REQUEST FOR SCOPING OPINION BY DP MARINE ENERGY LIMITED

in respect of

ISLAY TIDAL ENERGY PROJECT

Environmental Impact Assessment Scoping Report
May 2009

Submitted by DP Marine Energy Ltd
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1.0 Introduction

This proposal for the Islay Tidal Energy Farm sets out the scope and method by which it is intended to carry out the environmental impact assessments (EIA). The Islay Tidal Energy Farm EIA is structured around the recommendations for EIA proposed within Scottish Marine Renewables Strategic Environmental Assessment (SEA) Environmental Report March 2007 [(2)], and its Scoping Report 2006 both prepared for the Scottish Government by Faber Maunsell & Metoc plc.

The SEA is used as a key document in respect of developing the Islay EIA, and consequently the Islay Scoping Document both follows the guidance of the report in structuring topics and utilises extracts of text where appropriate. This guidance has also been supplemented by feedback from consultations, site surveys, and by reference to other potentially related guidance and EIA documents (e.g. for offshore wind farms or other marine experience).

1.1 Scope and Method Proposal

The technology proposals (device type), physical environment, biological environment and consequences of human activities will be assessed for the full life cycle of the tidal farm including decommissioning.

The scope of work, existing guidelines and knowledge and potential effects are presented including a statement on the proposed consultation exercise, a list of consultees approached and the legal framework associated with the proposal.

This document forms a request for a Scoping Opinion under the Marine Works (Environmental Impact Assessment) Regulations 2007 inviting responses from statutory consultees as to the scope and methodology required to effectively assess the potential impact of the proposal with the aim of gaining consent to build and operate the tidal farm. In addition, the views of other associated parties will be sought to highlight local issues, minimise uncertainty and provide clear information as the knowledge gap diminishes throughout the EIA process.

It is proposed that a single ES will be submitted with content sufficient to meet the requirements of each of the following consents and licenses:

- Electricity Act 1989 – Section 36;
- Food and Environmental Protection Act 1985 – Section 5; and
- Coast Protection Act 1949 – Section 34.

1.2 Legislation and Guidance

1.2.1 Legislation

1.2.1.1 Electricity Act 1989 – Section 36

Developers proposing the construction, extension or operation of a marine based generating station within Scottish territorial waters or the Scottish Renewable Energy Zone (REZ) will require Scottish Ministers consent under section 36 of the Electricity Act 1989. This is due to the Scottish Ministers powers being extended on September 2002 by means of a Statutory Order (SI 2002/207) to cover all offshore wind and water driven developments above 1MW capacity.

1.2.1.2 Food and Environmental Protection Act 1985 – Section 5

Under FEPA, a license is required from the Scottish Ministers for work associated with the placing of materials, disposal or introduction of other activities in the marine environment.

1.2.1.3 Coastal Protection Act 1949 – Section 34

For the CPA, ministers must determine whether marine works will be detrimental to the safety of navigation.

1.2.1.4 Marine Works (Environmental Impact Assessment) Regulations 2007

The UK-wide Marine Works (Environmental Impact Assessment) Regulations 2007 (the ‘Marine Works Regulations’ or the ‘Regulations’), which came into force on 24th June 2007, transpose Directive 85/337/EEC (the ‘Environmental Impact Assessment Directive’), as last amended by Directive 2003/35/EC (the ‘Public Participation Directive’), for various marine activities. This includes projects under Annex II Part 3, Energy Industry.

1.2.1.5 Water Environment and Water Services (Scotland) Act 2003

The Act, implemented on the 29th January 2003, makes provision for the protection of the water environment, including provision for implementing European Parliament and Council Directive 2000/60/EC.

1.2.2 Guidance

As described in the introduction to this chapter, guidance for the scoping of the proposal has been taken from the Scottish Marine Renewables SEA [(2)] and this report forms a key document in respect of developing the Islay EIA and consequently the Islay Scoping Document. However, although there have been a number of small tidal demonstration projects such as the Marine Current Turbines project in Strangford Lough, at this time other than tidal barrage systems (e.g. La Rance in Brittany) no large scale commercial tidal farms have been developed. Consequently, whilst guidance does exist for marine energy devices it is perhaps best interpreted to be the result of anticipated impacts rather than clearly understood identified impacts.

As further operational experience is gained from the deployments at EMEC and from demonstration proposals such as that at Strangford Lough, it is likely that further guidance will develop and this will be considered as the EIA process unfolds.

Guidance relevant to each specific topic can be found in chapter 6 and has been based on both pre-consultation discussions, and associated guidance for the offshore elements of other offshore developments in particular offshore wind farms.

2.0 Project Description

2.1 Site Description

2.1.1 Location and Scale

The Islay Tidal Energy Farm proposal is located approximately 8km west of the south-west tip of the island of Islay off the west coast of Scotland and when fully developed is expected to have an installed capacity of 400MW+.

The site is centred on latitude 55^0 40.20N and longitude 06^0 38.50W and is illustrated on Admiralty Chart 2723 (Figure 1).

The proposed development extends over an area of approximately $8.5km^2$.

2.1.2. Navigation

There are no defined Traffic Separation Schemes within the vicinity of the proposal, and the site is located in a navigationally unconstrained area of water in the approaches to the North Channel.

2.1.3. Water Depths

Water depths across the survey area have been determined from both Admiralty data and site specific survey data and varies from 25 to 50m LAT. The seabed has been characterised with a rock outcrop extending southwest from the Rhinns of Islay and gravely sand with superficial sediment.

2.1.4. Resource

A detailed resource assessment of the development site was undertaken utilising both seabed mounted acoustic doppler current profilers (ADCP) and moving vessel transects (conducted over the summer of 2008). The mean spring peak tidal velocities have been measured at approximately 3m/s. Mean neap peak tidal velocities were recorded at around 1.3 to 1.6m/s.

2.1.5 Environmental Constraints

Preliminary desktop studies have indicated that there are no designated areas in or around the site. However, there is a Marine Consultation Area in Loch Indaal and several onshore SSSI, SAC, Ramsar and SPA sites particularly on the Rhinns of Islay. Further detail on designated areas is provided in section 6.1, Protected Sites and Species.

2.2 Proposed Development

2.2.1 Tidal Farm – Outline Development Strategy

2.2.1.1 Fundamental Criteria

Islay is one of a number of potential tidal energy sites which have been reviewed and assessed (and continue to be assessed) based on a clear set of criteria. At the top level these are defined around:

- Installed capacity,
  All the proposals being considered have the potential for utility scale development (i.e. minimum 100MW+ with an objective of >200MW).

- Available resource,
  The sites range from tidal velocities of 2.5 to 4m/s (mean spring peak)

- Physical Installation and Maintainability,
  The sites vary in water depths from 30 to 80m+, and with varying degrees of protection from wave action.

2.2.1.2 Technology Options

With reference to The Scottish Marine SEA: Environmental Report Section B: Resource and Technology, section B2.2.2, tidal energy devices or technologies can be loosely grouped into a number of different categories. For the purposes of considering sites technologies have been grouped into horizontal axis rotating machinery (either open rotor or closed rotor), or oscillating aerofoil, and with bases either piled or drilled versus those which are gravity mounted.

2.2.1.3 Technology Neutral Approach - Purpose

As far as possible the site development proposal has been based on a technology neutral approach. It is, however, acknowledged that an entirely neutral approach is not possible and a clear understanding of technology types (and likely candidate machines) is essential to make the EIA process meaningful. Clearly not all tidal devices are compatible with each specific site particularly in respect of water depth and this is considered as part of the review of fundamental criteria.

The purpose of the neutral approach is to minimise development risk by deferring final device selection until technology is more proven whilst still ensuring that the project progresses to reach the point of construction as quickly as possible in order to contribute to government renewable energy targets. Specifically, this means limiting risk as far as possible to site risk rather than both site and device risk. This will be achieved by obtaining consents for a development envelope which could accommodate a number of candidate machines subject to demonstration of performance on their respective test sites.

2.2.1.4 Technology Neutral Approach – Effect on the EIA

The principle objective of an EIA is to identify, avoid, and then minimise impacts by use of appropriate mitigation measures. The intent of identifying a generic device envelope is that environmental impacts of that envelope may be considered with the broad presumption being made that generally speaking if a location is considered environmentally suitable for a given tidal device it is likely to be suitable for another. Similarly it is probable that if a location were determined to be unsuitable for one device, it would also be unsuitable for another.

Considering this in more detail within the EIA process means that a broader range of impacts may need to be considered than if a single specific device were selected and therefore the assessment is inevitably more involved.

Variation in foundation methods (whether gravity or piled for example), would be a key element with respect to the degree of sediment loading. If the EIA determined that sea bed disturbance was a critical issue and impacts could not be satisfactorily mitigated there may be no option other than to adopt a gravity base solution. This would have an effect on device selection by excluding those which relied on drilling or piling as part of their installation.

Similarly navigational or visibility issues on a given site might mean that surface penetration was undesirable and again this may limit device type to those over which vessels can navigate. (As an overall comment in this respect it is noted that there are clearly issues with permitting navigation over any devices and cables which would preclude anchoring even under emergency loss of power or rudder conditions).

It is recognised that if significant changes to this envelope materialised during the EIA process as a result of device experiences or proven devices coming to market further works may be necessary.

2.2.1.5 Islay Technology Approach

The Islay tidal resource resulting from the flood and ebb tides flowing into the North Channel is largely developed by the flow being accelerated over the rocky spur which extends from the Rhinns of Islay out several kilometres into the sea. The specific resource assessments illustrate, as was predicted by the coarse tidal speed mapping of the tidal atlas [(1)], that the resource falls off markedly as the water depths increase. This makes Islay a very different site from, for example, some of those found in the Pentland Firth. For the purposes of the EIA assessment the Islay devices are therefore those likely to be best deployed in water depths of around 40m, and able to extract resource at speeds of around 2.5 – 3.5m/s (msp).

Navigational safety for both commercial and recreational traffic is also a factor in respect of technology choices. Traffic Separation Schemes (TSS) are often employed in busy areas where large vessels are funnelled through constrained waters and this results in inshore traffic zones which are used by smaller and recreational vessels. Use of surface penetration devices in these areas may then result in further constraint on the inshore waters possibly forcing recreational traffic into or outside the TSS. For Islay it is assumed in the first instance that given the amount of navigable open water in the approaches to the North Channel it would not be essential to permit shipping movement over the devices and therefore surface penetration devices may be considered.

2.2.2 Tidal Farm – Islay Strategy

In order to minimise development and device risks it is proposed to develop the tidal farm in three phases. This reflects both the relative immaturity of tidal devices in commercial operation, and facilitates the infrastructure upgrades which will be necessary for construction of the 400MW project.

2.2.2.1 Phase 1 – Approximately 7.5MW Installed Capacity

Initially, a small array of devices will be installed to demonstrate lead technology. In addition, it is noted that Islay has a peak electrical load of around 5MW which could in part be supplied by the lead devices.

It is anticipated that the preliminary phase devices will be heavily instrumented and monitored as site specific demonstrations of technology. It is intended that this will provide both site-specific experience of the device performance, and of maintainability.

2.2.2.2 Phase 2 - Approximately 50MW Installed Capacity

This phase featuring in excess of twenty devices is dependent on progress towards resolving electrical grid access and recognises potential supplier chain issues with respect to the availability of devices and infrastructure to support installation and commissioning.

Discussion has taken place with representatives of Islay's business community, focussed on the very high commercial heat load requirements of a number of the distilleries and the malting's on the island. Potential exists to reduce the heavy bias on using imported oil, currently delivered by tanker, and develop a greener solution provided the solution is economically and commercially viable.

2.2.2.3 Phase 3 – Approximately 400MW Installed Capacity

Constructing 400MW+ installed capacity of the Islay Tidal Farm will require significant grid infrastructure improvements. However, Islay is not alone in this respect and many of the potential wave and tidal projects on the West Coast and elsewhere are in a similar position.

The intent is that the tidal resource in the development area is fully exploited and, at this point in time this has resulted in a 400MW prediction of potential installed capacity. Whether this is entirely achievable is dependent on further detailed resource assessment and the outcome of the EIA process.

2.2.3 Tidal Devices

Pending the pre-construction detailed assessment and selection of the most appropriate commercially available device, the following generic design characteristics have been assumed for the purposes of the EIA.

2.2.3.1 Design Layout – Device Envelope

As discussed in section 2.2.1.3, as far as possible a technology neutral approach has been adopted in relation to developing the scoping document for the EIA. However, it is recognised that whilst specific devices have not been specified, given the physical constraints of the Islay site and resource, an envelope has been developed based on a generic design philosophy of:

- Horizontal axis tidal turbines (HATT) using either closed or open rotor;
- Sea bed mounted by drilling/piling or gravity mounting; and
- Surface or non-surface piercing structures.

Example machines of this type are illustrated in Figure 2.

As previously noted, it is recognised that if significant changes to this envelope materialised during the EIA process as a result of device experiences or proven devices coming to market further works may be necessary.

2.2.3.2 Design Layout – Array Spacing

The optimum spacing of a multiple turbine array is essential to ensure minimal yield loss resulting from interaction with neighbouring turbines. Adequate spacing is also important to minimise wake and turbulence effects on blade mechanical integrity.

In onshore wind farms in the UK, an environmentally and topographically unconstrained site would typically feature a turbine array with spacing across the prevailing wind direction of around 4 rotor diameters with a downwind spacing of anywhere from 5 to 10 rotor diameters depending on wind speed and turbulence levels. In more bidirectional sites where the winds tend to be more constrained such as those in Tehachapi or the Altamont pass in America where the winds are essentially thermally driven by desert cooling and heating, the spacings tend to be 2-3 diameters across the predominant wind direction and 7-10 diameters in the downwind direction.

Tidal regimes also tend to be similarly bidirectional particularly where accelerated and constrained by physical features. An equivalent tidal array might then consist of a device spacing of around 5 rotor diameters across the stream and 10 rotor diameters downstream

(Figure 3). Further research in this area is being undertaken at present based on the specific characteristics of a number of different devices and it is anticipated that more detailed design criteria will become available as the course of the EIA develops.

2.2.3.3 Rotor Diameter – Turbulence and Depths

The turbine rotor diameter selected will be limited by the depth of water available. A general criteria of a minimum 5m clearance between the blade tip and seabed has been defined and a minimum 5m clearance (at LAT) between blade tip and surface. This, for example, would require a minimum 30m water depth for a 20m rotor diameter.

Although a 5m surface clearance may be acceptable in some conditions in practice, however, strong wind against tide events can result in the development of substantial standing waves in many of the locations where tidal farms are likely to be developed. This wave regime can thus have a significant effect on the upper surface layer and increase the surface clearance requirement. Similarly turbulence in the seabed boundary layer caused by rapid tidal flows across the seabed can also be an important factor for some sites where the seabed roughness (analogous to surface roughness in wind analysis) is significant. This may both reduce turbine yield and also affect the mechanical integrity of the rotor. Again, further generic research is ongoing in this area but it is noted that turbulence layer thickness will be site specific based on tidal strength, wind direction and seabed bathymetry.

On Islay, site data from both the fixed ADCPs and from the moving vessel transects suggests that a more conservative approach to boundary layers is warranted and consequently a depth criteria of nearer 40m has been applied as part of the design brief.

2.2.3.4 Foundation

For the purposes of the EIA devices are assumed to be mounted either into the seabed or gravity mounted on the seabed floor.

