking shark

Basking sharks are common sightings around the coast of the UK and Ireland, particularly during the summer months, and are known visitors to Strangford Lough. Even less is known as to how these sharks detect their surroundings than with seals, especially at night. It is therefore once again uncertain how they are likely to react to the presence of a turbine. The most significant relevant issue is likely to be the potential effects of electromagnetic fields generated by the current passing through the sub sea cable between the turbine and national grid sub-station. Noise is unlikely to be an issue in the same way as for seals and cetaceans.

It is worth noting that as basking sharks are typically recorded close to the surface they could pass over the turbines. However, these animals are relatively slow moving, particularly when feeding and therefore the potential does exist for collisions to occur. Stranded and washed up basking sharks clearly demonstrate that collisions with boats occur as some bear the scars of propeller impacts caused through impact with boats and boat propellers. However, according to MCS data the frequency of basking shark sightings in the main body of Strangford Lough is low, therefore there is a correspondingly lower risk of impact.

Effects of electromagnetic fields on electro-sensitive organisms such as elasmobranchs
Many elasmobranchs (sharks and rays) are sensitive to electromagnetic fields, which they use largely to detect prey. As discussed previously, basking sharks, tope and possibly skate are noted visitors to the Lough. Concerns have been voiced that the installation of cables transmitting electricity from offshore turbines may create corridors over the sea bed that adversely influence elasmobranch behaviour (e.g. the ability to capture/detect prey items). Research into the potential effects of electro-magnetic cables flux on elasmobranch fish (lesser spotted dogfish) (CCW 2001) showed that 8% of the fish in the studies exhibited an avoidance reaction to the electrical fields used, whilst only 2% showed a positive response. Avoidance was observed around a 150kV cable,

whereas a slight attraction was seen towards low-level electromagnetic fields. The avoidance reactions were noted at a distance of around 10cm, suggesting that these effects are localised. This project will only employ an 11kV connector, which will result in a lessening of the potential electromagnetic field effects, which means that it is unlikely any avoidance reaction would be taken except up to 15m from the monopile base, the maximum error factor when drilling this distance (Appendix 3).

These studies were limited in their extent and recognised the need for further research. As a result of continuing concern Phase 2 of an in depth study is currently underway as part of the COWRIE research program. Phase 1 has reported, characterising the electromagnetic fields arising from subsea cables, indicating that burial of cables is ineffective in 'dampening' the magnetic field induced by electric cables, but that burial to a depth of 1m physically removes the cables to sufficient distance from species sensitive to EMF effects as to provide mitigation (CMACs, 2003).

The proposed cable will run for approximately 500m west of the turbine location, passing under around 200m of water deeper than 5m below chart datum. Directional drilling of the cable will take it at least 1m below the sea bed until breaking through at the turbine location. For the majority of this distance the cable will be deeper than 1m. Power will be transmitted through the cable during turbine operation during periods of tidal flow. The electromagnetic fields emanating from the cable will therefore be attenuated and at a minimum 1m from the sea bed, intermittent, and run under less than 50% of the width of the Narrows.

Given the rare presence of basking shark within the main body of Strangford Lough, approximately four recorded sightings over the last 20 years (MCS, 2000), and the possibility that tope and rays will be present in the area, there exists a small potential for these species to exhibit avoidance of the proposed turbine during peak tidal flows due to EMF effects. The intermittent, localised nature of this is likely to result in an adverse impact to visiting elasmobranchs through barrier effects. In order to mitigate this impact, directional drilling of the cable has been chosen, despite the associated cost and technical difficulties. This is therefore characterised as a residual **negligible** impact, although this is a precautionary approach and it is recognised that this assessment is based on an area where further research is required and on *ad hoc* observations of visiting basking shark. The temporary nature of the cable, which will be operating no longer than five years, gives sufficient confidence that the Seagen commissioning programme is unlikely to have a significant impact on wider basking shark populations in the region.

8.12.8 Otters

Whilst otters are thought to be present in the Narrows it is unlikely that they will feed in the fast moving currents found where the turbine will be situated, and there is evidence that otters tend not to feed in water over around 10m depth. It is for this reason that the Loch Sunart SAC boundary in Scotland extends only to the 10m depth contour. There is therefore a low risk of rotors striking an otter.

8.12.9 Ornithology

The potential impact of marine turbines on ornithological interests is likely to be limited to those species that utilise marine and tidal waters for feeding, as there are no recognised breeding colonies in the vicinity of the proposed turbine and any birds loafing or transiting the Narrows either on the sea surface or in flight are well clear of any potential collision risk. The potential impact of this form of energy production on birds is therefore significantly less contentious than that of wind turbines. In addition, the scale of this proposal is very small in comparison with commercial renewable ventures. The main routes by which birds could be affected are:

- Disturbance and loss of potential foraging habitat through human activity and noise; and
- Collision by diving birds with turbine rotor blades.

Collision risk

There is the remote possibility that diving birds may collide with turbine blades. The types of birds likely to be affected relevant to Strangford Lough include diving ducks commonly seen on the Lough such as mergansers. Seabirds are also possibly at risk such as visiting gannets and auk species, and cormorants or shag. This is not considered to include resident breeding terns feeding in the Narrows as they do not dive to sufficient depth when feeding for an impact pathway to exist. Wintering waders are also not likely to be affected due to the lack of a potential impact pathway.

The risk of collision arises from a combination of factors, but most notably the presence of these birds within the working area of the turbine itself, along with bird behaviour and hunting characteristics, current speed (i.e. potential for entrainment) and depth of turbine blades below the water surface. Considering these factors in turn (as discussed below), it is proposed that the overall risk of collision is extremely low or potentially non-existent under the large majority of situations.

The most significant risk is one of actively attracting hunting species to bubbles entrained in the water, as those generated by scuba divers are known to attract diving birds such as guillemots and razorbills. Bubble entrainment from the spinning blades is expected to be minimal (MCT *pers comm*) as this would result in significant reductions in power generation efficiency.

Seabirds use a variety of techniques to feed. They can take food from the surface or just below it while on the wing, exploit the surface layer while swimming and pursuit diving, capture food by deep plunge-diving and swimming at depth as well as scavenging food on the surface. Prey is normally located by eyesight, although plunge diving species such as gannets may also use a more hit or miss approach.

The depth to which birds actively forage depends on the species. Tern species found in the Lough are plunge feeders taking small fish at or just below the water surface. It is considered very unlikely therefore that the feeding terns could come into contact with the turbine blades, which will always be at least 3m below the sea surface.

As the majority of diving seabirds and waterfowl locate their prey by eyesight it is likely that they would be able to discern the presence of a relatively large structure such as a turbine in the water column and therefore contact would be avoided.

Plunge diving species such as gannet may be at more risk of collision as active perception may not be utilised during the dive into the water. Gannets dive to between 10-30m into the water, usually remaining submerged for less than 10 seconds during which time they swallow their prey. It is considered that gannets will be rare feeding visitors to the Narrows (RSPB *pers comm*), although this information will be gathered as part of the strategic monitoring programme (Appendix 8). Data from recorders attached to birds shows that species such as guillemots actively search for food between 15m and 60m, and shag between 15m and 25m. These species are therefore at risk of strike from the turbines. However, the relatively slow rotor speed and small area occupied by the turbine indicates that this impact risk is very small, considerably less than that for larger inanimate objects discussed in Section 8.12.5.