If seabed penetration were necessary it is likely the devices would be supported on a single or double steel pile with a cross section of around 3 to 5m in diameter. A hole (or two) would be drilled into the seabed rock into which the pile would be grouted. The depth of pile into the seabed would be dependent upon the strength of the seabed rock but would typically be around 20m. Exact borehole depths would be confirmed following a detailed geotechnical survey and device design.

2.2.3.5 Structure

Whilst some devices are designed around a surface penetrating philosophy, almost all device manufacturers have declared future plans for their devices to be non surface penetrating.

Non surface penetrating structures clearly have advantages in relation to minimising impacts on Seascape, and arguably on Navigation, however, there are significant operational advantages to having accessible structures above the sea surface.

At the depths being considered (nominally 40m) it is unlikely that there would be any potential for the safe navigation for large vessels over the site and consequently there is no navigational advantage to avoiding surface penetration.

For the purposes of the EIA and determining environmental impacts surface piercing is assumed, since this structure type results in the most significant impacts on Seascape and navigation. Consideration will, however, also be given to the use of non surface penetration devices and any potential differences this might have on operations and vessel movements.

It is assumed that for a surface penetrating device the main structure would be surface piercing to around 20m above LAT to enable the rotor assembly to be winched clear of the water for the purposes of operation and maintenance. The use of divers would be minimised. In addition, auxiliary components would, where possible, be housed above the surface again for component reliability and maintainability.

2.2.3.6 Rotors

The design envelope considers two potential horizontal axis tidal turbine (HATT) machine types, the first being a twin rotor system with blades capable of 180 degree rotation to optimise on flood and ebb tidal streams. The rotor diameter would be typically up to 20m. The second system is a bi-directional ducted tidal turbine with direct drive to a permanent magnet generator. Examples of both types of device are shown in Figure 2.

This envelope would notionally cover a number of potential device types:

- Atlantis Solon Turbine;
- Clean Current Turbines;
- Hammerfest Strom Lanstrom Turbine;
- Lunar Energy;
- Marine Current Turbines;
- Open Hydro; and
- TGL Tidal Turbine.

2.2.3.7 Ancillary Equipment

Mechanical and electrical switchgear and control equipment and electrical connection including transformers to the grid system would be housed in a protective enclosure either above or below the surface of the water.

2.2.3.8 Corrosion and Anti Fouling

Corrosion and anti fouling is relatively well understood and developed within both the Oil and Gas and Shipping industry. Generic protection is likely to include a combination of anti corrosion coating of all sub sea components and cathodic protection. Anti fouling coating will be utilised on blades, guide vanes and ducting if applicable.

2.2.3.9 Mineral Oils

Rotating machinery requires lubricants and it is likely that these will be mineral oil based. Any blade pitching/yawing will be hydraulically controlled using hydraulic fluids.

2.2.4 Electrical Connection from Tidal Devices to Onshore Control Building

A detailed electrical design will evolve as the project develops. However, for the purposes of scoping it is assumed that low to medium voltage step up transformers will be installed in each tidal device, and these will then be linked by subsea cable to a number of larger transformer/control rigs as illustrated in Figure 4. It is expected that these larger transformers will export the electricity at around 132kV to a substation/control building near the village of Portnahaven.

2.2.4.1 Sub-sea Cabling to Near-shore

As illustrated in Figure 5, it is proposed to connect the tidal farm to the island of Islay by subsea cables. There is a degree of uncertainty over the detailed design of the electrical system and the carrying capacity of the cabling proposed particularly in relation to the phase 3 proposal. It is possible, for example, that some clustering of the west coast offshore projects may be suggested by National Grid in order to rationalise the overall electricity system. However, at this time a connection application has been made based on the assumption that all three phases of the project will be routed along the same route corridor (and potentially through the same conductors). As far as possible cable routes will avoid traversing areas of very high tidal flow and will be either trenched or pinned depending on the seabed characteristics. Installation methods and routing will be defined in more detail as part of the EIA to identify the most appropriate subsea and shoreline routing.

2.2.4.2 Sub-sea Cabling from Near-shore to Land

The EIA will consider various potential locations for the nearshore to landfall cable routing. In addition, potential options for transition of the cable will be explored including the use of directional drilling to minimise the impact on near-shore ecology and visibility.

2.2.4.3 Onshore Cable Routing to Onshore Sub-station

Cables will be routed underground from the shoreline to the onshore substation.

2.2.4.4 Onshore Sub-station and Control Building

The sub-station and control building will be located in the vicinity of Portnahaven. The control room will house metering and switchgear equipment required to link the tidal farm to the electrical grid system. It is proposed that a section of the building will be utilised as a control room to monitor the activities of the tidal farm plus as a storeroom and small workshop for substation operation and maintenance activities.

2.2.5 Maintenance Facility

Installation, operation and maintenance facilities will be required to support the fleet of tidal turbines. It is envisaged that the service base will be established as part of the proposed development and will be located in the vicinity of Portnahaven harbour. However, the EIA is not intended to cover the details and planning for this specific project element beyond consideration of the potential size and outline of the facility. The maintenance facility will form part of a separate planning application following identification of a suitable site in conjunction with both the Local Authority and with the Local Community.

2.2.6 Decommissioning

The tidal farm and ancillary equipment is expected to have a life of around 25 years after which time it will be removed or a new planning application will be made to upgrade the farm.

2.2.6.1 Turbines

The turbines will be decommissioned by removing all equipment previously installed. If piling has been undertaken the piles will be detached below the level of the seabed and removed.

2.2.6.2 Subsea Cables

The cables will be disconnected at the turbine termination point and recovered as far as the seabed. Buried cables will be left in situ.

2.2.6.3 Sub-station/Control Building

Following removal of all electrical equipment, the sub-station and control building will be dismantled and removed in sections including the base section unless an agreement is reached with the local authority to retain the building for other uses.

2.2.6.4 Maintenance Facility

Following removal of all equipment, the maintenance facility will be dismantled and removed in sections including the base section unless an agreement is reached with the local authority to retain the building for other uses.

3.0 Potential Environmental Impact and Other Issues.

3.1 The EIA Process

3.1.1 Scope

An extensive EIA of the proposed project will be undertaken to assess any possible impacts from the Islay Tidal Energy Farm on the environment. The assessment will include all phases of the development including construction, operation and decommissioning. Potential effects including possible mitigation measures for minimising effects will be assessed for the physical, biological and human environments.

3.1.2 Objectives and the Technology Neutral Approach

The principle objective of an EIA is to identify, avoid and then minimise impacts by use of appropriate mitigation measures. The intent of identifying a generic device envelope is that environmental impacts of that envelope may be considered with the broad presumption being made that generally speaking if a location it is considered environmentally suitable for a given tidal device is likely to be suitable for another. Similarly it is very probable that if a location were determined to be unsuitable for one, it would also be unsuitable for another.

Considering this in more detail within the EIA process means that a broader range of impacts may need to be considered than if a single specific device were selected and therefore the assessment inevitably is more involved.

3.1.3 Current Assessment Status

A number of site specific surveys and consultations have already been undertaken in order to inform this EIA scoping exercise. This has been done to both quantify the potential resource and identify potential constraints.

3.1.3.1 Desk Based Assessment

An extensive desk based assessment has been undertaken, which included:

- An outline resource assessment using data from a number of sources including the Atlas of UK Marine Renewable Energy Resources, the Admiralty Tidal Stream Atlas (NP222), as well the relevant Admiralty Navigational Charts and tidal tables;
- Environmental assessment using the Scottish Marine SEA (2);
- Constraints mapping including bathymetric profiling and geological characterisation;
- Location and definition of designated areas in and around the site, and;
- An assessment of the electrical grid network.

3.1.3.2 Prescoping Consultation

A number of prescope consultations have also taken place. This has included a number of meetings with the following parties:

- The Crown Estate;
- Scottish Natural Heritage (SNH);
- Argyll and Bute Planning Authority;
- Islay Community Council;
- Scottish Hydro Electric Power Distribution;
- National Grid Electricity Transmission;
- The Scottish Government;
- Jim Mather MSP and Energy Minister, and;
- Islay businesses including Distilleries and Maltings.

Briefing notes in respect of the proposal were also distributed to the three locally elected councillors for Islay.

3.1.3.3 Site Surveys

The following site survey work has been undertaken:

- Resource assessment using three seabed mounted devices for thirty days and transects using a moving vessel device;
- Drop down sea bed survey using video camera;
- Field survey to assess current grid infrastructure and potential port facilities, and;
- Potential landfall location for electrical connection

3.1.3.4 Summary of Assessment and Consultation Status

None of the desktop, field assessments, or consultations have indicated insurmountable difficulties or the likelihood of significant impacts in respect of the proposal.

3.1.4 Purpose of Scoping Document

This scoping report is a formal request to relevant authorities to comment on the nature of the proposed EIA scope and methodology.

3.1.5 Consultation During the EIA

It is recognised that the development of Tidal Energy Farms is a new process and inevitably there will be uncertainties as to the specific assessments required. As more experience is gained from demonstration projects or other development sites, and as more detailed technical information becomes available from candidate turbine manufacturers, it is possible that further assessment work will be required and therefore this report must be considered a “live” document reflecting current status of knowledge.

It is essential that a clear understanding of details as they emerge is shared with relevant parties and in that respect DPEM proposes to adopt an open EIA process with scheduled meetings/discussions with relevant bodies as the EIA develops.

When the EIA is complete, DPME will compile an Environmental Statement (ES) containing relevant information gained through the EIA process as part of the application for consents for the respective elements of the development.

3.2 Topics to be Addressed by the EIA

3.2.1 Marine Activities and Risk Assessment

As part of the scoping exercise and based on the site and device data gathered to date, a baseline risk assessment has been undertaken for the marine phase of the project including the tidal farm, subsea cabling and shoreline transition. It should be noted that this is not an exhaustive list and will be developed as the EIA progresses.

The risk assessment is illustrated by a colour coded table with red, yellow or green being used to highlight the potential degree of impact. Table 1 is colour coded as follows:

- RED – Potentially significant impact without mitigation measures.
- YELLOW – Potential Impact
- GREEN – Negligible impact predicted

In addition, the number highlighted in each box refers to the chapter where further details are presented.

If the development is deemed appropriate following the full EIA process with the necessary potential mitigation measures applied, all boxes should be green.

Table 1: Baseline Risk Assessment - Marine

Topic	Project Phases			
	EIA Surveys	Construction	Operation	Decommission
Physical				
Geology		5.1		5.1
Marine & Coastal Processes		5.2	5.2	5.2
Contamination & Water Quality		5.3	5.3	5.3
Biological				
Protected Sites and Species		6.1	6.1	6.1
Benthic Ecology & Intertidal Habitats		6.2	6.2	6.2
Fish and Shellfish		6.3	6.3	6.3
Marine Birds		6.4	6.4	6.4
Marine Mammals		6.5	6.5	6.5
Human				
Commercial Fisheries & Mariculture		7.1	7.1	7.1
Marine & Coastal Historic Environment		7.2	7.2	7.2
Cables & Pipelines				
Military Exercise Area		7.4	7.4	7.4
Disposal Sites				
Shipping & Navigation		7.6	7.6	7.6
Recreation & Tourism		7.7	7.7	7.7
Noise		7.8	7.8	7.8
EMF		7.9	7.9	7.9
Landscape & Seascape		7.10	7.10	7.10

3.2.2 Onshore Activities and Risk Assessment

As part of the scoping exercise and based on the site and device data gathered to date, a baseline risk assessment has been undertaken for the onshore phase of the project including buried cable from the shoreline and the sub-station/control building. It should be noted that this is not an exhaustive list and will be developed as the EIA progresses. Table 2 is similarly colour coded as Table 1 as follows:

- RED – Potentially significant impact without mitigation measures.
- YELLOW – Potential Impact
- GREEN – Negligible impact predicted

In addition, the number highlighted in each box refers to the chapter where further details are presented.

If the development is deemed appropriate after following the full EIA process with the necessary potential mitigation measures applied, all boxes should be green.

Table 2: Baseline Risk Assessment - Onshore

Topic	**Project Phases**			
	EIA Surveys	**Construction**	**Operation**	**Decommission**
Physical				
Geology				
Hydrology & hydrogeology		5.1		5.1
Biological				
Protected Sites and Species		6.1	6.1	6.1
Birds		6.4	6.4	6.4
Ecology		6.2		6.2
Human				
Landscape & Visual		7.10	7.10	7.10
Cultural Heritage		7.2		
Noise		7.8		7.8

4.0 Alternatives and Rationale

4.1 Introduction

It is a requirement of The Marine Works (Environmental Impact Assessment) Regulations 2007 under Schedule 3 section 6 that information to be included in an Environmental Statement should include "An outline of the main alternatives studied by the applicant and an indication of the main reasons for the applicants choice, taking into account the environmental effects of those alternatives and the project as proposed."

This can be interpreted to mean not only alternative sites, but also alternative technologies. The EIA will consider alternative technologies and alternative sites, and also describe the site selection process and the rationale for the proposed development.

In order to develop a meaningful scoping document in what is a relatively new area (i.e. the early stage of exploitation of tidal energy), some explanation of the site selection criteria and consideration of alternative technologies is considered worthwhile in respect of both sites and devices.

4.2 Tidal Energy Versus Other Energy Sources

4.2.1 Scottish Government Policy and Aspirations

The Scottish Government's Partnership Agreement "Partnership For A Better Scotland" confirms the Government's commitment to ensuring that by 2020, 40% of Scotland's electricity is generated from renewable sources. However, the aim of the Scottish Government is that 50% of Scottish demand for electricity should be met by renewable source by 2020. In making that commitment, Ministers took account of the contribution which established renewables technologies, such as on-shore wind and hydro, could be expected to make towards the existing 18% target by 2010, and concluded that Scotland was unlikely to achieve a target of 40% based on these technologies alone. *"Rather, the key to realising Scotland's full renewable energy potential lies in our ability to develop new technologies, particularly (but not exclusively) wave and tidal power."*

Scotland has some of the best wave and tidal-stream resources anywhere in the world. In 2001, the report "Scotland's Renewable Resource" [27] found that up to 21.5 Gigawatt (GW) of wave and tidal energy capacity could be produced in the waters around Scotland.

4.2.2 Why Tidal Energy?

There are many different forms of renewable energy which can contribute to meeting the challenge of reducing our reliance on fossil fuels. Potentially all renewable energy solutions have a place and in respect of the choice of resource it is simply a question of which solution is appropriate for a given location or region.

It is fairly obvious that solar farms for example make sense in some parts of the world and not in others. The same is also true of wind energy, biomass and of course marine energy (encompassing wave and tidal). Scotland has a significant wind energy resource and this continues to be developed both on and offshore. It also has a significant tidal and wave resource but it is unlikely to be a location chosen for 400MW solar farm.

Wind energy is a mature technology and almost certainly the quickest and most reliable (in terms of equipment) means of generating large quantities of renewable power. Tidal and wave energy should not been seen as alternatives rather as complimentary solutions to energy needs. That said, tidal energy does have some significant benefits in comparison to wind (and also wave). Like wind it cannot simply be called in to provide power if the resource (the tide) is not flowing, however, tidal energy is entirely predictable. Tides can not only be predicted on a daily basis, they may be predicted many years into the future. This means for a utility or grid operator balancing a system, other plant can be scheduled to come on and off line, or ramped up on load with no uncertainty.

4.2.3 Alternative Marine Energy Sources

Offshore wind has been grouped in with this discussion of Alternative Marine Energy sources on the basis of geography and land take i.e. competition for seabed.

4.2.3.1 Offshore Wind Farms

In recent years there has been a significant increase in the development of offshore wind farms around the UK. Successful Round 1 applicants were announced in April 2001 with leases awarded for 18 sites at 13 locations around the east and west coasts of England and Wales. In December 2003 the final results of Round 2 were announced, with the right to develop 15 sites totalling 5.4 - 7.2 gigawatts (GW) awarded. Again, the sites were located around the east and north west coasts of England. In August 2008 interested parties were invited to submit proposals for Round 3. Again the bulk of the potential areas for development are around the coasts of England and Wales with two areas identified on the Scottish east coast.

On the 16th February 2009 The Crown Estate announced the results of the allocation of offshore wind farm sites in Scottish territorial waters. Ten sites were awarded to nine consortia and companies with the potential to generate an estimated 6GW of power. The sites are distributed around the east and west coasts of Scotland.

An opportunity exists to develop an inclusive marine renewable energy infrastructure incorporating the technologies of offshore wind, wave and tidal energy which when distributed around the coast have a greater capability to smooth the potential peaks and troughs of renewable energy generation.

4.2.3.2 Wave Power

There is huge potential for wave development on the exposed north and west coasts of Scotland and Ireland. Islay itself already has a small onshore wave energy facility named the Limpet [(3)] and there is certainly scope for wave capture off the coast of Islay.

Wave energy is developed by the action of the ocean winds on the surface of the water and thus is essentially wind energy derived. Consequently although wave action tends to rise more slowly and decrease less quickly (as we see on beaches with heavy surf long after a storm has blown through) it still has a similar problem to wind in that it is not predictable.

The weather systems which create these waves are many times larger than the localised site geographic features which create tidal resource hotspots and consequently wave devices (at the utility scale) have more scope for site location than tidal devices. On this basis it is arguable that utilising a potential tidal site (of which there are few) for exclusive wave energy development would be an inappropriate use of resource.

In the future there may be scope for combined wave and tidal devices on the Islay site. However, in respect of technology status, whilst tidal energy is still in its infancy in a commercial sense, there are still challenges associated with the commercial deployment of a wave farm which have not been yet been addressed, especially on the more exposed west coasts.

4.3 Alternative Tidal Energy Development Sites

4.3.1 Introduction

Based on tidal energy resource data presented in the Atlas of UK Marine Energy Resources [(1)], there are a number of potential development areas with a significant tidal flow around the United Kingdom. Inevitably application of physical and environmental constraints reduces the potential development areas significantly especially when the tidal area would also be required to support a substantial development of several hundred MW.

With reference to the Tidal Stream Energy Resource and Technology Report published by the DTI [(4)] it was concluded that the best prospects for the extensive deployment of cost-competitive tidal stream energy devices lie in turbine devices that are suitable for deployment in sites of depth > 30m and a mean spring peak velocity > 2.5 m/s.

From this initial resource mapping a set of prospective sites were identified of which Islay was one. These potential tidal energy sites have been reviewed and assessed (and continue to be assessed) based on a clear set of criteria as described previously.

4.3.2 Site Selection Process

4.3.2.1 Introduction

In order to identify the best sites in terms of the defined criteria (listed previously), a filtering approach was adopted by looking at the different levels of available resource. These are:

- Technically Available Resource – Meeting the general criteria of tidal velocity over a sufficient area, with appropriate depths;
- Practical Resource – Limiting technical resource by applying constraints of shipping lanes (Traffic Separation Schemes), military zones, disposal sites and pipelines and cables; and
- Accessible Resource – Includes proximity to the electrical grid network, environmental and fishing grounds and recreational use.

4.3.2.2 Technically Available Resource

A desk based study was undertaken to identify potential sites in United Kingdom waters out to 12Nm to define the following information:

- Tidal resource availability;
- Water depth; and
- Area sufficient to generate in excess of 100MW;

The Atlas of UK Marine Renewable Energy Resources [(1)] provides semi empirical data on wave and tidal resource in UK territorial waters. In addition, the bathymetry of coastal areas is provided. A model forms the basis of the Atlas which enables detailed information to be assessed down to a resolution of 1/60° latitude x 1/40° longitude (1 nautical mile (approximately 1.8km)).

The Highland Renewable Energy Strategy [(5)] contains a similar model which can be interrogated for detailed sea and bathymetric states down to $1km^2$.

The model was run using parameters of water depth between 25 and 50m LAT and 2, 3 and 4m/s mean peak spring current. The areas meeting these constraints are identified in Figure 6. In order to focus on locations with the best resource, sites with a tidal velocity of less than 3m/s were discounted.

4.3.2.3 Practical Resource

Admiralty charts and navigation Pilot Notes were reviewed to gain a better understanding of the areas identified in terms of a more detailed bathymetric characterisation and of potential constraints including Traffic Separation Schemes, military zones, disposal sites and pipelines and cables.

4.3.2.4 Accessible Resource

<u>Introduction</u>

Following a review and identification of potential development areas where a practical resource was present, a detailed assessment of grid access, environmental and commercial constraints was undertaken.

For potential Scottish sites, this activity was made easier by referring to the Scottish Marine Renewables SEA (2) and Highland Renewable Energy Strategy (5).

Electrical Grid Access
The locations of many of the high tidal resource areas are remote from the electrical grid infrastructure required to transport the power to its users. This is certainly the case on the west and north coasts of Scotland. Grid infrastructure maps of the UK down to 132kV were surveyed to determine proximity and therefore level of deep reinforcement likely to be attributable to a project. In Scotland, infrastructure maps down to 33kV were available for review.

Environmental Assessment
The Marine SEA (2) issued by the Scottish Executive and the Highland Renewable Energy Strategy (5) provides comprehensive top level information on the potential sensitivity of the seas around Scotland.

4.4 Islay Site

A number of Scottish sites were identified from the course sift to match the criteria deemed necessary for potential development of tidal devices and these continue to be assessed. The south west coast of Islay was identified as one of these sites for the following reasons:

- It has a high tidal resource peaking at 3.5m/s (mean peak spring);
- The bathymetry (between 30 and 50m) and sea bed profile matches the general requirements of leading tidal flow devices;
- An area large enough to deliver in excess of 300MW is present;
- There is no major shipping activity; and
- The area appears to be relatively environmentally benign.

The most significant development risk identified at the preliminary review stage after technology is that of electrical grid availability although this is something the Islay proposal has in common with most of the tidal alternatives.

Following identification of the area off the coast of Islay, a detailed desktop constraints assessment was undertaken by ABPmer titled "Extended Tidal Technology Constraints Assessment – South West Islay, July 2008[6]. This confirmed the initial findings of the site sift process and that the site is a suitable candidate for further evaluation.

4.5 Technologies – Alternatives

Although the consideration of technology alternatives will be more fully explored within the EIA itself, the rationale for design envelope selection which will form the basis of the EIA is outlined below as part of the scoping exercise. It should be noted that this is not an exhaustive review of technologies but a top level assessment to aid understanding of design envelope rationale.

4.5.1 Introduction

As discussed in 2.2.1, the site has not been selected for its suitability as a technology demonstration site, rather it is being developed because it has been identified through the site selection process as a site with good potential for a substantial commercially viable tidal energy farm. The selection process has therefore been driven by the site rather than the technology.

In previous sections this document has described the technology neutral approach being proposed, the purpose of which is to minimise development risk by deferring final device selection until technology is more proven. It also explained that an entirely neutral approach is not possible because clearly not all tidal devices are compatible with all specific sites particularly in respect of water depth.

The specific constraints of the Islay site have therefore been used to define an operational envelope based on a range of devices which are likely to be able to be successfully deployed and operated in this location. Therefore, it is probable that final manufacturer selection and detailed design information will not become available until later in the EIA process. In addition, it may also be possible that different devices may be selected for phases two and three of the project or even that a range of devices will used for phases 2 and 3. In each case a detailed assessment of the potential impacts of the device will be carried out as part of the EIA process.

4.5.2 Types of Device - General Discussion

There are essentially two ways of harnessing power from tidal flows either through tidally impounded water (tidal range) utilising naturally occurring basins, manmade barrages or offshore lagoons or by extracting the energy from the tidal movement of water (tidal streams).

These fundamental methods may then be broken down by type, and then by descriptive type based on turbine design, mounting and then whether surface or submerged.

The rationale for the choice of technology route and the proposed development envelope is outlined below through a discussion of the general types of technology, but it should be noted this will be subject to continual review throughout the EIA process.

4.5.2.1 Tidal Basin, Barrages and Lagoons.

The tidal barrage has been actively developed since the 1960`s with the construction of La Rance barrage near St Malo in France. At 740m long it features 24 two-way pump turbines operating at 10MW each. The tidal range is around 12m with a typical head of around 5m. There are two other commercial schemes at the Bay of Fundy 1982 25MW (Canada) and in China 100MW since 1987.

In the UK the prime locations are associated with the Severn and Bristol Channel. The most notable scheme is the Severn Tidal Barrage (STB) proposal which with an 11m tidal range is estimated to be capable of supplying 17,000 GWh/yr (or around 5% of demand in England and Wales). Other potential locations include Conwy (33MW), Loughor (5MW), Milford Haven (96MW) and Dyfi (20MW).

Tidal lagoons operate on the same principle as the barrage but are constructed offshore and feature a self contained lagoon which captures and converts tidal energy (using low head turbines). Optimum locations for these devices are at or around low tide level in near shore areas. Tidal Electric Ltd are proposing sites in North Wales (52 km^2) with an estimated cost of around £500M, Swansea Bay 30MW and the Bristol Channel also 30MW.

There are a number of capital and strategic issues with barrage systems:

- A high capital investment;
- They require very significant quantities of raw material import for construction, and
- They have potentially significant lead times from development to commercial operation.

In addition, there have been significant concerns voiced in relation to the potential environmental impacts resulting from changes to tidal regimes. The STB is a particular case in point. The Severn estuary provides nationally and internationally significant feeding areas for wildfowl, and it is a concern that substantial changes to the ebb and flow of the estuary might have a dramatic effect on a number of important avian species. It is perhaps pertinent to note that the Severn Barrage has been a subject of debate for some 30 years or more.

Tidal lagoons have the potential to reduce some of the environmental concerns since they do not directly affect the level of exposure or otherwise of intertidal mudflats. They do, however, have potentially higher associated costs since the full lagoon must be constructed rather than a partial barrier. In general terms whilst these types of tidal energy conversion have the potential to develop large numbers of MW's the associated costs, likely lead times to construction and potential environmental impacts are not insignificant.

4.5.2.2 Energy Stream Converters and Tidal Fences

Unlike barrage systems which rely on enclosing a body of water thereby generating a hydrostatic head to generate energy, stream converters permit the tidal flow to pass over them relatively unimpeded. This is of course only partially true since without some from of 'blockage' there would be no energy transfer and no electricity produced.

In practice from a negative perspective this means that stream converters can only extract a certain percentage of the resource since they rely on the fact that the tidal flows continue albeit slightly abated. The more positive side to this being of course that since the tidal regime still remains the environmental impacts should under normal circumstances be significantly lower.

Currently there are many technology designs at varying stages of development. However, there are only three main methodologies of harnessing tidal stream energy.

Reciprocating Hydrofoils

This device utilises a set of hydrofoils placed in a tidal stream. By controlling the pitch of the foils, the tidal flow forces them to move up and down repeatedly. Reciprocating devices therefore either need to have a means of translating this oscillatory energy into rotational power to drive a conventional generator or adopt a linear generator technology. Conventional generators involve rotational motion (i.e. rotor and stator) and although linear generators are proposed for some marine installations (in particular wave devices), the most proven generator technology is rotational. Translation of linear energy into rotational can be achieved by either use of a ram and working fluid to generate pressure or by use of some form of mechanical cam action. In either case there is both an additional complexity of system and possible energy loss associated with energy conversion.

By their nature hydrofoils have some advantages in potential exploitation of shallower waters, and in areas where fish or mammal collision issues might be a problem. (The slow speed of the reciprocating action is likely to be easily avoided by most species).

The primary issue with devices of this type is their energy conversion efficiency, mechanical integrity and potential marine fouling and for these reasons alone they have been excluded from the Islay proposal envelope.

Vertical Axis Turbines

Vertical axis machines can either operate by generating lift or by drag, although since drag devices tend to have relatively lower energy capture it is most likely that those that progress to commercial development will be of the former i.e. lift.

Vertical axis machines can also be used in a number of different scenarios:

- in free stream, where the fluid action on the different element of the device create varying forces around the circumference, and thereby rotation, or

- in enclosed environment in gaps within structures positioned across the flow in a tidal fence.

Freestream turbines maybe completely open or semi-free stream and ducted to improve machine energy capture, although this also adds physical size and cost. They may be seabed mounted or slack moored.

Many of the features of the vertical axis marine turbines can be compared with those of the equivalent Darrieus vertical axis wind turbines and although the change of working fluid (water not air) potentially alleviates some of the problems experienced with the Darrieus wind turbines some questions still remain.

There are advantages to installing vertical axis turbines within tidal fences whereby the turbines effectively form “turnstiles” that stretch across a channel. The mounting and access to generators and gearboxes becomes easier, and the tidal fence itself enhances energy capture by effectively increasing stream velocities through blockage.

Suitable locations require a tidal regime of around 1.75m/s (3.5 knots). Developments are proposed for a 100MW scheme in San Francisco Bay and an 1100MW base installation in the Philippines. The Severn Estuary is also under consideration as a potential location, as an alternative to the Severn Barrage.

Although it is true that they are likely to have a lesser impact in respect of changes to wetland areas (since they impede the tidal flow less) tidal fences have a number of common issues with barrage systems. Like barrage schemes tidal fences create navigational issues, problems with migratory fish passage and have a requirement for significant quantities of raw material import for construction i.e. high capital costs.

<u>Horizontal Axis Turbines</u>
Generally horizontal axis tidal turbines are those in which the rotational axis is essentially the same as that of the ebb and flow of the tides.

Generally, there are ducted (closed rotor) and unducted (or open rotor) types of horizontal axis marine turbine.

With open rotor designs these devices are most analogous to the existing wind turbine configuration and in fact look and operate very much in the same way. The axial turbine is placed in a tidal stream, in the same manner to a wind turbine is across a high wind speed ridgeline, and the blades pitch to generate lift, thereby inducing rotation as the water flows across them.

Closed (or ducted) rotors are also possible, and although these look like under wing aero engines they are simply enclosed water driven blades with a generator.

There are advantages and disadvantages to both options and although it is notable that ducted wind turbines have been singularly unsuccessful commercially the problems associated with ducted rotor wind turbines do not necessarily translate directly into the marine environment. In fact a number of the closed rotor turbines currently under going test are certainly strong potential candidate machines.

4.5.3 Selected Design Envelope and Effect on EIA

The rationale for the design envelope selection starts with the objective of minimum technology risk, and is based on devices most likely to have the potential to perform, survive and be maintainable within the Islay environment.

For the purposes of the EIA scoping document the initial design envelope has been structured around a horizontal axis open or ducted turbine either seabed or gravity base mounted.

The design envelope has been chosen to provide a realistic outline of the device that might be employed. The key choices within this envelope which may affect the environmental impact of the device are listed below.

4.5.3.1 Open or Closed Rotor

The selection of whether open or closed rotor is essentially an engineering, and operability one. At this point, there is little evidence to point to any significant difference in the potential effects on marine life. This is clearly an area where further research is required but it is intended that this will be considered within the scope of the EIA.