The adaptive management process combined with the strategic environmental monitoring programme provides a similar approach to potential bird strikes, with the most likely observation being the presence of a corpse immediately downstream of the turbine. Such an incident would be fed back to the monitoring programme steering group. It is therefore concluded that the turbine operation will have a **negligible** impact on the breeding tern and wintering feeding wader SPA features. The residual impact on other species is likely to be either negligible or minor adverse, depending on whether any bubbles are entrained in the rotors, attracting feeding species. It is expected that this will not occur, however this uncertainty will also be investigated through observations carried out as part of the strategic environmental monitoring programme.

Loss of food resource or foraging habitat
The area of the turbine and a larger 'disturbed' area around it will essentially be lost as an undisturbed feeding habitat for seabirds and diving birds for periods during which humans are active on the turbine. In the context of the Narrows, this temporary loss of habitat over such a small area is not considered to be significant.

The loss of food resource is only likely to occur in situations where it is predicted that the operation of the turbine would lead to a significant loss of available prey or habitat on which these species depend. This latter effect is highly unlikely to occur as habitat loss would be associated solely with the basal footprint of the turbine monopile and natural fish resources are considered unlikely to be affected in any discernible manner by the installation of these structures. This impact is therefore characterised as **negligible**.

8.13 Construction and decommissioning impact assessment summary

Table 8.5 Classification of construction and decommissioning impact

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Loss or damage of benthic habitat of the Narrows during installation	Negligible (up to 112m^2 sea bed)	Short term (100m^2) Medium term (12m^2)	Negligible
Damage to other benthic SAC features during installation	Negligible	Short term	Negligible
Fish resources –loss of feeding habitat	Negligible (up to 112m^2 affected, 12m^2 lost for duration of commissioning)	Short term (100m^2) Medium term (12m^2)	Negligible
Fish resources – disturbance due to noise and vibration	Negligible, localised	Short term	Negligible

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Seals – noise disturbance	Minor, low level. No sudden noise bursts unless 15 mins hammering required	Short term	Minor adverse if hammering required Otherwise negligible
Seals – collision with construction machinery	Negligible	Short term	Negligible
Seals – accidental release of contaminants	Negligible	Short-medium term	Negligible (low risk of spillage)
Cetaceans – noise disturbance	Minor, low level. No sudden noise bursts unless 15 mins hammering required	Short term	Minor adverse if hammering required Otherwise negligible
Cetaceans – collision with construction machinery	Negligible	Short term	Negligible
Cetaceans – accidental release of contaminants	Negligible	Short-medium term	Negligible (low risk of spillage and likely avoidance reaction)
Impact on basking sharks	Negligible	Short term	Negligible
Impact on otter populations	Negligible	Short term	Negligible
Ornithology – disturbance and loss of feeding resource	Negligible	Short term	Negligible
Introduction of alien species during installation	Negligible	n/a	Negligible

Table 8.6 Construction and decommissioning mitigation and monitoring

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring (detailed monitoring schedule prepared separately)
Loss or damage of benthic habitats in the Narrows during installation	Pointed “rocktips” to rig legs Accurate positioning and minimise lateral slippage by use of single drop legs Discharge of drill cuttings on ebb tide	Post installation dive survey undertaken within 1 week and 10 weeks of installation. Using benthic marine life as biological indicator of sediment conditions undertake regular dive surveys within a 1km x 500m box around the turbine and at two reference sites at the Northern and of the Narrows

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring (detailed monitoring schedule prepared separately)
Damage to other benthic SAC features during installation	Pointed “rocktips” to rig legs Accurate positioning and minimise lateral slippage by use of single drop legs Discharge of drill cuttings on ebb tide	Post installation dive survey undertaken within 1 week and 10 weeks of installation. Using benthic marine life as biological indicator of sediment conditions undertake regular dive surveys within a 1km x 500m box around the turbine and at two reference sites at the Northern and of the Narrows
Fish resources – direct loss of habitat	None required	None proposed
Fish resources – disturbance due to noise and vibration	None required, although using drilling in place of impact piling will minimise noise levels	None proposed
Seals – noise disturbance	Good site management practice, including full sound insulation of plant machinery For construction period impacts expected to be negligible, therefore none required Construction outside pupping season	Observer placed on rig during daylight operation hours with ability to stop proceedings if necessary
Seals – collision with construction machinery	None required	None proposed
Seals – accidental release of contaminants	Provision of full briefing to construction staff on importance of the area Provision of first points of contact in event of spillage	None proposed
Cetaceans – noise disturbance	Good site management practice, including full sound insulation of plant machinery For construction period impacts expected to be negligible, therefore none required	Observer placed on rig during daylight operation hours with ability to stop proceedings if necessary
Cetaceans – collision with construction machinery	None required	None proposed
Cetaceans – accidental release of contaminants	Provision of full briefing to construction staff on importance of the area Provision of first points of contact in event of spillage	None proposed

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring (detailed monitoring schedule prepared separately)
Basking shark	None required	Observer placed on rig during daylight operation hours with ability to stop proceedings if necessary
Otter	None required	Observer placed on rig during daylight operation hours with ability to stop proceedings if necessary
Ornithology	Construction outside key breeding times Directional drilling to avoid foreshore impacts	Observer placed on jack-up rig during daylight construction hours with ability to stop proceedings if necessary
Introduction of alien species during installation	Rig body will be exposed to the air for a minimum of 2 days, plus normal hull antifouling procedures	None proposed

8.14 Operational impact assessment summary

Table 8.7 Classification of operational impact

Potential Impact – Operational	Magnitude	Duration	Classification of residual or overall impact
Impact on benthic habitats in the Narrows through direct loss of habitat	Negligible, localised	Medium term	Negligible
Impact on benthic habitats in the Narrows through changes in physical parameters	Minor, localised	Medium term	Negligible
Combined impacts on benthic habitats in the Narrows	**Negligible**	**Short term (275m^2)** **Medium term (40m^2)**	**Negligible**
Impact on other benthic SAC features through changes in physical parameters	Negligible	Medium term	Negligible
Fish resources – loss of feeding habitat	Negligible	Medium term	Negligible
Fish resources – noise and vibration effects	Negligible	Medium term	Negligible
Seals – noise disturbance and barrier effect	Uncertain	Medium term, reversible	Uncertain
Seals – collision	Uncertain	Medium term	Uncertain
Cetaceans – noise disturbance and barrier effect	Uncertain	Medium term	Uncertain
Cetaceans – collision	Uncertain	Medium term	Uncertain
Basking shark – physical impacts	Uncertain	Medium term	Uncertain
Basking shark – EMF impacts	Minor, very rare and localised	Medium term, intermittent	Negligible

Potential Impact – Operational	Magnitude	Duration	Classification of residual or overall impact
Otter	Negligible	Medium term	Negligible
Ornithology – collision	Minor, very localised	Medium term	Negligible
Ornithology – loss of food resource or foraging habitat	Negligible	Medium term	Negligible