4.5.3.2 Surface Piercing or Submerged Structure

There are significant and obvious advantages to the use of surface piercing structures in which the structure provides a platform for access, and field maintenance. There is also no doubt that early commercial devices will require a significant operation and maintenance regime until the technology reaches maturity. Even then a device which can be raised to the surface on its own structure in a greater range of weather conditions is likely to achieve higher availability than one which requires more extensive subsurface activity to maintain or recover.

The obvious disadvantages of a surface penetration device are its effect on seascape and its effect on navigation. The former is self evident but in respect of the latter it is fair to say that it is at best uncertain whether intentional over navigation of submerged devices will be considered acceptable by the relevant authorities.

Both types of design have advantages and disadvantages and will be considered further within the EIA.

4.5.3.3 Foundations

The EIA will consider the potential foundation solutions included the use of drilling, piling and gravity bases. These alternative solutions for anchoring the devices to the seabed each have their advantages and disadvantages from both an engineering and ecological perspective. Intrusive foundations for example may result in short term release of sediment, and high noise levels (particularly for piling), whilst gravity bases may induce larger changes to the seabed environment with greater degrees of scour over a longer period.

A detailed assessment of the potential impacts of the alternative solutions will be carried out as part of the EIA process.

5.0 Scope of Work – Physical Environment

5.1 Marine Geology

5.1.1 Introduction

Whilst understanding the seabed geology is not in itself an environmental issue it does provide information necessary to assess the likely or potential impacts associated with both intrusive investigation during the geotechnical assessment and piling, drilling or trenching during construction.

A site geological study can be broken down into two phases, non intrusive (Geological Assessment) and intrusive (Geotechnical Assessment).

5.1.1.1 Non Intrusive Surveys (Geological Assessment)

Non intrusive surveys involve developing an understanding of the seabed geology by desktop study, and field observation (by camera, echo sounder, side sonar and magnetometer). Together they can provide a relatively broad but accurate indication of the seabed geology both at and below the surface layer.

This provides information necessary to assess the likely or potential impacts associated with more intrusive investigation and piling, drilling or trenching during construction. This is discussed further in section 5.2 Marine and Coastal Processes.

5.1.1.2 Intrusive Surveys (Geotechnical Assessment)

During on shore wind energy development a geotechnical survey is conducted prior to developing engineering designs suitable for construction. This typically involves the digging of trial pits at bases and borrow pits and where necessary (e.g. on sites with deep surface peat or soils) shallow core drilling. Normal practice is to consider possible impacts and mitigation measures of the geotechnical survey on for example archaeological sites as part of the EIA even though these activities are undertaken post consent.

For offshore wind projects normal practice is for a systematic programme of sea bed drilling down to a depth of around 30m to be undertaken prior to construction in order to confirm both the exact turbine base locations and also the specific turbine foundation designs. Again the methods and potential impacts of this drilling are considered as part of the EIA process, even though undertaken as a preconstruction exercise.

For construction of a Marine Tidal Park detailed geotechnical knowledge of the seabed will ultimately be required for turbine micrositing to confirm both the exact turbine base locations and also the specific turbine foundation designs on a turbine by turbine basis. It will also inform the location of any other associated infrastructure such as electrical collector stations, and the optimum subsea cable route particularly if trenching or directional drilling is required. The methods of geotechnical core drilling employed for offshore wind farms are likely to be very similar to those used for marine tidal parks.

5.1.2 Current Knowledge

5.1.2.1 Field Assessments

Survey work to date has consisted of a bathymetric analysis to profile the sea bed as reported in "Extended Tidal Technology Constraints Assessment – South West Islay, July 2008" (6) and a video survey of 23 points across the site as shown in Figure 7. Results from the subtidal survey "Subtidal Survey of Rhinns of Islay, Argyll for DP Energy, September 2008: Final Report" (7) has indicated that the development area can be split into two main seabed types.

In the northern and western camera drops surveyed: 1 – 3, 8 – 12, 16 – 21 and 23, the seabed was composed mostly of cobble and boulder fields at depths of 38 – 45m with underlying course sand and gravel. Of these, drops 8 – 10 and 17 also had areas of outcropping bedrock.

In the south-eastern area, represented by camera drops 4 – 8, 13 – 15 and 22, the seabed was relatively shallow (30 to 35m) and consisted mostly of bedrock.

5.1.2.2 BGS Data Records

The British Geological Survey (Malin sheet 55N 08W Sea Bed Sediments and Quaternary) based on grab samples and shallow core indicates that the site area consists of an extensive rock outcrop with gravelly sediments. The majority of the area falls under the category of "Shallow course sediment plains" as shown in Figure 8. This description refers to an area of seabed characterised by course sediments with strong currents.

The British Geological Survey (Malin sheet 55N 08W Solid Geology) indicates that limited survey work has been undertaken with boreholes in the Loch Indaal Basin to the east of the Rhinns of Islay. Bathymetric data would suggest a shallower area potentially representing an extension to the nearby peninsular of land (The Rhinns of Islay). This area covers the east and southerly sectors of the proposed development area and geological data would suggest that this is an area of Gneiss. The deeper waters to the north and west are cited on the BGS map as Metasedimentary Rock. The geological map of the area is shown in Figure 9.

5.1.3 Potential Effects

5.1.3.1 EIA Surveys

As is described in the introduction geotechnical intrusive surveys are not proposed as part of the EIA with the exception of grab sampling to determine the surface properties of the sea bed.

Grab sampling is a very localised and small scale activity and is unlikely to result is any significant disturbance of the seabed or release of previously settled material. The potential effects of this are therefore extremely limited.

5.1.3.2 Preconstruction Geotechnical Survey

During the preconstruction phase a detailed geotechnical assessment will be required to inform the foundation design specification. Core drilling and other associated intrusive activities do have the potential to create impacts due to release of sediments or lubricants etc used during drilling and these impacts will be considered as part of the EIA within the construction phase impacts. The potential effects are presented in section 5.2.3.

5.1.3.3 Construction

The construction phase has the potential to create the most significant impacts in respect of seabed disturbance and increased sediment. This will be considered as part of the EIA. The potential effects are presented in section 5.2.3.

5.1.4 EIA Surveys for Marine Geology Scope and Methodology

The non intrusive surveys undertaken as part of the EIA are designed to assess the sea bed conditions for both the tidal farm and subsea cable connection routes. They are designed to identify the likely methods of equipment installation (i.e. drilling or piling and to what depths), and to enable an assessment of the likely environmental impacts these installation techniques might have on the surrounding environment. This will be undertaken in two phases:

5.1.4.1 Phase 1 – Desk Based Study

A study of existing data sources including the British Geological Survey (BGS) database will be undertaken. It is envisaged this would expand on the BGS assessments already undertaken as part of the scoping exercise and review all available data which may be available from other sources such as the oil and gas industry or mineral extraction surveys.

5.1.4.2 Phase 2 – Geophysical Assessment

Multi-beam Echo Sounder

Swath and single beam bathymetry surveys will determine seabed topography and provide information on the relief of seabed structures. Measurements will cover the proposed site in a grid pattern using a main line of 75m. The cable route corridor will be surveyed in a centreline plus two wind lines at 75m intervals.

The echo sound data will be reduced to Lowest Astronomical Tide (LAT) using Admiralty Chart data. Reporting will consist of XYZ datasets which are processed using GIS software to produce an interpolated map of the bathymetry.

Side-scan Sonar

Sidescan sonar surveys will determine the nature of the seabed and any structures on it. In addition, it can provide information regarding the texture of the substrata within the site area which will then assist in the development of sediment transport modelling (section 5.2.4) and benthic communities (section 6.2). The survey will be carried out as per the echo sounder and presented with other appropriate data in GIS format.

Sub-bottom Profiling

Sub-bottom profiling surveys will determine the subsea bed geology and location of buried structures. Surveys will be undertaken in a grid pattern as per side-scan sonar and echo sounder for the tidal farm and along the centreline of the proposed cable connection corridor. Data will be stored digitally and presented in a GIS format.

Magnetometer

Magnetometer surveys will enable the position and nature of ferrous objects to be identified whether they are on the sea bed or buried beneath the sediment. Wrecks, archaeological features, cables and pipelines will be located using this technique. Surveying will take place as previous and the digital data recorded will be converted to GIS for presentation.

Grab Samples

Grab samples acquired in conjunction with the benthic assessment will provide information on the sea bed sediment. The location of grab samples in the site and along the cable corridor will depend on the data recovered from the Side-scan sonar and from the video recording of the seabed. For each significant shift in the sea bed texture or per $2km^2$ a grab sample will be taken to identify the sea bed material. Depending on the specific seabed conditions, samples will be selected for grain size distribution analysis, content of carbonate, minerals and content of organic matter. The laboratory tests will in general be performed on cohesive and non-cohesive soils. A photograph of the sample at each sample site will be taken.

If hard ground is encountered for an extensive area which seems likely given the video footage, a dredge will be used instead of grab sampling.

The grab samples will also be used to inform the benthic investigation as reported in section 6.2.

Data will be stored digitally including information about position and measured parameters. Based on the data provided, a seabed condition map will be created with a clear indication of specific soil areas and a specification of physical and chemical behaviour.

5.1.5 Marine Geotechnical Surveys Scope and Methodology

The following is included for completeness since intrusive assessment surveys or geotechnical are solely conducted as part of the preconstruction micrositing and detail design exercise not part of the EIA. They are intended to inform the micrositing of the turbines, and associated structures, and enable the detailed engineering design of each individual turbine base structure across the site.

5.1.5.1 Geotechnical Assessment (Phase 3)

Following review of the geophysical data previously gathered, a geotechnical assessment programme is devised to identify exact locations where more intrusive sampling is required. The programme not only includes extraction of the subsurface material for study it also details a laboratory programme for the analysis of the physical and chemical characteristics of the erodable sediments and the strength and deformation parameters of the specific soils.

The assessment is undertaken in two steps

Vibrocore and Cone Penetration Tests (CPT)

Vibrocoring is usually undertaken to a depth of 5-6m and CPT to maximum tip resistance/stop criteria. A penetration depth to a minimum of 20m is normally planned. During the CPT all observations are recorded and the soil cores from the vibrocoring are carefully cut, labelled and properly sealed in samples of around 1m in length. The samples can then be classified and reported.

Geotechnical Boring

Following the results of previous data from both non intrusive and vibrocore and CPT, a geotechnical boring programme is devised to provide representative samples across the development site. During the boring, in-situ drilling tests are performed for the determination of the un-drained shear strength in cohesive soils (vane tests) and for the determination of the friction angle in non-cohesive soils (SPT).

Disturbed/remoulded samples go through simple classification tests whilst intact samples undergo more rigorous testing such as consolidation and tri-axial. Additional tests may include loss of ignition, carbonate content and Atterberg limits.

It is predicted that investigative drilling on site would be to a depth of approximately 40-50m below seabed.

5.1.6 Onshore Geology, Hydrology and Hydrogeology Scope and Methodology

The assessment will be based upon the landfall cable corridor and the potential area for the substation/control room (to include the access track), and the catchments down stream of these locations where there may be a potential effect.

Onshore geology, hydrogeology and hydrology are closely linked aspects of the environmental assessment, with the possibility of common effects. For the purposes of the assessment, geology is considered to include bedrock, mineral soil, peat and drift deposits; hydrogeology and hydrology include groundwater and surface water.

The identification of effects and impacts will be carried out by requesting the relevant soil data from The Macaulay Institute and Geological data and British Geological Survey. Confirmation of the site baseline data will take place during a walkover survey following an initial desktop study. Argyll and Bute Council will be contacted for details of private water supplies and the location and nature of these will also be confirmed during the walkover survey. Typical hydrological characteristics of the catchments that the site lies within will be sought and the catchment flow volumes calculated from the Flood Estimation Handbook (1999).

The assessment will provide baseline information, identify potential impacts based on the magnitude of the impact and the sensitivity of the site. Mitigation proposals where appropriate will be made followed by an assessment of the significance of any residual impacts.

5.2 Marine and Coastal Processes

5.2.1 Introduction

The construction and operation of tidal devices and the installation of subsea cables can have an effect on current regimes and attenuation of wave energy. This in turn can have an effect on sediment dynamics and scour patterns leading to effects on species existing in or around the proposed development and on the characteristics of coastal areas. Survey work is required to fully understand the natural physical environment of the site and surrounding area.

5.2.2 Current Knowledge

Admiralty Chart 2723 and tidal tables have been used to provide indicative information on tidal flows in conjunction with The Atlas of UK Marine Energy Resources.

The Scottish Marine Renewables SEA has been used to provide pertinent background information on marine and coastal processes

The wave and tidal regime of the site has been assessed using three static Acoustic Doppler Current Profilers (ADCP) located as shown in figure 10. The devices were deployed for one lunar cycle from the 12th July to the 9th August 2008. In parallel, tidal current data was recorded over a neap tide using a Moving Vessel ADCP on the 10th August 2008. Additional wave, turbulence and wind data was also recorded to provide a complete metocean picture over the recorded period.

A drop down video camera was employed to determine the seabed sediment characteristics at sample points as previously discussed in section 5.1.2 and illustrated in figure 7.

5.2.3 Potential Effects

5.2.3.1 EIA Surveys

Potential effects on assessing the seabed sediment have been discussed in section 5.1.4.

5.2.3.2 Geotechnical Survey and Construction

Increased sediment loading is likely to result from geotechnical survey work although this predicted to be localised and over a short period of time and therefore not considered significant. Similarly, sediment loading will increase during drilling work for turbine foundations.

Increased turbidity and release of contaminants could occur as a result of the foundation installation and cable laying

5.2.3.3 Operation

The turbines will interact with current and waves, which will produce turbulence, diffraction and reflection. This will directly affect the hydrographical and sedimentary process resulting in the potential for scour and changes to the sediment transport pattern. Secondary impacts may be seen in benthos, fisheries, coastal protection, water quality, sediment quality and conservation designated sites.

5.2.3.4 Decommissioning

Potential effects are predicted from some decommissioning activities although this will be dependent on the level to which the in seabed foundations must be excavation and extracted.

5.2.4 Scope and Methodology – Marine and Coastal Processes

The assessment of the potential impact of the proposal on marine and coastal processes can be broken down into four areas.

5.2.4.1 Geophysical Survey

This has been previously discussed in section 5.1.4 and will enable depths, seabed texture and sediment types to be mapped for the site and sub-sea cable corridor.

5.2.4.2 Metocean Data

As discussed in section 5.2.2, data characterising the area has already been produced and will assist in the creation and calibration of a hydrodynamic and wave model.

5.2.4.3 Sediment Processes

The potential impact on sediment processes can be sub-divided into near field and far field changes to the baseline condition. In the vicinity of the turbines there will be some local scour and changes in the local sediment transport pattern. The presence of the tidal energy farm could result in a decrease in marine energy affecting the overall sediment transport pattern and coastal morphology. In order to assess the current and future potential changes to the hydrodynamics and sediment dynamics the following data will be reviewed.

- Bathymetric data – single/multibeam echo sounder, side scan sonar, sub bottom profiles and grab samples;
- Sediment analysis from the benthic monitoring programme (section 6.2) including chemical/radioactive analysis;
- Current and historical seacharts and aerial photos to define changes in the shoreline and variations in the seabed profile;
- Coastal data – shore profiles, sediment data onshore and offshore; and
- Wind, wave and current data.

5.2.4.4 Mathematical Modelling

Modelling is necessary to characterise the local and regional effects of the proposed development. Models will be constructed and calibrated to describe tide, current, waves, sediment transport and shoreline evolution for the North Channel and in the vicinity of the proposal in greater detail.