Table 8.8 Operational mitigation and monitoring

Potential Impact – Operational	Mitigation measures	Proposed monitoring (detailed monitoring schedule prepared separately)
Benthic habitats in the Narrows	None required	Annual video and dive surveys. Using benthic marine life as biological indicator of sediment conditions undertake regular dive surveys within a 1kmx 500m box around the turbine and at two reference sites at the Northern and of the Narrows
Other benthic SAC features	None required	Annual video and dive surveys. Using benthic marine life as biological indicator of sediment conditions undertake regular dive surveys within a 1kmx 500m box around the turbine and at two reference sites at the Northern and of the Narrows
Fish resources	None required, although ongoing consultation with local fishing interests will continue	Community and individual perception surveys
Seals	Marine observers – trained observer on platform for six months from installation date with authority to shut down operations if necessary MCT commitment to effective and prompt action if problems identified through monitoring programme or if requested by EHS Cease turbine operation during June-July pupping season	Full monitoring programme provided in Appendix 8 including effort-limited observations, satellite tracking, sonar and low-res camera observations
Cetaceans	Marine observers – trained observer on platform for six months from installation date with authority to shut down operations if necessary MCT commitment to effective and prompt action if problems identified through monitoring programme or if requested by EHS	Full monitoring programme provided in Appendix 8 including effort-limited observations, sonar and low-res camera observations

Potential Impact – Operational	Mitigation measures	Proposed monitoring (detailed monitoring schedule prepared separately)
Basking shark	Marine observers – trained observer on platform for six months from installation date with authority to shut down operations if necessary MCT commitment to effective and prompt action if problems identified through monitoring programme or if requested by EHS Directional drilling of sub-sea cable	Full monitoring programme provided in Appendix 8 including effort-limited observations, sonar and low-res camera observations
Otter	Reduction in footprint of shore works through design stage (seawater pumps relocated away from intertidal)	Full monitoring programme provided in Appendix 8 including effort-limited observations
Ornithology	Directional drilling in construction phase will avoid loss of intertidal habitat Minimum depth above turbine blade 3m	Full monitoring programme provided in Appendix 8 including effort-limited observations, sonar and low-res camera observations

9 NAVIGATION

This section should be read in conjunction with Appendices 9 and 21.

The proposed turbine location is close to the centre of the Narrows. This location has been chosen in place of a more westerly option (discussed in the Scoping Document, see Appendix 9), as a result of advice from the Maritime & Coastguard Agency (MCA). Whilst the pile will be a prominent and suitably lit structure, consultation with local sailing clubs and their representatives regarding the navigational safety aspects has highlighted some concerns over potential implications of Seagen for navigation which are addressed in this section. The proposed site for the development has also been the subject of detailed consultation with both MCA and the Commissioner of Irish Lights.

Navigational interests could be affected in two main ways through the installation of current turbines:

- Direct interference with established navigational routes; and
- Potential squeeze on sea areas through loss of peripheral sea space.

A navigational risk assessment has been provided as Appendix 21 to this ES. The MCA existing guidelines MGN275 with respect to renewable energy installations have formed the basis for this assessment. It must be noted that this assessment is not yet complete due to the requirement for collection of vessel movement data in the Narrows. This will be available prior to installation, and installation will not be able to proceed unless the MCA is content that the structure does not pose a risk to navigation. This is particularly relevant to the potential for increased risk of oil spillage as a result of navigational risk, i.e. if there is an increased risk according to the MCA, the structure cannot be installed. The following section is therefore based on existing data and consultation provided in the preliminary navigation risk assessment (Appendix 21).

Consultation with MCA Belfast resulted in the proposal that Seagen should be a minimum of 60m from the navigation line that runs through the Narrows. The proposed installation location is 85m away. Levels of commercial traffic are reported as very low in the area and the navigation line contains no beacons maintained for the leading lines, therefore the addition of a lit tower would provide an aid to navigation through the Narrows. It is believed that the navigation line is rarely adhered to rigidly and this is expected to be confirmed by the traffic analysis.

The Navigation Risk Assessment followed standard Marine Navigation Guidance (MGN275) and concludes the following:

1. Commercial shipping traffic through the survey area is extremely low. Only one AIS (Automatic Identification System) equipped vessel transited the area during the four weeks of recording. “Balmoral” only visits the area once per year and therefore, although, her tracks transited the proposed site, this represents a low risk situation. In addition, there is ample room for her to navigate round the proposed site;
2. The users of the Lough have vessels less than 3m draught – the minimum draught above the turbine blades in their uppermost position at LAT;
3. The predominant vessel types in the area are yachts, dinghies and other leisure craft;

4. The busiest time of year for predominant vessel types are the months of July and August;
5. Figures for 2003 and 2004 show levels of leisure boat activity below average for Strangford Lough;
6. The Narrows has a ferry route at the northern end, crossing to the north of the proposed location;
7. The ferry operation is not restricted by states of the tide or the current flow and operates 364 days a year;
8. Mobile fishing in the area has been banned indefinitely;
9. Creel (pot) fishing activity occurs only in areas of shallow waters less than 10m depth, on the sides of the Narrows;
10. The exposed top of the monopile and the proposed navigation light on the installation would provide an aid to navigation in an area where there is currently none;
11. The installation will be marked in accordance with IALA using the scheme of black and red with a single white flashing light with 3Nm range;
12. During the maintenance of the generators, additional warnings will be issued at least of 24 hours in advance; and
13. An ATBA (Area To Be Avoided) of radius 50m could be imposed for vessels greater than 300GT.

It is therefore considered that navigation past the temporary single installation, with a navigation light placed on the top of the tower providing night time warning, would not pose any difficulty to the vessels and craft types currently using the waterway or those identified during consultation as potential future trade.

An ATBA for larger vessels could be imposed, however it is not expected that any other restrictions would need to be placed on vessels within the area. Further consultation will address the need for an ATBA and for the extent and application to vessel types/groups. Placing an ATBA of approximately 50m radius around the proposed location should not have an effect on or give rise to any other safety, routing or navigational issues within the area.

The location of the proposed installation and implementation of an ATBA around it may move traffic using the existing recommended route a small distance to the west. In this event there is water of similar depth and flow characteristics to the existing recommended route available. It is not expected that any small shift of route to the west would cause or permit any adverse effect on navigation, safety or ship handling.

The methods of promulgating information and warnings of new restrictions or ATBA's could include distribution of information leaflets supplied to sailing/yacht clubs, warning signs placed on local slipways, detailed warnings in Notices To Mariners (NTM), local navigation warnings (VHF broadcast by Coastguard), websites, email and advertisements in the local press in addition to the safety and mitigation measures listed within Annex 3 of MGN 275(M). It is proposed that local VHF announcements will be used to warn sea users of periods when the rotors are raised for maintenance.

During the construction period the presence of the jack-up rig and the various movements of supply and construction vessels could pose additional hazards to navigation. To ensure that the potential for accidents and risk to existing users of navigation routes is minimised, all structures and vessels will be adequately marked in line with adopted regulations, and operations would be co-ordinated with the local harbour master.

The risk posed to vessels using the Narrows of collision with the turning rotors is considered to be negligible given the minimum clearance of 3m at LAT, and the deepest draught reported of vessels that use Strangford Lough (1.6m). It is recognised that the navigational risk assessment is incomplete pending reporting from the vessel movement surveys. Once complete the MCA will take a view on any likely increase in risk to navigation posed by the Seagen installation. If at this stage the MCA consider an increased risk is likely, they can advise that the development should not proceed under the provisions of Section 99 of the Energy Act 2004. Based on the preliminary risk assessment presented in Appendix 21, the current assessment of operation and construction can be characterised as a **minor beneficial** impact, due to the benefits likely to be seen from an additional navigation marker in the Narrows, and due to the slight risk posed by an additional obstacle being present in the channel.