Mathematical modelling of hydrographical and sedimentary processes is integrated and consists of the following fundamental steps:

- Data preparation and analysis;
- Collection of available data from other sources;
- Preparation of data to calibrate and verify model;
- Statistical analysis of wind, tide, current and waves;
- Setup of hydrodynamic, wave and sediment model;
- Selection of calibration and verification periods;
- Model calibration and verification;
- Selection of scenarios to describe (normal year, storm year);
- Modelling of scenarios (different weather conditions, foundation types, layouts etc); and
- Presentation of modelling results.

5.3 Contamination and Water Quality

5.3.1 Introduction

This section considers the potential effects of the proposed development on water and sediment quality in the study area. In addition to direct effects there is also a potential for secondary effects on ecosystems. This latter effect is discussed further in section 6.2.

5.3.2 Current Knowledge

There are several directives associated with the targeted reduction of dumping at sea. However, one of the most far reaching, The Water Frameworks Directive (2000/60/EEC) which was transposed into Scottish law via “The Water Environment and Water Services Act 2003” only extends to 3nm and therefore does not cover the tidal farm. Other more appropriate directives are:

5.3.2.1 Bathing and Shellfish Waters Directive

In areas designated as Shellfish Growing Waters or Bathing Waters, there is additional monitoring to establish compliance with the EC Shellfish Waters Directive (79/923/EEC) or EC Bathing Water Directive (76/160/EEC) respectively. There are approximately 19 Bathing Water sites, 188 Recreational Water sites and 244 Shoreline Water sites along the coastlines of Scotland. Loch Gruinart has been identified as a Shellfish Waters Directive Area. The south and west coasts of Islay contain several Shoreline and Recreational Waters under the Bathing Waters Directive.

5.3.2.2 Urban Waste Water Treatment Directive

Since 1994, the dumping of most types of industrial waste has been prohibited and the disposal of sewage sludge was phased out at the end of 1998 under the Urban Waste Water Treatment Directive (91/271/EEC). Dredged material from port and navigation channel excavation and coastal engineering works now constitutes the majority of material that remains eligible for disposal at sea.

5.3.2.3 London Convention

The "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972", the "London Convention" for short, is one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. The convention enforces prohibitions for dumping of industrial and radioactive wastes, as well as for incineration at sea of industrial waste and sewage sludge.

5.3.2.4 Food and Environment Protection Act

The Secretary of State for Environment, Food and Rural Affairs has a statutory duty to control the deposit of articles or materials in the sea / tidal waters; the primary objectives being to protect the marine ecosystem and human health, and minimising interference and nuisance to others. This duty is exercised under powers conferred by the Food and Environment Protection Act 1985 Part II (FEPA), which require that a licence be obtained from the licensing authority to deposit any articles or substances in the sea or under the seabed.

5.3.3 Potential Effects

5.3.3.1 Geotechnical Survey and Installation

Disturbance of Natural Sediments

Any seabed operation carried out on a sediment substrate is likely to temporarily re-suspend particulate material including foundation installation for turbines and burying of subsea cables. However, given that the turbines will be sited in high energy environments, it is likely that readily disturbed sediments (e.g. unconsolidated silts and muds) will not be present. Such sedimentary material, as exists is likely to be sand sized or greater.

Release of Additional Sediment During Construction

Various installation activities including grouting drilling or piling operations and vessel movements may lead to the release of toxic or otherwise hazardous materials, temporarily affecting the water quality of the local environment.

Disturbance of Contaminated Sediments

There is the potential for adverse effects from disturbing historically contaminated sediments during turbine and cable installation. This depends on the nature (e.g. domestic or industrial waste, radionuclides, munitions) of the contamination and local receptors. The disturbance of contaminants is likely to temporarily reduce the quality of the water.

Accidental Release of Contaminants

Installation activities may lead to the release of contaminants to water and sediments. These could include fuel and lubricating oils, cleaning fluids, paints, specialised chemicals and litter. Contamination from accidental spillage is likely to enter the environment either through the dissolved phase or as low solubility, slick-forming organics. The presence of visible litter can lead to failure of bathing waters to reach mandatory standards. Accidental contamination could also result from leakage of cargoes or fuel carried by a vessel involved in a collision with one of the turbines.

5.3.3.2 Operation

Once installed, cables are not expected to have an effect over the lifetime of the project. Potential effects are therefore restricted to the turbines.

Accidental Release of Contaminants

Routine maintenance operations may lead to release of contaminants to water and sediments. These could include fuel and lubricating oils, cleaning fluids, paints, specialised chemicals and litter. Contamination from accidental spillage is likely to enter the environment either through the dissolved phase or as low solubility, slick forming organics. In the case of significant oil spills damage can be widespread and long lasting, affecting a wide range of ecosystems and amenities. Accidental contamination could also result from leakage of cargoes or fuel carried by a vessel involved in a collision with a turbine.

Contamination - Leakage of Hydraulic Fluids

During the normal operation of some types of generation system it is possible that there will be minor leakage of hydraulic fluids. Contamination may be through the dissolved phase or in the form of slick forming low solubility liquids. Local water quality may be impacted by the leakage of hydraulic fluids and depending on the nature and quantity of material lost there is a risk of tainting of shellfish.

Contamination - Anti-fouling Compounds

In many applications non-toxic materials, which prevent settling of fouling organisms by mechanical means are now available. Assuming non-toxic materials are used no measurable effects, on water or sediment quality from the use of anti-fouling paints, are predicted. Even if small quantities of toxic materials such as copper are used it is expected that the highly energetic environment in which devices are likely to be located will result in rapid dilution and dispersal.

<u>Changes in Sediment Dynamics</u>
Changes in sediment dynamics could also result in disturbance of natural and contaminated sediments. These effects are described under installation effects. The same effect, if it occurred during operation, is likely to be of a lesser magnitude than during installation.

5.3.3.3 Decommissioning

Potential effects are predicted to be similar to installation except that there will be less effect of release of additional sediment than during construction. The degree of release will be dependent on the level to which the in seabed foundations must be excavation and extracted.

5.3.4 Scope and Methodology - Contamination and Water Quality

Monitoring for specific contaminants may be needed if a significant risk to water quality is identified at the project planning stage. Targeted monitoring of water quality issues associated with the proposed development will need to be determined and agreed with relevant consultees as part of the EIA and consenting process.

6.0 Scope of Work – Biological Environment

6.1 Protected Sites and Species

At present there are currently no designated offshore-protected sites. Those that are designated are onshore, nearshore or in coastal environments. This is illustrated in figure 11. However, work is currently being undertaken by the Joint Nature Conservation Committee (JNCC) to designate official offshore Special Areas of Conservation (SAC`s) and Special Protection Areas (SPA`s) under the EC Habitats Directive. These include international sites:

- Natura 2000 sites (Special Areas of Conservation (SAC) and Special Protection Areas (SPA));
- Ramsar; and
- World Heritage Sites.

It is likely that this will be completed before the end of 2009. However, none of the current proposed sites is likely to affect the Islay development.

National Sites include:

- Marine National Parks (NNP);
- National Nature Reserves (NNR);
- Sites of Special Scientific Interest (SSSI);
- National Scenic Areas;
- Geological Conservation Review Sites (GCR); and
- Marine Consultation Areas.

Even though the site area itself is not designated there is always the potential that there may be site usage by protected species either foraging or transiting the site on passage. This will also be assessed as part of the EIA.

6.1.1 Offshore

The proposed tidal farm does not lie within any designated areas or in a marine consultation area, although (as noted above) with any body of water there is always the potential that protected species may pass through it or use it for foraging.

6.1.2 Nearshore / Onshore

The island of Islay has several designated areas, covering a range of different interests including species; seals, butterflies etc and habitats; blanket bogs etc. Most are associated with avian interests, and their habitats. These are listed in Table 3.

Table 3: Designated Areas Around the Proposed Development.

Name	**Designation**	**Conservation Significance**	**Development Area Affected**
South-east Islay Skerries	SAC – Common Seals (UK 0030067)	Annex 2 Species - The skerries, islands and rugged coastline of the Inner Hebridean island of Islay hold a nationally-important population of the common seal *Phoca vitulina*. The south-east coastline areas are extensively used as pupping, moulting and haul-out sites by the seals, which represent between 1.5% and 2% of the UK population.	None
Eilean na Muice Duibhe	SAC & NNR - Blanket Bog (UK 0019773)	Annex 1 Species - Eilean na Muice Duibhe on Islay in the Inner Hebrides occurs at low altitude on a coastal plain and contrasts with the other Islay Blanket bogs, which have different topographic features. The vegetation shows affinities to that found on many Irish bogs because species such as black bog-rush *Schoenus nigricans* and purple moor-grass *Molinia caerulea* are present, replacing species such as hare's-tail cottongrass *Eriophorum vaginatum* that are more commonly found in the UK. There is a rich variety of surface patterning, from small lochs, through continuous *Sphagnum* lawns to many hummock-forming species. Of particular note are *Sphagnum fuscum* and *S. imbricatum*, which are frequent across this largely active blanket bog site.	None
Rinns of Islay	SAC - Marsh Fritillary Butterfly (UK 0030247)	Annex 2 Species - The Rinns of Islay supports a large, extensive metapopulation of marsh fritillary *Euphydryas aurinia*, the largest known in Scotland and one of the largest in the UK. It is well-known as a high-quality area for the species, with records dating back over a number of years. Records for the species are	None

		patchy across the overall Rinns area and so the proposed site is made up of a complex of areas which are known to hold some core parts of the overall Rinns metapopulation (together with the neighbouring Glac na Criche cSAC) which persist even when the marsh fritillary is at a low stage in its population cycle. The population is of the Scottish form *E. aurinia scotica*, which is completely isolated from populations in England and Wales.	
Feur Lochain	SAC – Blanket Bog(UK 0019774)	Annex 1 Species - Feur Lochain at the northern end of the Rhinns of Islay in the Inner Hebrides differs from the other Islay Blanket bogs because it lies on a broad watershed ridge. It exhibits an extensive area of hummock, hollow and pool patterning and is notable for the abundance of white beak-sedge *Rhynchospora alba*. Marginal flushes and drainage basins with poor-fen vegetation add to the diversity of interest.	None
Glac na Criche	SAC – Blanket Bog(UK 0019775)	Annex 1 Species - Glac na Criche, in Islay, Inner Hebrides, contrasts with the other Islay Blanket bogs in having a much more complex topography, giving rise to watershed, valleyside and valley mires. Areas of mineral flushing on this site are more species-rich than at neighbouring Feur Lochain, while truly ombrotrophic areas also support significant amounts of black bog-rush *Schoenus nigricans*, presumably in response to salt spray from the sea cliffs below.	None
Gruinart Flats	SPA & Ramsar – Barnacle Goose and Greenland White Fronted Goose (UK 9003051)	Gruinart Flats are located on the Hebridean island of Islay on the west coast of Scotland. The SPA comprises a diverse array of coastal habitats typical of western Scotland. The main features are a sheltered estuarine and intertidal sea loch (holding sand- and mud-flats as well as an extensive saltmarsh and sand dunes) surrounded by pastoral farmland and backed by semi-natural upland habitats (including ombrogenous peatlands). The grass fields of the farmland support large wintering goose populations which roost at night on the saltmarsh, whilst the intertidal areas support a diverse assemblage of wintering waterbirds important in a regional context. The entire population of the Greenland race of Barnacle Goose *Branta leucopsis* arrives at the site in early autumn before dispersing to other	Onshore grid connection

		wintering areas in Ireland and western Scotland.	
Rinns of Islay	SPA & Ramsar – Chough, Corncrake, Hen Harrier, Whooper Swan, Greenland White-fronted Goose and Common Scoter (UK 9003057)	The Rinns of Islay SPA is located on the Hebridean island of Islay on the west coast of Scotland. It comprises extensive areas of the western side of the island, being a mosaic of natural and semi-natural habitats including bog, moorland, dune grassland, maritime grassland, marsh and farmland. Much of the natural vegetation is utilised as rough grazing for sheep and cattle and is managed extensively. These habitats are used by an extremely rich assemblage of scarce bird species throughout the year. The site is of particular importance for a number of breeding and wintering birds, including raptors, Greenland White-fronted Goose *Anser albifrons flavirostris* and Chough *Pyrrhocorax pyrrhocorax.* The Choughs depend on the diverse mix of habitats present and their continued low-intensity agricultural management. The site also includes the subsumed SPAs of Glac na Criche and Feur Lochain, which were subject to separate classification.	Onshore grid connection
Laggan	SPA – Barnacle Goose and Greenland White-fronted Goose (UK 9003053)	Laggan is located on the Hebridean island of Islay on the west coast of Scotland. The Laggan Peninsula is situated on the eastern shore of Loch Indaal, a sea loch, and comprises the rocky headland of Laggan Point and the land backing Laggan Point and Laggan Bay. The bay is an 11-kilometre long sandy sweep open to the Atlantic. This is backed by a rare and uninterrupted habitat transition from sand dunes and intertidal rocky shore habitats through acidic dune grassland, coastal heath and ultimately to blanket bog. The blanket bog is used as a roost by wintering Greenland White-fronted Goose *Anser albifrons flavirostris*. Intensively managed farmland on the site is an important feeding area for wintering Greenland Barnacle Goose *Branta leucopsis*. Goose using this site as a feeding area also use roosts elsewhere (including Bridgend Flats SPA for Greenland Barnacle Goose and Eilean na Muice Duibhe SPA for Greenland White-fronted Goose).	None
Duich Moss	SPA & Ramsar – Greenland White-fronted Goose (UK 9003054)	Eilean na Muice Duibhe is located on the Hebridean island of Islay on the west coast of Scotland. It is a patterned mire (peatland with extensive pool systems) occurring at the	None

		south-western limit of the distribution of this peatland habitat in the UK. The diverse nature of the peatland habitat includes hummocks, ridges and deep watershed pools as well as an unusual transition from blanket bog to raised mire habitats. Eilean na Muice Duibhe is one of the largest single roost sites in the UK for Greenland White-fronted Goose *Anser albifrons flavirostris*. The main feeding grounds for these birds are on surrounding agricultural areas although significant feeding also occurs on the roost site.	
Bridgend Flats	SPA & Ramsar - Barnacle Goose (UK 9003052)	Bridgend Flats are located on the Hebridean island of Islay on the west coast of Scotland. The site lies in a sheltered location at the head of Loch Indaal and comprises natural saltmarsh and intertidal sand and mud-flats. The flats are used as a roosting site for overwintering geese that feed during the day outside the SPA on surrounding areas of farmland as well as in other wetland habitats.	Onshore grid connection
The Oa	SPA – Chough (9003058)	The Oa Special Protection Area (SPA) comprises part of The Oa peninsula in the south-west of Islay, in the Inner Hebrides. The area covers a mosaic of habitats including coastal and herb rich grassland, arable grassland and coastal heath which supports extensive sheep grazing, cattle grazing.	None
Ardmore, Kilalton & Callumkill Woodlands	SSSI – Woodland (076)	The largest remaining example of native woodland in Islay and a representative of the former woodland cover of the Hebrides. Well developed stretches of coastal scrub occur throughout the site on parallel bands of Dalradian schists and slates with wet willow and alder carr in the hollows. On drier knolls at Ardmore and Callumkill and at Ard Imersay oak is dominant. Elsewhere the woods are mixed with oak, birch and hazel scrub most common together with rowan, sallows and alder. The woods are rich in the oceanic ferns, hay-scented buckler fern and filmy fern, and the arboreal lichens are the richest recorded from Islay. They are strongly indicative of a continuity of woodland cover from ancient times. The scattered nature of the woods produces a mosaic of woodland amongst open habitats of wet-heath, grassland, mires and rock outcrops. The diversity of habitats is a feature of the site as is the transition from woodland to coast	None