9.1 Construction and decommissioning impact assessment summary

Table 9.1 Classification of construction and decommissioning impacts

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Navigation	Negligible	Short term	Negligible

Table 9.2 Construction and decommissioning mitigation and monitoring

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring
Navigation	Construction and decommissioning to take place outside busier summer months	None (note that vessel monitoring surveys will be completed prior to installation)

9.2 Operational impact assessment summary

Table 9.3 Classification of operational impacts

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Navigation	Major	Short term	Minor beneficial

Table 9.4 Operational mitigation and monitoring

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring
Navigation	Appropriate colouring, lighting and marking to standard MCA guidance	None

10 CULTURAL HERITAGE AND SOCIO-ECONOMICS

This section should be read in conjunction with Appendices 9 and 21.

10.1 Introduction

There is potential for a range of economic impacts to result from all phases of marine current turbine development, including job creation and supply chain revenue for Northern Ireland fabricators and distributors (e.g. local ports), as well as local businesses. The economic impact, both direct and indirect, will be most significant during the construction phase, in particular if, as intended, significant elements are sourced locally within Northern Ireland.

During the initial commissioning and early test and evaluation phases, the system will be continuously manned by MCT personnel. When the R&D and characterisation phases have been completed, the system will be visited by MCT, QUB staff and contractors on a regular basis.

Additionally the system will be used as a showpiece for the technology. In this respect it will be visited frequently by potential investors, potential customers, politicians and the media. It is difficult to predict the number of visits likely to occur, however, based on experience with the existing Lynmouth installation a delegation has visited it and used the local facilities at least every fortnight during the spring, summer and early autumn months for the last 18 months, and these visits continue.

The ongoing need for environmental monitoring and assessment over the installation and operation phases is likely to generate significant opportunities, primarily for local research institutions such as Queens University Belfast.

The operational and monitoring service requirement of the system over its 2-5yr life will generate a requirement for a local power delivery service and monitoring contract. It is also highly likely that a dedicated service vessel will be stationed in Portaferry and the services of a local boatman will be retained.

There are, however, a number of potential socio-economic concerns that have been highlighted as part of the consultation process undertaken to date. The siting of the turbine in the Narrows will essentially exclude fishing from a safe area up and down-tide of the pile. However, a permanent mobile gear ban is currently in place within Strangford Lough and traditionally mobile gear is rarely used in the fastest flowing areas of the Narrows. The Narrows is used by local creel fishermen but effort tends to be concentrated in the shallower areas of the Narrows to the edges of the channel and in areas less than 10m of water. The impact of siting the turbine on the operation of the creel fishermen will be considered as part of a final navigation risk assessment, and further consideration is given to fisheries impacts below.

The Narrows is heavily used as a recreational yachting, boating and diving area, as well as a relatively safe site for teaching diving and sailing. The presence of a perceived danger posed by the turbines may have a negative economic impact for this activity. The potential navigational hazard and its assessment are discussed in Section 9.

10.1.1 Land use and Development

The land around Strangford Lough is under considerable pressure for housing development. There are several towns bordering the Lough and some (e.g. Portaferry, Greyabbey, Kircubbin and Killyleagh) have had fairly recent periods of growth, with more proposed for the future.

The areas surrounding the towns and villages are generally in agricultural use and many of the islands that provide important nesting and roosting sites for the internationally important bird population are also used by farmers for grazing sheep and cattle.

As discussed in Section 7, sea defences are present around the Lough, protecting property and infrastructure from erosion. The favoured strategy appears to be the use of rock armour revetments. The development of coastal engineering works has had a history of altering small bays and areas of saltmarsh and tidal flats. These 'hard' structures have modified the physical processes of the Lough in localised areas, and have led to changes in the habitats found there. When examining the Narrows, there is very little coastal modification away from the main villages.

The proposed development will make a grid connection within the existing compound of the Strangford sewage farm. It is not anticipated that the provision of a small transformer station will require any increase in the size of the compound. However, it is possible that the sewage farm will be upgraded in the near future (DoE Water service *pers comm*). It is currently unclear precisely whether the transformer will be placed within the compound or immediately adjacent to it. This will form part of a separate planning application.

10.1.2 Leisure and Tourism

Strangford Lough is an extremely important tourist destination both for informal (walking, bathing, angling, birdwatching etc.) and more formal recreational pursuits.

Boating and sailing activities are especially popular, with over 2000 vessels and 12 clubs located around the Lough and the Ards Peninsula. Numerous events, races and regattas taking place throughout the year. The proposed turbine site is close to the starting line used by a number of local sailing clubs. A large racing buoy is placed along a sight line from Black Boat Bay (to the south of Portaferry) to a spot close to the middle of the Narrows and adjacent to the proposed turbine location. From consultations carried out with yachting interests, it is known that the Black Boat Bay start line is used by Portaferry Sailing Club, Ballyhenry Sailing Club and Strangford Sailing Club. It is principally used for larger regattas.

Windsurfing is popular, as is jet skiing and water skiing, in certain areas of the Lough although mainly to the north of the Narrows. The areas of most use are generally dictated by the presence of suitable facilities, such as access to launching facilities, car parking and toilets.

Strangford Lough is one of Northern Ireland's top destinations for recreational SCUBA divers who use the sheltered waters of the Lough for training, observing marine life or exploring wrecks. The fast flowing currents to the northern end of the Narrows also provide excellent drift dives for the more experienced. Drift diving tends to be concentrated at the upper end of the Narrows in areas such as Ballyhenry Island and Audleys Point. Consultations indicate that whilst drift diving can occasionally occur in the middle reaches of the Narrows, it remains unusual. In order to ensure divers are aware of the potential hazard further information will be disseminated to dive clubs and key training operators.

The level of publicity and consultation carried out to date is likely to have raised the profile significantly in the local area, therefore it is considered that the risk of harm arising to divers as a result of the turbine is negligible. However, there will be an area of the Narrows that will no longer be of a similar level of safety for diving as at present, particularly on drift dives.

The majority of navigation in Strangford Lough, including the Narrows, is recreational. Further information on navigation is provided in Appendix 21.

10.1.3 Archaeology and Cultural Heritage

The archaeological value of Northern Ireland is widely recognised and Strangford Lough is no exception. EHS commissioned a 4 year research survey in order to establish the archaeological record of the Lough's extensive intertidal zone. The survey report (McErlean *et al*, 2002) presents plenty of evidence that the intertidal area of the Lough provides an excellent archaeological and cultural heritage of the varying landscape and use of the Lough from the 19th century right back to the early Mesolithic period. The survey found evidence of submerged landscapes of peat and forests that provide evidence of post-glacial sea-level rise and landscape change in Northern Ireland.

The survey also uncovered a substantial amount of evidence of past human exploitation of the Lough's resources. These artefacts included wooden and stone fish traps, the earliest of which were found at the northern end of the Lough and dated between the 8th and 13th centuries AD. There are 61 Landing stages of varying design and age that were also found around the Lough. The majority of the structures are currently thought to date from the 18th and 19th centuries and, although not particularly 'old', provide a good picture of the historic reliance on boats for trade, communication and resources.

The late 17th and early 18th centuries witnessed a shift in the exploitation of Lough's resources. The Lough's inhabitants began to cultivate and harvest seaweeds. Large numbers of artefacts from this industry have been discovered along the foreshore including:

- Intertidal walls;
- Kelp grids;
- Kilns; and
- Boulders placed in the intertidal, specifically for the cultivation of seaweed.

10.1.4 Commercial Fisheries

Commercial fishing in Strangford Lough has declined rapidly in recent years. Concerns that the use of mobile fishing gear was causing severe damage to the sea bed and, in particular, to the *Modiolus* reefs, has led to a temporary total ban of dredging and trawling within the Lough. Potting can still take place during the ban and vessels targeting crabs, whelks, lobsters and Dublin Bay prawns still occurs in the Narrows and around the periphery of the Lough.

The operation of commercial fishermen could be impacted in a number of ways by the construction and presence of marine current turbines, including:

- Exclusion from established fishing grounds with resultant reduction in catches and loss of income;
- Creating an entanglement risk to fishermen hauling pots;
- Increased navigational risk; and
- Loss or damage to gear.

Aquaculture is a growth industry in Northern Ireland and, accordingly, shellfish cultivation has developed and increased in the Lough in recent years. Species that are farmed in the Lough include oysters, mussels, clams and scallops. Apart from oyster cultivation in the shelter of Castleward Bay, no aquaculture is practised in the Narrows.

10.2 Potential construction and decommissioning period Impacts and mitigation measures

10.2.1 Land use and development

The only construction or decommissioning impacts on land use around the Narrows will be the small area of land required for directional drilling. This is considered to be a **negligible** and reversible impact.

10.2.2 Leisure and tourism

Construction activities may bring occasional visitors to different parts of Strangford Lough, but the short duration is likely to result in this impact being very small. The construction activities may also disturb or exclude diving or sailing activity from a small part of the Narrows, particularly during any activities that could generate noise. Such activities will not go ahead if a dive vessel is noted in the vicinity. This impact is in the winter months when activity is generally slightly less than the summer months, and last for a very short time, covering a relatively small part of the Narrows. The impact is therefore characterised as **negligible**.

10.2.3 Archaeology

The placement of any structure on the seabed has the potential to impact upon archaeological resources. Potential impacts include:

- Disturbance and damage during construction to known sites of marine archaeological interest;
- Damage to unknown/undescribed resources; and
- Changes in the exposure of seabed sediments (and potentially archaeological resource) due to alterations in wave/current activity resulting from flow change around the base of installed monopiles (operation).

Of all the works involved in this initiative, the installation of the turbine has the greatest potential to disturb or damage archaeological resources. Damage could potentially occur through:

- Positioning of the jack-up rig;
- Drilling of the socket to take the monopile, or pile hammering of the monopile;
- Cable laying; and
- Installation of any land-based infrastructure for connection to the electricity grid.

Of these operations, the first two would be limited to a relatively small area of the seabed and, therefore, sites of known archaeological interest could be avoided during the turbine site selection process. Any sites discovered during construction will be reported as appropriate. The use of directional drilling (as proposed) is a method that will reduce the potentially significant short term disturbance and impact arising from cable laying on the seabed.

The divers who undertook the subtidal ecological surveys were asked to comment on areas of gravel sediment which had the potential to shelter artefacts. No such areas where reported in the dive records. The potential archaeological impact of the installation phase is therefore considered likely to be **negligible**.

10.2.4 Commercial Fisheries

Obstruction to fishing vessel movement and deployment of fishing gear
For the duration of the construction period it is likely that the area in which the jack-up rig were to be located and the route for cable-laying would be off-limits to fishing activity. Consultation carried out as part of the navigation risk assessment (Appendix 21) indicates that no commercial fishing will conflict with the proposed location as the only fishing currently permitted in Strangford Lough is shellfish potting, which takes place in water generally shallower than 10m in the Narrows.

The displacement of or reduction in fish and shellfish resources due to the potential effects of current turbines on habitat resources is not considered to be a significant issue and any change, if it did occur, would be outweighed by the exclusion of fishing from the turbine site. Any increase in suspended sediments arising from the construction phase is considered likely to be negligible (see Section 7) and therefore impacts to shellfisheries are expected to be **negligible**.

10.3 Potential operational impacts and mitigation measures

10.3.1 Leisure and tourism

MCT observations have indicated that the Lynmouth system has provided an added tourist interest to the area. The boat trips that leave Lynmouth and travel up the coast to the lighthouse now circle the tidal power system. There are interpretation boards on the promenade at Lynmouth and in the tourist centre explaining the system, alongside a section in the Exmoor tourist brochure.

There have been some initial discussions between MCT and the Portaferry Aquarium about the possibilities of providing an additional exhibit at the aquarium, and MCT will provide publicity materials on request. This exhibit would include real time displays of the SCADA system, remote CCTV of the Lough, display boards explaining the technology and associated benefits to the environment.

As part of their forward planning process, MCT have provided estimates for the number of man nights of accommodation required in Strangford over the first 3 years operation, as shown in Table 10.1.

Table 10.1 MCT's anticipated accommodation requirements associated with the development

Year	Bed nights			
	1	2	3	Total
Installation	30	0	0	30
Commissioning	30	0	0	30
Press Launch	100	0	0	100
Initial Testing	100	0	0	100
Extended Testing	50	100	100	250
Show and tell visits	150	150	150	450
Total man nights hotel accommodation	460	250	250	960
Value (£70/accomodation night assumed)	£32,200	£17,500	£17,500	£67,200

Note that these visits will be throughout the year even in off peak vacation periods.
(Source: MCT)

In addition local services will be required for:-

a) Ongoing environmental assessments

b) RIB access to the system

c) Local mechanical engineering services

d) Local electrical engineering services

e) Local telephony services

f) Local diving services

g) Local office space and workshop facilities

h) Local maintenance and operation support services

Therefore potential additional input into the Northern Ireland economy from skill related revenue could be in the order of £250,000 per year.

It must be noted that moderately adverse impacts on landscape character and on medium and short term views have been identified as likely to arise as a result of this project. This could have a slightly detrimental effect on the attractiveness of the area to tourists, but it is likely this will be counteracted to some degree by the potential attraction feature represented by the turbine.

Potential adverse impacts that could arise as a result of the operation of the turbine relate to sailing and diving activities. There are three or four key regattas using the Black Boat Bay starting line each year. As part of the mitigation measures discussed with sailing clubs, the option of ensuring that the turbine system is not operating during regattas is proposed. This will avoid any significant impacts on recreational boating in the Lough. In addition there will be clear contact procedures provided to sailing clubs with the site surveillance operators and MCT to ensure any unforeseen circumstances can be dealt with directly. This communication route will also be provided to major dive clubs and operators in the area.

Diving activities are likely to notice little impact except the requirement to plan any drift dives in the area at appropriate tidal states so as to ensure the drift takes divers away from the turbine. In this way only the sea bed immediately adjacent to the turbine is likely to be removed as a diving area.

Operational impacts are therefore characterised as a combination of slightly beneficial to certain tourist activities but slightly adverse to some leisure activities. The impact is therefore characterised on balance as **negligible** from a leisure and tourism point of view, due mainly to the novelty attraction of a developmental turbine in the area.