		particularly at Ard Imersay where oak and sallows merge into wet heath and marsh and then into saltmarsh and intertidal mud. The site is rich in insect life, particularly butterflies, and there are breeding otters, red deer, fallow deer and roe deer. The small off-shore islets and skerries have breeding terns and are seal haul-outs.	
The Oa	SSSI – Chough (9191)	The Oa SSSI lies on a peninsula of land approximately 7km to the west of Port Ellen on the Isle of Islay. The site comprises 2 sections with a coastal strip supporting cliffs, coastal grassland, dune grassland, coastal heath and improved grassland and an inland section supporting unimproved grassland and heathland. The site is of special importance for its breeding chough *Pyrrhocorax pyrrhocorax*, and is home to approximately 2.3% of the GB population. The chough breed mostly in caves on the coastal cliffs and feed mostly on invertebrates found on the grassland habitats.	None
Rubh' a' Mhail to Uamhannan Donna Coast	SSSI – Coastal Geomorphology (1390)	Rubh' a' Mhail to Uamhannan Donna Coast extends over 7 km along the north coast of Islay, from Rubh' a' Mhail in the east to Uamhannan Donna in the west. The boundary follows the edge of the High Rock Platform cliff line, fences and boundary walls. Seawards, the boundary extends to the mean low water spring mark. It is one of the most important sites in Britain for coastal and Quaternary geomorphology, demonstrating a range of landforms of different ages and their geomorphological relationships. Of particular note is the presence of three distinctive shore platforms that occur variously in Western Scotland and the Inner Hebrides – the High, Main and Low Rock Platforms. Two of the platforms have been modified by glaciers and the whole assemblage of features is significant in indicating past changes in the level of the sea relative to the land and the relationships of these changes to periods of glaciation.	none
Loch Tallant	SSSI – Basin Fen (1058)	Loch Tallant SSSI is a basin fen situated north of the Laggan River, located 2 miles to the south-east of Bowmore. The site comprises an extensive area of mire vegetation developed in a large basin at the east and south-east ends of Loch Tallant. The central area has excellent rich fen communities	None

		and there is a clear transitional zone between the aquatic communities, the fen and the surrounding blanket mire. The fen is virtually unique in its floristic composition and ecological situation.	
West Coast of Jura	SSSI – Coastal Geomorphology (1605)	The West Coast of Jura SSSI extends over 37 km of the west coast of the island of Jura. It is split into one long stretch from Bagh Gleann Speirig in the north, around the head of Loch Tarbert to Rubha Aoineadh an Reithe in the south, and two smaller areas which enclose the embayments at Bagh Gleann nam Muc in the north west and Inver in the south west. It is a locality of international importance for coastal geomorphology, displaying a magnificent assemblage of raised marine landforms and including some of the most extensive areas of raised gravel ridges and terraces in Western Europe, other raised beach deposits, shore platforms and cliffs.	None
Jura	NSA	Jura forms the western visual limit of a large-scale coastal tract, which encompasses Mid Argyll, but it is the southern part of the island, which has outstanding scenic interest. The island is made up of quartzite, which usually results in remarkable upland landforms and Jura is no exception. The Paps of Jura, all three between 700 and 800 metres in height, are dominant in views from the mainland and Islay. Their shapely cones rise abruptly from rolling moorland, and their summits shimmer with quartzite screes. 'In the opinion of the well known Scottish writer Alisdair Alpin McGregor, their steepsided elegance can be compared only with the famous Cuillins of Skye' (Whittow 1977). The coastal fringe has dramatic raised beaches and cliff lines on the west side of the island, and indented bays and islets on the east shore, with some woodland, both semi-natural and planted.	None
Loch Indaal	Marine Consultation Area		
Several Sites	Geological Conservation Review Sites		

6.1.3 Current Knowledge

Background information on designated areas and species has been gained from:

- Scottish Marine SEA [(2)];
- Extended Tidal Technology Constraints Assessment – South West Islay, July 2008 [(6)];
- Subtidal Survey of Rhinns of Islay, Argyll for DP Energy, September 2008: Final Report [(7)]
- Consultation with SNH officers, and from the SNH database website; and
- JNCC website.

6.1.4 Potential Effects

6.1.4.1 Offshore

Since the nearest designated sites are all onshore no direct impact on designated and protected areas from the proposed tidal farm is expected. The nearest ecologically sensitive area is located at Loch Indaal approximately 17km around the Rhinns peninsular to the north-east and the nearest designated area on the Islay Skerries approximately 30km around the Oa peninsular to the east. Both are illustrated in Figure 11).

Indirect effects on designated areas may result from increased sediment transfer, changes in the wave or tidal regime, or impacts on protected species transiting the site to reach the designated areas. Some of the potential indirect effects have been highlighted previously in section 5.3.3 and will be assessed following interrogation of the sediment transport model. Impacts on species in transit or foraging might relate to collision, area avoidance and thus loss of foraging area, or disruption to their normal navigational routes and this will be assessed within the respective EIA chapters.

6.1.4.2 Nearshore/Onshore

As illustrated in Figure 11, much of the Rhinns of Islay and nearshore areas are designated as SSSI and SPA for hen harriers, corncrakes, chough Greenland White Fronted Geese, whooper swan, barnacle geese and common scoter, and any sea to land cable connection to the control building is therefore likely to pass through this designated area.

In addition, two SAC's for Fritillary butterfly's exists to the east of Portnahaven on Rhinns Point.

Direct or indirect impacts (e.g. on migrating species) are therefore possible and will be assessed as part of the EIA.

6.2 Benthic, Intertidal and Terrestrial Ecology

6.2.1 Introduction

The term benthos refers to the plants and animals that live within or on the seabed. Terrestrial ecology refers to plants and animals (excluding birds) which inhabit the land above the shoreline. The scope and methodology assessment can therefore be broken down into three areas.

6.2.2 Current Knowledge

Background information has been gained from:

- Scottish Marine SEA (2);
- Extended Tidal Technology Constraints Assessment – South West Islay, July 2008 (6);
- Subtidal Survey of Rhinns of Islay, Argyll for DP Energy, September 2008: Final Report (7)
- Consultation with SNH officers, and from the SNH database website; and
- JNCC website.

6.2.2.1 Background Research – Benthic Environment

Background information on the benthic environment was taken from "The Benthic Environment of the N and W of Scotland and the Northern and Western Isles" (8) which states that:

"The large area to the west of Islay under consideration as a potential tidal energy site overlies a sea bed grading from gravel to gravelly sand (British Geological Survey, 1991). There is practically no published information on benthic biotopes and communities in this area, apart from a small number of coastal sites in west Islay surveyed by Hiscock (1983). From the nature of the bottom sediments a

community characterised by burrowing echinoderms (such as irregular urchins) and bivalves would be expected."

6.2.2.2 Field Research - Benthic Environment

A drop down seabed video survey was undertaken in the proposed development area Subtidal Survey of Rhinns of Islay, Argyll for DP Energy, September 2008: Final Report (7)

"The rock surfaces in these areas were apparently barren for the most part, and characterisied by common sea urchins *Echinus esculentus,* occasional common starfish *Asterias rubens* and brittlestars, and smaller encrusting fauna such as barnacles and the white tubes of the polychaete *Pomatoceros triqueter.* It is likely that these substrata are at least seasonally unstable and subject to severe wave action and tidal sediment scour or both.

Second, in the south eastern part of the search area the seabed was mostly shallow and consisted mostly of bedrock. Although some of the rock in this area was sufficiently shallow (at a depth of approximately 30 - 32m) to support some red algae, the region typically comprised exposed circalittoral (animal dominated) rocky habitats. The more stable habitats appeared to support a slightly richer fauna, still with open bare areas characterised by common sea urchins and starfish, but also with small patches of sponges (largely unidentified but including the grey elephants ear sponge *Pachymatisma johnstonia,* a yellow or orange encrusting species, and a possible erect axinellid sponge at drop 4), the soft coral *Alcyonium dititatum* and occasional anemones, encrusting sea mats or bryozoans and erect bryozoans such as *Porella compressa."*

The summary noted the extent of the benthic community as follows:

"Overall, the observations of physical habitat type and the biological communities present were found to fall into four biotopes:

- SS.SCS.CCS.PomB: *Pomatoceros triqueter* with barnacles and bryozan crusts on unstable circalittoral cobbles and pebbles (present at drops 1-12, 16-21 and 23);
- CR.HCR.XFa: mixed faunal turf communities on circalittoral rock (present at drops 4-6 and 13-15);

- CR.MCR.EcCr.FaAlCr: faunal and algal crusts on exposed to moderately wave exposed circalittoral rock (present at drops 7&8); and
- CR.MCR.EcCr: echinoderms and crustose communities (present at drop 22 only)."

6.2.2.3 Current Knowledge – Intertidal Environment

There is insufficient detailed information currently available to enable a full ecological assessment of potential landfall sites to take place. Additional survey works will be required and undertaken as part of the EIA.

6.2.2.4 Current Knowledge – Terrestrial Environment

There is presently insufficient detailed information available in the vicinity of the potential landfall sites around Portnahaven to enable a full terrestrial ecological assessment to be completed. However, two SAC's for Marsh Fritillary butterflies have been identified exist to the east of Portnahaven on Rhinns Point as discussed in 6.1.4.2.

Further inland from the landfall sites much of the Rhinns of Islay is designated as a SSSI/SPA and information is available on both habitat and species within these areas.

6.2.3 Potential Effects

6.2.3.1 Benthic Communities

<u>Installation</u>

During installation of devices and cables, benthic communities in the vicinity of installation operations could be impacted in the following ways:

Substratum Loss of species located within the installation area as a result of cable trenching, installation of piles, gravity bases or clump weights, and deployment of anchors and jack-up rigs if used. Indirect effects (increased turbidity and smothering) on the surrounding area could also result from the re-distribution of sediment into the water column. These impacts will be localised and temporary and are likely to be most significant for installation of export cables, and devices which require structures to be piled into the seabed. Devices which use gravity bases, anchors and clump weights will cause a much smaller impact resulting from disturbance of the seabed and sediment suspension.

Smothering can occur within the immediate vicinity of the seabed disturbing works, as the coarser fraction of the sediment disturbed is likely to be re-deposited on the seabed within about 50m of the works. This impact is only expected to be temporary, as material deposited will be re-suspended and distributed by natural hydrodynamic processes, and will only affect those species/habitats that are sensitive to smothering.

Increased suspended sediment and turbidity can occur as finer particles travel further from the disturbed area, swept by tidal currents, with potential effects on sessile filter feeders. However, given that the turbines will be placed in high energy environments, it is likely that the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed into the surrounding environment, and will have a negligible impact on background suspended sediment and turbidity levels.

Disturbance of contaminated sediments is also possible during cable and device installation, should seabed disturbing works be undertaken within an area of contaminated seabed, which may cause potential effects on nearby species that are sensitive to contamination.

Operation

During device operation the following impacts are possible:

Substratum loss due to the presence of piles, gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed. Depending on design devices are expected to each occupy a seabed area of between approximately $12m^2$ (piles) and $40m^2$ as defined in the Scottish Marine SEA(2) (gravity bases).

Decrease in water flow resulting from extraction of tidal energy, may potentially impact on habitats and species which are sensitive to changes to tidal flows and wave exposure. Marine life in tidal rapids relies primarily on the strong water currents to carry food in, and waste materials and fine sediments away. Therefore, interruptions of tidal flows may have implications for fauna and flora. Benthic habitats are also potentially affected by changes in sediment patterns as a result of reduction in tidal flows. Whether significant changes in community structure would occur and whether they would be considered deleterious would depend on the degree of change and the nature of the receiving environment. Based on limited existing projects and modelling studies, it is estimated that the extent of measurable impact on tidal energy can extend up 0.5 km from the tidal device as defined in the Scottish Marine SEA(2). Maerl beds, *Modiolus* beds and *Lophelia pertusa* reefs, and some deep mud habitats are highly sensitive to changes to tidal flows.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tidal energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of impacts on sediment processes of up to 50m from devices as defined in the Scottish Marine SEA(2).

There is also the potential for leaching of toxic compounds from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from a device. Tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. Most of the priority habitats likely to be present in the proposed development area for which there is relevant sensitivity information are not particularly sensitive to heavy metal contamination that could result from use of copper based antifoulants or from sacrificial anodes.

The potential for leakage of hydraulic fluids through accidental storm or collision damage could potentially present a significant impact if it occurred, but it is considered that there is a very low likelihood of such a leakage occurring. Potentially more significant still are the possible impacts that could result from leakage of cargoes or fuel carried by a vessel involved in a collision with a tidal turbine.

There is also potential for colonisation of structures causing increased biodiversity and leading to increased food availability for fisheries. Whilst this therefore has potential to be a positive impact, species colonising underwater structures may lead to undesirable changes in community structure, giving rise to negative impacts. On balance, colonisation of underwater structures is generally considered to be of neutral significance.

Decommissioning

Potential effects are predicted to be similar to installation except that since much of the foundation will be left insitu the amount of sediment release is likely to be significantly lower than that released during construction. This is clearly dependent on the depth of excavation required.

6.2.3.2 Terrestrial Ecology

Installation

The provision of a temporary construction facility, substation/control building and electrical connection could result in the loss or disturbance of habitat and secondary effects on associated fauna.

Operation

Operational effects are considered to be minimal with infrequent maintenance causing a temporary disturbance of habitat and associated fauna.

Decommissioning

The dismantling and removal of the substation/control building and electrical connection cables will result in a habitat change due to the restoration of affected areas.

6.2.4 Scope and Methodology - Benthic and Terrestrial Ecology

6.2.4.1 Benthic Ecology

Sample Sites

Based on the findings of the seabed drop down video assessment as reported in the Subtidal Survey of Rhinns of Islay, Argyll for DP Energy, September 2008: Final Report [7], additional assessment will be focused on the shallower waters and more specifically on the subsea cable route corridor.

Representative samples from the different habitat types will be gathered across both the tidal farm footprint and subsea cable corridor. For each significant shift in the sea-bed texture or approximately per $2km^2$ a grab sample will be taken to identify the seabed material. However, the exact number and location of each sample site will be agreed upon in consultation with statutory nature conservation agencies. As discussed in section 5.1.4.2 an acoustic survey (e.g. side-scan) will be carried out initially to determine the different seabed habitats present. This survey will be combined with the analysis for sediment transport.

Grab Sampling

Grab sampling is undertaken using a $0.1m^2$ grab with stainless steel buckets to avoid possible contamination of sediment samples prior to chemical analysis. The volume of the samples will be at least 5 litres. It is proposed that 3 grab samples are taken from each sample site for invertebrate analysis. Two samples will be analysed for taxonomy while the third will be sieved and held for future taxonomical examination, should that be required.

A photograph of a grab sample at each sample site will be taken.

If hard ground is encountered for an extensive area, a dredge will be used instead of grab sampling. As it is very difficult to determine the length of seabed over which the dredge has been towed, this method is classified as providing qualitative results rather than quantitative results, which therefore cannot be directly compared with those from the grab samples. For dredge sampling, the equipment does not bite into the sediment as does the grab, but it tows along the surface of the seabed, collecting primarily epifauna (fauna living in the surface of the sea-bed), some infauna (fauna living within the sediment) and epiflora in shallow water.