10.3.2 Archaeology

Geophysical surveys completed in April 2002 (Titan Surveys 2004) did not pick up any obvious features on the sea bed that require further investigation as potential wrecks or archaeological sites. There is therefore no anticipated impact on archaeological interests arising from the operation of Seagen.

10.3.3 Commercial Fisheries

Exclusion from established fishing grounds with resultant reduction in catches and loss of income
The proposed area of installation of the current turbines in the Narrows are regularly but lightly fished. The installation effectively excludes fishing activity from around the vicinity of the turbines and a safety area around the installation. This represents a **minor adverse** impact on fishing activities in the area.

The impact of this reduction in fishing area may also result in increased effort in other areas of the Narrows and lower reaches of Strangford Lough, although given the low effort currently in place this represents a **negligible** secondary impact.

Creating a physical obstacle to fishermen employing certain fishing methods and potential for loss or damage to fishing gear
Once operational, Seagen will constitute an underwater obstacle that would effectively preclude the use of trawling within a certain area of the turbine. It is possible that certain techniques, such as potting, could still be employed relatively close to a turbine, although even with this technique there would be a risk that potting lines could become entangled around the turbines during deployment or the reeling in of the lines.

The normal practice of local fishing vessels hauling fleets (strings) of creels in the tide swept narrows could introduce the risk of entanglement of a fleet of creels in the blades of the turbine, whilst the fleet of creels is being winched to the surface. However, consultation carried out as part of the navigation risk assessment indicates that the only fishing activities currently permitted in the Lough take place in water no greater than around 10m depth, which would keep these activities away from the proposed location. Rope cutters will be fitted to Seagen as a precaution to reduce the risks of serious entanglement.

Discussions with the MCA and the Commissioner for Irish Lights have resulted in an agreed lighting and colour coding for the Seagen superstructure. This is illustrated in Figure 1.1. The pile will be 8-10m above the height of the sea surface. It will be a prominent marine feature and could play a temporary beneficial role as a navigational mark in Strangford Narrows.

The residual impact on commercial fisheries is therefore characterised as **negligible**.

10.4 Construction and decommissioning impact assessment summary

Table 10.2 Classification of construction and decommissioning impacts

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Archaeology	Indeterminable	n/a	Negligible
Commercial fisheries - obstruction to fishing vessel movement and deployment of fishing gear	Negligible	Short term	Negligible (based on existing fishing levels)
Diving and sailing	Negligible	Short term	Negligible

Table 10.3 Construction and decommissioning mitigation and monitoring

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring
Archaeology	None required	None proposed
Commercial fisheries - obstruction to fishing vessel movement and deployment of fishing gear	None required	None proposed
Diving and sailing	Ensure activities generating underwater noise are not carried out when dive vessel is in vicinity	Public perception surveys

10.5 Operational impact assessment summary

Table 10.4 Classification of operational impacts

Potential Impact – Operational	Magnitude	Duration	Classification of residual or overall impact
Archaeology	Indeterminable	n/a	Negligible
Commercial fisheries - creating a physical obstacle to fishermen employing certain fishing methods and potential for loss or damage to fishing gear	Negligible	Medium term	Negligible (based on current fishing levels)
Commercial fisheries - exclusion from established fishing grounds with resultant reduction in catches and loss of income.	Negligible	Medium term	Negligible (based on current fishing levels)
Diving and sailing	Minor	Short term	Negligible (adverse and beneficial impacts likely)

Table 10.5 Operational mitigation and monitoring

Potential Impact – Operational	Mitigation measures	Proposed monitoring
Archaeology	None required	None proposed
Commercial fisheries	None required	None proposed
Diving and sailing	Information dissemination and closure during sailing regattas	Public perception surveys

11 LANDSCAPE

This section should be read in conjunction with Appendix 22.

Strangford Lough lies in one of the most scenically attractive areas of Northern Ireland. This is reflected in the designation of all of Strangford Lough and its hinterland as an Area of Outstanding Natural Beauty (AONB). Strangford Lough has been an AONB since 1972. The designation covers the foreshore, the islands and landward margins around the Lough and does not extend into the marine environment. The AONB is primarily concerned with conserving and enhancing the natural beauty and amenity of the area.

The impact of the proposal to site a temporary structure in the Narrows for 2-5 years has therefore been subject to a full landscape assessment following the Guidelines for Landscape and Visual Assessment, published by the Landscape Institute, to characterise impacts on visual receptors and landscape character, and to identify mitigation where this is possible. The full assessment report is provided in Appendix 22 and summarised below.

11.1 Landscape character

The existing landscape character of the site and its surroundings is rural. The shoreline is rugged in nature, with few direct public access points, and is made up of various inlets and islands, which give the area further character. This irregular coastline shape is mirrored by the undulating ridge formed by the surrounding drumlin hills, upon which a patchwork field pattern has become established, broken up by mature hedgerows, stone walls and areas of gorse scrub vegetation. Nestled amongst the foot of the drumlins is well established farmland, utilised as both grazing and arable land, giving the landscape a varied texture and the two settlements of Strangford and Portaferry, which have a strong physical link through the ferry.

The overall effect is that of natural, well-managed and unique landscapes, where traditional land use along this stretch of unspoilt coastline contributes to creating a sense of continuity throughout.

Around the proposed turbine location, the Narrows provides an interesting transition from the classic drumlins and pladdies of the main Lough to a more open and flatter landscape of the coastal plain at Killard and Ballyquinton Points. The shoreline consists of rock outcrops and offshore skerries, which are important components when considering new development in the coastal zone, as they may provide further screening and thereby accommodate small discrete structures.

Various aspects of the built heritage also heavily contribute to the character of Strangford Lough. The most distinctive feature of this area is Castleward House and its estate. The six tower houses at; Kilclief, Strangford, Portaferry, Bankmore Hill and Castleward Tower, also form a strong architectural link along The Narrows. These are complemented on the water by the white channel markers located towards the mouth of the Lough.

The proposed site for the development is visible from both the Portaferry and Strangford villages. The sea views from these villages are a part of their scenic value and setting. The quality of the landscape and visual amenity is also a major draw for people coming to visit and live in the villages and surrounding area.

White pillar structures between six and 15m tall are a distinctive feature of the Strangford Lough Narrows landscape. These navigational beacons of the Narrows and Angus Rock lighthouse punctuate the views to the Irish Sea. Whilst looking north up the Lough, Ballyhenry Beacon and Church Point Beacon continue this effect. The pile top has been designed to reflect the simplicity of these structures but also to contain the necessary equipment and services required by the turbine and its maintenance (see Figure 1.1). Table 11.1 provides a summary of conspicuous landmarks in the Lough.

Table 11.1 Review of conspicuous landmarks in Strangford Lough Narrows

Narrows Landmark	Height above MHWS (metres)	Visibility (nautical miles)
Angus Rock Tower	15m	6 miles
Dogtail Point	2m	5 miles
Salt Rock Beacon	8m	3 miles
Gowlands Beacon	6m	5 miles
Portaferry Beacon	9m	9/6 miles
Proposed Seagen System	*9m*	*8.5/5 miles (estimated)*

Data source: Admiralty chart 2159

A landscape impact assessment will be undertaken on the proposed design once it has been finalised.

11.2 Potential construction period impacts and mitigation measures

The presence of the jack-up rig during construction could act as a significant visual detractor. However, this influence would be temporary and, as with many large construction projects, could generate public interest. The main impacts during construction are likely to be visual, as follows:

- Presence of large construction machinery, principally a 'jack-up barge' measuring 60m x 32m, afloat within the Narrows, for approximately one month;
- Slightly increased site traffic on the A2, during the construction of the transformer building.

These impacts will have no lasting effect on the character of the landscape.

The visual impact will be major whilst the jack-up barge is on site, lasting for approximately one month. In the context of the relatively unspoilt nature of the coast this impact is characterised as moderate adverse for the short construction phase. The public perception impacts arising from this has been and will be further mitigated by the significant publicity and consultation carried out with local individuals and groups around the Narrows, although the residual physical impact will remain **moderate adverse**. These impacts can only be mitigated by increasing public awareness of the project, although this will not reduce the residual impact level.

11.3 Potential operational impacts and mitigation measures

During operation transitory/permanent impacts are likely to arise as a result of:

- Localised, medium term impact of the proposed turbine on the seascape of the Narrows and the Strangford Lough shoreline;
- A visually obvious wake will be created as the tide pulls around the structure;
- The navigation lights will attract attention to the structure at night;
- During maintenance, the rotors will be lifted above the water surface, which may create further visual intrusion; and
- Another small structure on the shoreline is the transformer station, around the size of a single garage, which is primarily a very rural and natural landscape.

Visual impacts
Unlike wind turbines, the main part of a current turbine is permanently submerged beneath the sea and is not, therefore, normally visible to the human eye. The only evidence for the presence of a turbine would be the upper 9m of the monopile and the cross beam during servicing.

In order to reduce the visual impacts arising from a more angular structure used in the Seaflow turbine (see Figure 1.2) the design of the turbine monopile has been modified so that it successfully addresses the need to incorporate an operations room at the top of the pile, a graphic representation of which is provided in Figure 1.1.

Even within the confined area of the Narrows of Strangford Lough, the visual impacts of the turbine are likely to be limited. The Zone of Visual Influence (ZVI) of the turbine structure is provided in Figure 11.1 using a model of 10m above HAT, although the final design will be less than this at 9m above HAT. These heights and the ZVI result in the proposed development having a **negligible** impact on the long distance views and a **minor to moderate adverse** impact on the medium and short distance views of the site.

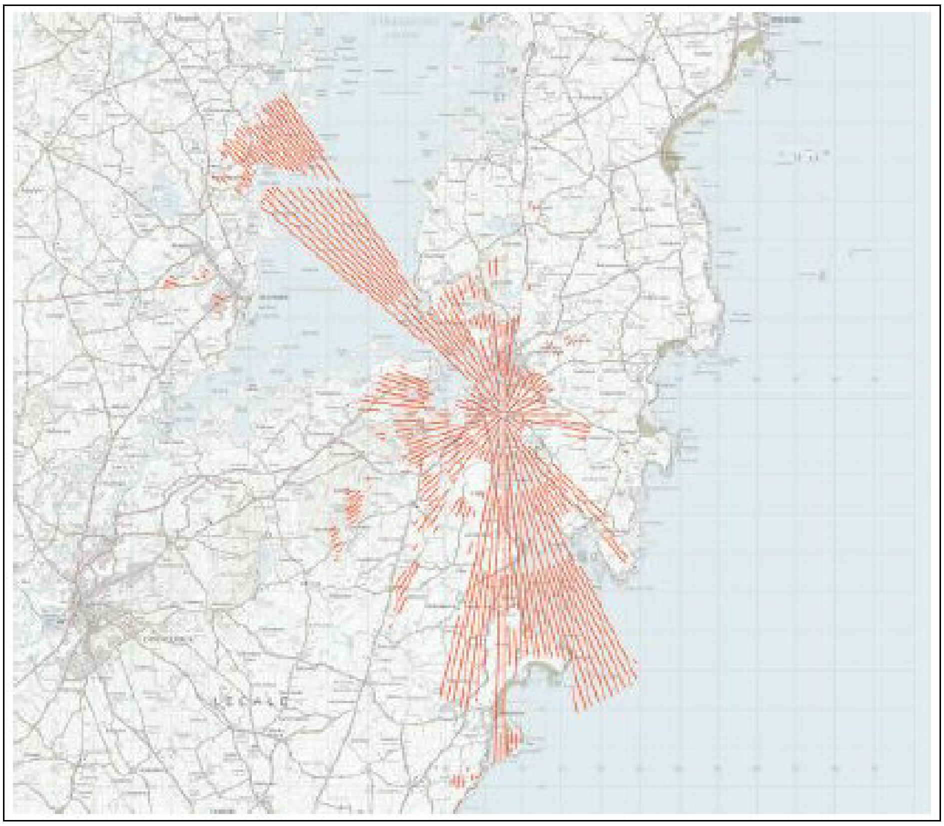


Figure 11.1 Zone of Visual Influence for the proposed SeaGen turbine

Landscape character
Due to the existence of several navigation buoys in the Lough, the structure will not appear as being abnormal to the resultant landscape character of the area during normal operation. The channel markers of the Narrows are 8-10m high and represent white beacons of a remarkably similar size and shape to the upper tidal turbine pile (see Table 11.1 above and Figure 1.1). This represents a moderate impact on landscape character.

However, during maintenance the area covered by the structure increases and the rotors, the design of which does not fit naturally within the local context, will create an occasional moderate impact. The impact of the development could therefore only be described as **minor adverse** as the turbine will result in a large man-made structure which will sit within an open seascape as viewed by the casual observer or receptor.

Summary
The proposed turbine will be perceived as a new element within what is a natural landscape and seascape, resulting in an impact on the local areas when viewed from both shorelines and for those afloat within The Narrows.

The impact will be greatest during the construction of the turbine due to the scale of the machinery used, in relation to the width of the Lough in this area; this will take place over a period of approximately month. Once in place the structure will broadly complement the various maritime elements already in place in the Lough.

The visual impact brought about by the development is likely to be significant mainly from short distances, both along the shore and on the water. The most severe impacts on the landscape, seascape and views occur at low water when more of the turbine structure is visible and during occasional periods of maintenance when the two 16-metre diameter rotors appear above the water surface.

11.4 Construction and decommissioning impact assessment summary

Table 11.2 Classification of construction and decommissioning impacts

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Visual	Moderate	Very short term	Moderate adverse
Landscape	Negligible	Very short term	Negligible

Table 11.3 Construction and decommissioning mitigation and monitoring

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring
Visual	Provide public awareness materials	Public perception (see environmental monitoring programme)

11.5 Operational impact assessment summary

Table 11.4 Classification of operational impacts

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Visual – long distance views	Negligible	Medium term	Negligible
Visual – short to medium distance views	Moderate	Medium term	Minor to moderate adverse
Landscape	Moderate	Medium term	Moderate adverse

Table 11.5 Operational mitigation and monitoring

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring
Visual	Provide public awareness materials	Public perception (see environmental monitoring programme)
Visual and landscape	Minimise angular design and reduce physical size as far as possible	None

12 TRAFFIC AND ACCESS

Navigational issues have been dealt with in Section 9 above, so this section covers land-based traffic only. It is intended that the installation of the turbine will involve as little road transport as possible. This will be limited to vehicles supporting the directional drilling operations and occasional transport of staff or site visitors from Belfast. The installation method statement (Appendix 2) demonstrates that the materials required for the installation will be transported where possible to site by sea.