For each sample site, the co-ordinates will be monitored on GPS, the time will be recorded as well as depths from the vessel's echo sounder.

Particle Size Analysis

All samples will be analysed for particle size (PSA). The samples will be taken before sieving. The depth of each collected sample is registered and made at the centre of the grab buckets. The samples for PSA are stored chilled, but not frozen. Samples from each sample site will be analysed in a specialist laboratory.

Sediment Chemical Analysis

Sediment samples for chemical analysis (metals, total petroleum hydrocarbons (TPH) and radio nuclides from muddier sample locations or locations where elevated concentrations are suspected to be present) are taken from the surface layers of the fourth grab sample taken at selected sites. From a selected number of sites the samples will be selected based on the side scan analysis. The number and location of the sample sites will be agreed upon with The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) and Scottish Natural Heritage (SNH).

Invertebrate Analysis of Benthic Samples

Samples are rinsed on board through a 1.0mm mesh – all retained material being preserved in 4% buffered formaldehyde solution. Identification and sorting of the benthic invertebrate samples will take place in specialist laboratories. All animal specimens are identified to the lowest taxonomic group and to species level where possible.

6.2.4.2 Nearshore and Shoreline Ecology

Intertidal habitats include the areas between the top splash zone, and the low tide mark. Following an intertidal skilled eye assessment, a detailed shoreline assessment will be undertaken to identify the most appropriate route for the subsea cable landfall. The survey methodology will follow the relevant guidelines outlined in the CCW Handbook for marine intertidal Phase 1 survey and mapping (Wyn et al. 2000) [9]. Any field surveys will be carried out within the period from April to October.

6.2.4.3 Trenched Cable Route and Control Building Location – Terrestrial Ecology

A walkover survey of potential landfall and control building locations will be undertaken to identify avian and non-avian species present. The scope and method proposal for avian species is reported in section 6.4.4

Non avian ecological surveys will consist of a desk based survey to determine the ecological sensitivity of the site in the local, regional, national and international context.

An extended Phase I Habitat survey of the area will be carried out, following the standard methodology for Phase I survey, and extended to include species lists and indications of species abundance for each habitat type encountered. The study area will extend to 100m beyond the search area and 200m either side of the trenched cable route. All habitat patches greater than 0.1ha in extent will be classified according to the methodology and recorded on 1:10,000 scale maps.

Target notes will be used to record habitats smaller than 0.1ha and other features of nature conservation interest, as well as information on ecologically important habitat features. Any incidental observations of priority species, or European Protected Species will also be recorded in the target notes.

For priority or Annex 1 habitats identified during the Phase 1 survey, more detailed Phase II surveys will be conducted to provide detailed information on the individual communities. The Phase II survey will identify the communities and sub-communities of the priority habitats, based on 2m x 2m quadrat sampling and using the standard National Vegetation Classification (NVC) classifications. In each priority habitat type, quadrats will be selected in representative stands of vegetation and data will be collected on the site characteristics, the vegetation structure, individual species identification, abundance and peat depth (in mire communities).

A full habitat survey report and GIS maps will be produced for both Phase I and Phase II surveys.

6.3 Fish and Shellfish

6.3.1 Introduction

There is potential for the construction of the tidal farm and subsea cables and the operation of the tidal farm to have an adverse effect on fish and shellfish resources, including spawning, overwintering, nursery, feeding grounds and migratory pathways.

An assessment is required to determine the extent of the interaction between the proposed development and the resources found at the site.

6.3.2 Current Knowledge

Desk based data has been gathered from the following sources:

- Scottish Executive Marine SEA;
- Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements – June 2004;
- CEFAS – Interactive Spatial Explorer and Administrator (iSEA);
- Scottish Fisheries Protection Agency (SFPA) Database; and
- The Marine Life Information Network for Britain and Ireland (MarLIN).

Additional information has been gathered during the video recording of the seabed Subtidal Survey of Rhinns of Islay, Argyll for DP Energy, September 2008: Final Report (7).

6.3.3 Potential Effects

6.3.3.1 Installation of Turbines and Subsea Cables

<u>Disturbance</u>

Disturbance of mobile species can occur during installation of turbines and cables, as a result of the presence of the installation vessels and equipment (and associated noise) within the vicinity of operations. In addition, the noise generated by piling is likely to have a greater disturbance impact than for developments where piling is not required. Whilst piling noise would only be produced over a temporary period, for the duration of construction activities, the impacts may continue for longer, as fish may not immediately return to an area, particularly if they have been excluded for lengthy periods. The timing of installation works is also a key factor, as the disturbance effect is likely to be greater during mating aggregations, as it may affect mating activity.

Smothering

Smothering of fish spawning habitat or shellfish habitat could occur within the immediate vicinity of the seabed disturbing works, as the coarser fraction of the sediment disturbed is likely to be re-deposited on the seabed within about 50m of the works. This impact is only expected to be temporary, as excess material deposited will be re-suspended and distributed by natural hydrodynamic processes. Based on the sensitivity data available from The Marine Life Information Network for Britain and Ireland (MarLIN). [(10)], most fish species within the study area are not sensitive to, and therefore not affected by the impacts of smothering. The exceptions however include certain demersal species: lesser spotted dogfish, thornback ray, common skate, lemon sole and plaice which all have a low sensitivity to smothering. The spawning areas of finfish species herring and sandeels are highly sensitive to smothering impacts, and a smothering episode on a herring gravel bank, for example, could potentially impact an entire year class in the locality. Shellfish inhabiting the seabed are generally more sensitive to the impacts of smothering. *Nephrops* (Norway lobster), king and queen scallop, cockles and periwinkles are all highly sensitive. Whilst European lobsters, edible crab, velvet crab, whelk and mussel have medium to low sensitivity.

Increased Suspended Sediment and Turbidity

This can occur as finer particles travel further from the disturbed area, swept by tidal currents, with potential effects on filter feeders. King and queen scallop, cockle, mussel, herring and sprat all have a medium sensitivity to increased suspended sediment. All other fish and shellfish species, for which the sensitivity is known, have low or no sensitivity to this impact.

Disturbance of Contaminated Sediments

This effect can occur during cable and device installation, which may cause potentially detrimental impacts on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are discussed in section 5.3.

Marine Noise

Noise from marine developments has the potential to impact fish in the immediate vicinity of operations. The expected sources and impacts of noise on the marine environment are discussed further in section 7.8.

Key sources of noise during installation are shipping machinery, dredging and pile driving. Pile driving is anticipated to have the greatest potential effects on marine wildlife, as it generates very high sound pressure levels that are relatively broad-band (20 Hz - > 20 kHz).

6.3.3.2 Operation

<u>Collision</u>

Collision risk is considered to be a key potential effect during turbine operation. The group of species at risk will vary depending on the type of device and its location within the water column. Demersal fish, for example spend their time near the sea bed and are unlikely to be affected by turbine rotors. It is possible that they may benefit from the habitat structure provided by the foundations. Some demersal species for example Plaice or cod may interact with turbines in mid water when they make excursions up the water column or when using tidal stream transport during migration.

Pelagic species of fish will be at some risk of interaction with all types of device. Their diurnal vertical migration behaviour forces them to occupy all depths in the water column at some time during the day.

In addition there are a number of other parameters that can be expected to affect the degree of collision risk:

Size:
Very small fish and larval fish with very low inertia experiencing viscous flow regime are more likely to follow the flow streamlines around moving parts and thus avoid collision. The collision risk increases with increasing fish size, and the greatest collision risk, as far as fish size is concerned, is therefore expected to apply to basking shark.

Schooling Behaviour:
Schooling species may be at greater risk than those with a solitary habit. A school could be regarded as a large “super organism” rather than behaving as individual. Schools of fish move together in polarised formations and their predator escape behaviour is coordinated.

Responses may lead to some individuals evading contact with turbine blades; whilst others could be directed into the path of a blade.

Life Stage:
Juveniles likely to be more at risk than adults because of reduced sensory and mobility abilities and/or experience.

Season:
Species at most risk will also vary with season, due to seasonal change in geographic distribution, migrations and spawning periods.

Fixed submerged structures (such as vertical or horizontal support piles, ducts & nacelles) are likely to attract marine life in the manner of artificial reefs or fish aggregating devices (FADs). Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column.

Collision risk is expected to be influenced by the nature of the environment where the turbines are located:

Open Water:
Deployment of devices in the open sea will present the least risk unless the spacing between devices increases the risk of encounter (see above). However, water depth at the point of deployment will be critical and turbines need to be raised far enough off the bottom to reduce interaction with benthic fish.

High Flow Environments:
High flows can combine with swimming speeds to produce high approach velocities and consequently reduced avoidance or evasion response times. In high flow environments, fish may hold station in front of a device until they reach exhaustion and then passively be swept downstream towards it. This observation is based on research undertaken into fishing methods, and why fish become swept into trawling nets (Wardle 1986, Walsh, 2003, Breen M. 2004, Jamieson, *et al* 2006).

Turbidity:
Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines themselves increase turbidity. This is because of the turbines' reduced visibility,

and also because turbid waters are actively selected by many fish species, possibly as a refuge from predators.

Ecological impacts resulting from fish interactions with devices can be expected to range from no impacts to the potential removal or injury of individuals, and, if rates are sufficiently high, declines in populations. If avoidance responses occur then habitat exclusion is possible while if structures provide foraging opportunities then this could cause positive impacts.

Consideration will be given within the EIA to the various device types which might fall within the design envelope. In particular any differences in collision risks associated with either open or closed rotors will be assessed.

Other Effects

Substratum Loss:

The presence of gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed, will cause loss of seabed habitat during device operation.

It is estimated that for a typical array of 30 – 100 tidal devices each occupying a seabed area of $12m^2$ an approximate estimate of the area of seabed lost for each array would therefore be $0.36km^2$ as defined in the Scottish Marine SEA [(2)]. This impact is only directly relevant for shellfish and benthic spawners such as sandeels and herring, although there could be a knock-on effect on other fish species by affecting their benthic food resources.

Decrease in Water Flow:

A decrease in water flow resulting from extraction of tidal energy, will potentially impact on habitats and species which are sensitive to changes to tidal flows and wave exposure. Based on limited existing projects and modelling studies, it is estimated that the extent of impact on tidal energy can extend up 0.5km from the tidal device as defined in the Scottish Marine SEA [(2)]. This impact mainly applies to shellfish which range from low – medium sensitivity to changes to tidal flows. However, as herring spawn on gravel beds created by high water flow, herring spawning areas are also likely to be sensitive to this impact.

Changes in Suspended Sediment Levels and Turbidity:

These changes may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of impacts on sediment processes of up to 50m from devices. King scallop, queen scallop, cockle, mussel, herring and sprat have a medium sensitivity to this impact. All other fish and shellfish species commonly found in the study area, for which the sensitivity is known, have low or no sensitivity to this.

Contamination:
Leaching of toxic compounds from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from the device is a potential effect during device operation. A number of tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. For most of the finfish species likely to be present in the study area, sensitivity to this impact is not known.

Shellfish species present in the study area have a generally low to very low sensitivity to heavy metal and synthetic chemical contamination that could result from use of copper based anti-foulants or from sacrificial anodes. The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small. The potential for leakage of hydraulic fluids through accidental storm or collision damage could potentially present a significant impact if it occurred. Potentially more significant still are the possible impacts that could result from leakage of cargoes or fuel carried by a vessel involved in a collision with a tidal turbine.

EMF:
Electricity cables produce small electric and magnetic fields, which have the potential to affect migration and prey detection in certain electro-sensitive fish species such as elasmobranchs (sharks and rays). This potential effect is assessed further in section 7.9 Electric and Magnetic Fields.

Noise:
Marine fish can produce and hear marine noise which, whilst not fully understood, is thought to be associated with alarm calls and social behaviour, and studies have found that general noise such as is generated by shipping activity can cause an avoidance or attraction

reaction in fish. Noise from tidal energy projects therefore has the potential effect on fish in the immediate vicinity of devices.

Fishing Exclusion Areas:
There is also a potential positive impact on fish resources should the tidal array be excluded from fishing activities, as this could create spawning grounds and nursery areas that will be able to exist undisturbed by commercial fishing activity. Furthermore, with sensitive design, tidal installations could potentially form artificial reefs.

Barrier to Movement:
There is the potential that arrays of devices may form a barrier to the usual migration and transit patterns of marine finfish, either because of collision risk, aversive reactions to operation noise or perceptions of devices and associated infrastructure. This is particularly relevant in constrained areas (such as mouths of sea lochs).

6.3.3.3 Decommissioning

Potential effects are predicted to be similar to installation except that since much of the foundation will be left insitu the amount of sediment release is likely to be significantly lower than that released during construction. This is clearly dependent on the depth of excavation required.

6.3.4 Scope and Methodology – Fish and Shellfish

The assessment will be structured in the following stages:

6.3.4.1 Desk Based Assessment

There is a considerable quantity of information on fish and shellfish for the UK coastal zone available in published documents, scientific reports and from the commercial fisheries. The first stage will be to assess this information to determine the presence, distribution and seasonality of the fish and shellfish resources. Information to be gathered will include:

- Major species of fish and shellfish in the area that are of significant importance in commercial and recreational fisheries;
- Species of fish in the area that are of conservation importance;

- Elasmobranch fish (fish able to detect electrical fields like sharks, rays and skates) in the area and along the cable route; and
- Species that have a restricted geographical distribution and are locally abundant in the area.

When the important fish and shellfish species present at or near the proposed site have been identified, aspects of their ecology that may be affected by the construction will be determined. For fish and shellfish, the following aspects of their ecology will be assessed where relevant and whenever information is available:

- Spawning grounds;
- Nursery grounds;
- Feeding grounds;
- Migration routes; and
- Overwintering areas for crustaceans (e.g. lobster and crab)

6.3.4.2 Consultation

The result from the desk study will be submitted to Marine Scotland, and the quality of the site specific information will be assessed jointly with the authorities. The requirement for field surveys will depend on whether the data set meets the requirements of the authorities and contains a sufficient amount and quality of information to determine possible impact from the proposed tidal farm, if so then no field surveys will be needed.

If, on the other hand, the data show that the information is insufficient to meet the requirements of the authorities, e.g. due to lack of information or due to an issue of local concern, specific field surveys will be initiated to cover information gaps.

6.3.4.3 Field Surveys

Methodologies for possibly field studies in relation to suitable gear, sampling method and data analysis will be agreed upon in consultation with Marine Scotland.

6.4 Birds

6.4.1 Introduction

The EIA will include a description of the main distributions of bird species within the area, and the potential effects that the proposed tidal farm will have on them. The assessment will be broken down into two areas, birds potentially affected by marine activities and birds potentially affected by associated onshore equipment.

6.4.2 Current Knowledge

6.4.2.1 Designated Areas and Protected Species

As described in previous sections of this scoping document (section 6.1.) Islay itself has significant avian interest, and there are a number of designated sites for both Species (SPAs) and Habitats (SAC/SSSIs) on the island. The presence and use of these designated areas is relatively well documented and will inform the onshore element of the proposal. There are, however, no nearshore or offshore designated areas associated with avian species in the vicinity of the proposed tidal farm development.

The locations of breeding bird colonies around the coast of the Rhinns have been identified as part of the constraints assessment as referenced in Extended Tidal Technology Constraints Assessment – South West Islay, July 2008 [(6)].