12.1 Potential construction period impacts and mitigation measures

The major pieces of equipment required for the installation will be carried to site loaded onto the jack up barge. Used drilling mud will be stored on site and removed in a single lorry trip. Settled drill cuttings will be removed by HGV taking approximately 10 trips.

The directional drilling process will involve one low loader with the drilling rig, a semi low loader with recycling unit, and 8 standard flat bed trailer loads, and 2 loads to dispose of cuttings, representing 24 HGV trips.

The most significant potential impact on traffic flow would be the requirement to lay out the directional drilling casing in a straight line, most likely along the road accessing the Sewage Treatment Works off the A2. This will be present for a maximum of 2 days, and in order to avoid blocking traffic visiting the works the cable will be lifted either side of the road so that vehicular access is maintained.

The roads around Strangford and Portaferry are suitable for HGVs and regularly carry local buses. The residual impact from construction activities on traffic is therefore characterised as **negligible**.

12.2 Potential operational impacts and mitigation

The periodic servicing, maintaining and monitoring of the Seagen installation is not expected to require the transport of heavy equipment nor will it require a significant number of additional staff to travel to the site. The main increase is likely to be from traffic bringing visitors or workers to the Strangford or Portaferry piers and this is not likely to exceed 200 trips per year. In the context of other public use of the roads to Strangford and Portaferry this is considered to represent a **negligible** impact.

13 NOISE AND VIBRATION

This section should be read in conjunction with Appendix 2.

This section considers noise generated above the surface of the sea as opposed to underwater noise, and therefore those sources most likely to affect human receptors. The rural setting of Strangford Lough makes it a relatively tranquil and quiet location. Key existing sources of water based noise in the vicinity of the proposed development would include the Strangford Ferry and, when it is in full flow, the Routen Wheel whirlpool.

13.1 Construction period impacts and mitigation measures

During construction, the presence of the jack-up barge and the drilling operations are likely to be within 1-2km of the villages of Portaferry, Strangford and possibly Kilclief. There are occasional isolated houses and groups of houses at various points closer to the proposed location.

Underwater drilling operations have little potential to generate noise above the sea surface as a direct result of the drill head. The drilling operations on site will be hydraulically driven and will operate for 24 hrs a day to reduce the duration of the period that the rig is on station. The main sources will be from the drilling head and from the two operating generators required to power equipment and lights aboard the drilling rig. Appendix 2 provides a graphic representation of anticipated noise levels from the generators, showing that a level of 60dB will be reached at a distance of 15m. Noise levels from the drill head cannot be accurately predicted due to the different rock types encountered.

It may be necessary for up to 15 minutes of light hammering of the drill head components at the start of operations in order to settle and position the bit correctly. The noise rating for this hammering is not expected to result in levels that will cause disturbance and will only last for 15 minutes, if required at all, resulting in a very short period of noise that may be heard from the adjacent shoreline. This will be carried out during daylight hours to ensure any disturbance to surrounding human receptors is not at night.

The residual impacts of surface noise are therefore characterised as **negligible** due to the low levels and short duration of any potentially disturbing activities.

13.2 Potential operational impacts and mitigation measures

It is not anticipated that any noise discernible to humans will be generated during the operational phase. It is possible that under full flow the wake effect on the pile may result in some additional water movement noise but this is considered highly unlikely to be significant or obtrusive in the context of the nearby ferry operation and the continual running of the Narrows. The implications of underwater operational noise for marine life are considered in Section 8.12.

13.3 Construction and decommissioning impact assessment summary

Table 13.1 Classification of Construction and Decommissioning Impacts

Potential Impact – Construction and Decommissioning	Magnitude	Duration	Classification of residual or overall impact
Drilling noise – power generators	Negligible	Very short term, although 24hr	Negligible
Possible hammering noise to settle drill bit	Moderate	Very short, 15 minutes	Negligible

Table 13.2 Construction and Decommissioning Mitigation and Monitoring

Potential Impact – Construction and Decommissioning	Mitigation measures	Proposed monitoring
Noise generation	None	None (see Nature Conservation section for impacts to wildlife)

13.4 Operational impact assessment summary

Table 13.3 Classification of operational impact

Potential Impact – Operational	Magnitude	Duration	Significance	Classification of residual or overall impact
Noise	Negligible	Throughout operation – 2-5 years	Negligible	None

Table 13.4 Operational mitigation and monitoring

Potential Impact – Operational	Mitigation measures	Proposed monitoring
Noise	None	None

14 AIR QUALITY

The installation and operation of the temporary turbine in Strangford Lough Narrows is not anticipated to have any significant impacts on air quality.

However, the proposed Strangford Lough marine current turbine is a critical stage in the development of commercial scale tidal turbine arrays. It is anticipated that commercial tidal arrays have the capacity to make a significant contribution to the reduction of greenhouse gas emissions from the UK and Europe, thereby contributing to international targets agreed under the Kyoto protocol and more ambitious domestic targets.

The residual impact is therefore characterised as likely to be **negligible** in the short and medium term and **beneficial** to air quality in the long term.

15 CONCLUSIONS

This document is submitted as the final Environmental Impact Statement in support of Marine Current Turbine Ltd's application for a licence to construct a monopile and operate tidal turbines in the Strangford Narrows under the FEPA. Wherever possible it addresses key issues identified through the ongoing consultation with regulators undertaken by or on behalf of MCT in support of this project.

Overall, it must be concluded that there are unlikely to be significant impacts arising from this proposal on the key issues, including the hydrodynamic regime and most nature conservation interests in Strangford Lough such as its European protected features. However, there are uncertainties associated with this conclusion, and consequently specific recommendations have been made to inform these uncertainties through intensive monitoring and assessment. This is directly in line with advice provided to EHS from the Joint Marine Partnership, representing the Ulster Wildlife Trust, WWF, and RSPB. It also follows draft guidelines on application of the precautionary principle currently *in prep* by SNIFFER, although it is important to note that these will be subject to change as a result of initial consultation feedback.

In the same way that they normally avoid collision with other static structures such as piers, a pragmatic approach to the possibility that marine mammals or other large fish will be directly harmed by the turbine during operational periods could suggest that these species will avoid collision. This argument could also be extended to suggest that these species, in particular those known to have relatively high intellectual capacity such as many cetaceans and seals, are likely to 'learn' about risks to their wellbeing posed by the generator rotors.

However, given the potential sensitivity of these species if they were to be struck by the rotor, it must be recognised that as tidal turbines are new structures in the marine environment some uncertainty exists with regard to the magnitude and likelihood of certain impacts, including the key uncertainty regarding turbine interaction with marine mammals and basking sharks. Throughout this document a precautionary approach has been adopted to the consideration of possible impacts, but in some instances it remains impossible to determine the exact likelihood of a negative impact prior to installation. In such cases a rigorous and cautious approach to mitigation and monitoring possible impacts is proposed. Through working in partnership with EHS and other relevant experts, and with suitable mitigation agreements in place prior to installation, it is hoped that these uncertainties can be clarified during the installation and commissioning phase of the project.

This approach is potentially compliant with the requirement of the Habitats Regulations for Competent Authorities to ensure that no plans or projects are consented for which it is uncertain, following completion of all reasonable supporting investigations, whether they are likely to have a significant adverse effect on the integrity of protected features.

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LIST OF APPENDICES