6.4.3 Potential Impacts

6.4.3.1 Marine Birds

Installation of Turbines and Subsea Cables

Collision Risk:

There is the risk of marine birds colliding with construction machinery and vessels present during the project installation phase. Collision can typically occur in two situations:

- Flying birds colliding with the surface structures of ships; or
- Ships colliding with birds rafting on the surface.

Risk is likely to be low for all species as vessels involved in installation of both tidal devices and export cables are likely to be either stationary or travelling considerably slower than commercial shipping vessels whilst involved in construction activities.

Physical Disturbance:
Physical disturbance of birds in the immediate vicinity of construction activities is a potential temporary impact during array and export cable construction. Noise is a key factor in causing the disturbance impact, but the physical presence of the installation vessels themselves can also cause a disturbance impact due to physical and visual intrusion. Birds' likely response to disturbance impacts would be to avoid the immediate area during construction.

Marine Noise:
Marine noise during installation could potentially impact marine birds whilst underwater, causing them to become disorientated and affecting their foraging success.

Increased Turbidity (Reduced Visibility):
This can occur during seabed disturbing installation activities, as fine particles travel further from the disturbed area, swept by tidal currents. Increased turbidity can have effects on foraging, and predator/prey interactions. However, given that the tidal turbines will be placed in a high energy environment, it is likely that the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed into the surrounding environment, and will have a negligible impact on background suspended sediment and turbidity levels. Marine birds are thought to have a high sensitivity to reductions in visibility.

Disturbance of Contaminated Sediments:
This may occur during cable and device installation, which may cause potentially detrimental impacts on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are discussed in section 5.3.

<u>Operation</u>
Collision Risk:
Collision risk is considered to be a key potential effect during device operation. Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column. Cables, chains and power lines extending up through the water will

have smaller cross-sectional area than vertical support structures and so produce reduced flow disruption and fewer sensory cues to approaching diving birds. Instead of being swept around these structures, they are more likely to become entangled in them. Marine birds have means of escaping moving or stationary hazards. The response of marine birds to a tidal scheme will depend on whether it is detected above or below the surface and how close the object is before the animal detects it, and whether it is interpreted as a hazard that needs to be avoided.

Above the Surface:
If schemes are visible from above the surface, birds in flight will probably operate broadly similar avoidance tactics to those employed when encountering other natural and man-made obstructions i.e. by taking alternative flight routes and avoiding obstructions to a greater degree at night as reported in Desholm & Kahlert 2005 Avian Collision Risk at an Offshore Wind Farm [(15)].

Below the Surface:
Similar avoidance tactics are likely to be employed by diving birds when they detect a stationary or moving object as flying birds when detecting obstructions. More drastic avoidance behaviours are likely to be required if an object is only detected very late, especially if the bird is in the path of a turbine blade. Birds have a moderately fast burst speed, which would enable escape under many situations where the bird manages to move out of the path of the blades.

Collision risk is also expected to be influenced by the nature of the environment where the turbines are located, proximity to protected areas/SPAs, foraging behaviour and encounter rates.

Open Waters:
The above concerns are likely to be of general relevance to schemes placed in open waters, which will potentially be equally visible from all directions (device orientation notwithstanding) both above and below the water surface to marine birds. However, marine birds do not fly evenly and in all directions across open water, and are aggregated in relation to oceanographic conditions and prey availability as reported in Daunt, *et al*, (2006) Impacts of Oceanogrophy on the Foraging Dynamics of Sea Birds in the North Sea [(16)]. Thus, detailed data on the use made of the area by birds, including travelling and underwater

foraging trajectories, would be required to further understand this issue.

Flow Characteristics:
Most species are attracted to areas of high flow because of good foraging opportunities (Daunt *et al*. (2006) [16]. Risk of collision could be increased if the tidal scheme alters the flow characteristics, especially if such changes create new foraging opportunities for marine birds, since this may impact on the manoeuvrability and underwater swimming agility of the birds. Risk will be higher among diving than surface feeding species. However, overall risk associated with change in flow characteristics is likely to be linked to the extent to which birds feed at night.

Water Depth:
Collision risk will depend on the extent to which species and devices are distributed through the water column. Thus, diving species will be at greater risk of collision with subsurface rotating turbines and mooring cables than surface feeding species, which would be at a lower risk of impact with floating devices, and above surface structures as these do not use rotating blades. Empirical data exist on the depth usage of a range of species including European shags, northern gannets, northern fulmars, common guillemots, razorbills and Atlantic puffins as reported in the Scottish SEA [2]. In general, depth distribution depends on maximum foraging depth, with shallow divers spending most time near the sea surface and progressively less time at depth, whereas deep divers, which are principally benthic feeders, showing a bimodal depth distribution with peaks of time spent at the sea surface and at deep depths and less time spent at intermediate depths.

Water Quality:
Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines increase turbidity, because of their reduced visibility. Birds' vision can be affected by small levels of turbidity as reported in Strod *et al*. 2004 [17]. However, no data exists on collision risk in relation to turbidity. Diving species will be more at risk of collision in turbid waters than surface feeding species, and night-time feeders more at risk than daytime foragers.

<u>Other Risks</u>

Marine Noise:
Construction noise produced during operation of devices could also potentially disrupt prey location and underwater navigation in marine birds, or even result in temporary or permanent hearing damage. Whilst the noise levels likely to be generated during device operation are currently not known (as there are no arrays of devices currently installed in UK waters), operational noise is expected to be considerably less in magnitude than construction noise. The potential noise sources during device operation include: rotating machinery, flexing joints, structural noise, moving water, moorings, electrical noise, and instrumentation noise.

Habitat Exclusion:
The presence of a tidal array will cause loss of habitat during device operation. Turbines may exclude birds from a suitable foraging habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat, with associated impacts on foraging and breeding success, stress on individuals and energy budgets. The array size is likely to be up to 8.5km^2 for the proposed tidal farm.

Evidence from wind farm projects indicates that many species, most notably diver and sea-duck have been displaced some 2 – 4km from wind farm areas, and this wider displacement impact is thought to be due to the birds perceptual reaction to turbines or maintenance vessels. Whether a tidal farm would have similar displacement effects is uncertain but it seems unlikely. Whilst it is considered that alternative foraging areas may be available to these species, the array will create a net loss of foraging area and removal of food resource, depending on the means of securing the device to the seabed. There may also be a knock-on effect on adjacent bird populations arising from increased competition for prey species in adjacent areas. In addition, the installation of marine turbines may also create new habitat that could potentially be colonised by benthic species and affect the availability of prey species in the vicinity of turbines.

Changes in Suspended Sediment Levels and Turbidity:
This may be caused by changes to sedimentation patterns resulting from extraction of tidal energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition.

Contamination:
Leaching of toxic compounds from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from the device is a potential effect during device operation. A number of tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. Marine birds are particularly sensitive to contamination by oil based compounds which may be included in the hydraulic fluids used by some devices. The oil damages the plumage causing it to lose its waterproofing as reported in Wernham *et al.* (1997). Survival Rates of Rehabilitated Guillemots [(18)]. Furthermore, considerable physiological damage occurs as a result of marine birds ingesting oil. The susceptibility of species is dependent on their distributions and general behaviour, in particular the proportion of time spent on the sea surface in relation to time spent flying and on land.

Potentially more significant still are the possible impacts that could result from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays.

Creation of Resting and Breeding Habitat:
If devices have surface structures, then there is potential that seabirds will use them as perching or breeding locations. Man-made objects are frequently used as perching posts by a range of species, notably gulls, terns, gannets and Cormorants. They may also provide breeding locations to these same species as reported in Craik, (2004), Record Breeding Success of Terns in West Scotland [(19)].

Foraging Opportunities:
Marine renewable devices, with associated seabed moorings and vertical structures, will potentially function as artificial reefs or fish aggregating devices. In changing the habitat they therefore have the potential to also change the distribution of marine seabirds. Their structures may offer enhanced opportunities for foraging for some species. The action of moving parts may scatter schooling prey or injure fish or squid and thus draw in opportunistic foragers.

6.4.3.2 Onshore Birds

Installation of Cable Trench and Substation/Control Building

Physical Disturbance:
The construction of this equipment is expected to last for a total of six months. During the construction period, disturbance levels within the

site, may result in the temporary displacement of some ground nesting species during the breeding season. Any displacement would be temporary. Consequently, construction impacts would be minimal and temporary although where possible, would be constructed outside the breeding season.

Operation

Permanent Loss of Habitat:

The footprint of the cable trench and substation/control building will result in a permanent loss of habitat for some ground nesting birds. This will be calculated for the respective vegetation encountered.

Collision Risk:

During the operational phase, the ornithological interest in the vicinity of the substation/control building may be affected by a long term risk of collision.

Decommissioning

Potential effects from decommissioning will be the same as those referred to above except that the timescale will be considerably shorter.

6.4.4 Scope and Methodology - Birds

6.4.4.1 Marine Birds

Consultation

DPEM will consult with SNH and RSPB to define a scope and methodology to enable an EIA to be undertaken for the proposed development area.

6.4.4.2 Onshore Birds

Consultation

DPEM will consult with SNH and RSPB to define a scope and methodology to enable an EIA to be undertaken for the proposed development area.

6.5 Marine Mammals

6.5.1 Introduction

Scotland holds about 85% of Europe's population of grey seals (*Halichoerus grypus*) and about 43% of the European population of common seals (*Phoca vitulina*), emphasising the important role that these mammals have in Scottish waters. In addition, Scotland also includes the richest regions in the UK, and one of the most important areas in north-west Europe for cetaceans. Over twenty species of whales, dolphins and porpoise can be seen around the Scottish coastline, including common dolphins (*Delphinus delphis*), minke whales (*Balaenoptera acutorostrata*), killer whales (*Orcinus orca)* and bottlenose dolphin (*Tursiops truncates*) (of which the Scottish population is the most northerly in the world).

6.5.2 Current Knowledge

No prescope field assessment work has yet been undertaken, desk based data has been gathered from the following sources:

- Scottish Marine Executive SEA;
- Extended Tidal Technology Constraints Assessment – South West Islay, July 2008 (6)
- Atlas of Cetacean Distribution in North-West European Waters, JNCC 2003; and
- Sea Mammal Research Unit, St Andrews University.

6.5.2.1 Pinnepeds

The west and north of Scotland is home to two species of seals, grey seals (*Halichoerus grypus*) and common seals (*Phoca vitulina*). The region is home to around 90% of the population of both species.

<u>Grey Seals</u>

Grey seals are the more abundant of the two species that breed around the western seaboard of Scotland. About 39% of the world population of grey seals is found around the coast of Britain, and approximately 90% of British grey seals breed in Scotland, the majority of which are found in the Hebrides and in Orkney. In Scotland, grey seals come ashore on remote islands and coastlines to give birth to their pups from September to early November. During this time they are ashore for periods of several weeks. In addition, they come ashore to moult their coat in winter - spring (December to March), and at other times of year to haul out and rest between feeding trips at sea. Grey seals feed mostly on fish that live close to the seabed, but this varies seasonally and regionally. Feeding trips generally take place within 40-50 km of haul-out sites and last between one and five days. They occasionally interrupt this pattern of short local trips by travelling longer distances (between 125 and 365 km) to a new haul-out site, which may then be the base for subsequent feeding trips.

Common Seals

Britain holds approximately 40% of the European population of common seals (also called harbour seals), over 90% of which are found in Scotland. They are widespread, primarily throughout the Hebrides and Northern Isles. Common seals come ashore in sheltered waters typically on sandbanks and in estuaries and on rocky areas (particularly on the west and north coasts). They give birth ashore to their pups in June and July and moult their coats between July and September. During pupping and moulting, and resting periods between feeding at sea, common seals haul out on land in a pattern that usually reflects the tidal cycle (periods on land are generally during low tide). Common seals normally feed within 40-50 km of their haulout sites, and feed on a variety of prey including sandeels, whitefish, herring, sprat, flatfish and octopus.

Isaly does hold important seal grounds and as described previously (section 6.1.2), The Skerries on south-east Islay has been designated an SAC for Common Seals.

6.5.2.2 Cetaceans

Presence

The following designated species are likely to be found in the vicinity of the proposed tidal farm.

Table 4: Protected Species Likely to be Found in the Vicinity of the Proposed Tidal Farm

Species	Abundance
Bottlenose Dolphin	Regular
Harbour Porpoise	Regular
White Beaked Dolphin	Regular
Rissos Dolphin	Regular
Common Dolphin	Regular
Atlantic White Sided Dolphin	Occasional
Killer Whale	Occasional
Minke Whale	Regular
Long Finned Pilot Whale	Occasional

Sensory Capabilities – Seals and Cetaceans

Vision:

All Scottish marine mammals use vision to navigate in their environment, avoid obstacles and forage. However, unlike many birds, marine mammals forage throughout the diurnal cycle, in very turbid waters and therefore are able to function as predators in very low light levels including at night. Vision is a primary sense for seals, whose large eyes face forward giving them binocular vision. Cetacean eyes are placed on the sides of the head and so give a more panoramic view. The visual fields do overlap, but binocular vision has not yet been demonstrated. Colour vision in cetaceans and seals is limited and skewed to the blue-green region of the spectrum.

Sound:

Marine mammals are known to have acute hearing capabilities. These senses are both passive, meaning that they listen to sounds already in the environment and active, meaning that they produce their own sounds and interpret the returning echoes.

Odontocetes are known to use both passive and active listening when navigating and foraging. The peak energy in echolocation signals are typically at high frequencies giving these animals good fine scale discrimination abilities. However, unlike vision, the information derived from echolocation is limited by the update frequency of the sound pulses and hence their perception of objects has a stroboscopic nature.

Although there has been much discussion of the capabilities of seals and mysticetes to echolocate, it seems that their use of sound to locate objects in the water column is primarily passive. The hearing sensitivities of these species groups differ significantly with the toothed cetaceans (odontocetes) being predominantly high frequency specialists; mysticetes thought to be low frequency specialists; and seals to hear a broad range of frequencies in between.

Mechano-reception:

Because of logistical difficulties in measuring the stimuli that might be used by marine mammals for mechano-reception, little is known about this sense. The best information concerns seals, which have been shown to use their vibrissae (whiskers) to sense small-scale hydrodynamic vibrations and flow vortices in the water column. They are thought to use this sense to track the wake of prey organisms swimming through the water column. Its use for navigation or detecting larger objects is unknown. The existence of a similar sense in cetaceans is unknown.

Electro-reception:
Electricity cables produce small electric and magnetic fields, which have the potential to affect migration and prey detection in seals and cetaceans. Little is known about the abilities of marine mammals to detect or use an electromagnetic sense.

Chemo-reception:
Olfaction (the sense of smell) in marine mammals is severely restricted in comparison to species groups such as fish. In seals it is used to detect con-specifics and predators in air on haulouts, however when underwater seals close their nostrils to prevent water from entering their pharynx, and do not use this sense underwater. There is no firm evidence that cetaceans use this sense to navigate or orientate underwater.

6.5.2.3 Otters

Whilst generally regarded as a freshwater/terrestrial species, in the Northern Isles and West coast of Scotland, an important part of their lifestyle is spent in or near the marine environment.

The European otter (*Lutra lutra*) is a semi-aquatic mammal, which occurs in a wide range of ecological conditions, including inland freshwater and coastal areas (particularly in Scotland). Populations in coastal areas utilise shallow, inshore marine areas for feeding but also require fresh water for bathing and terrestrial areas for resting and breeding holts. Coastal otter habitat ranges from sheltered wooded inlets to more open, low-lying coasts. Coastal otters generally forage close inshore in water depths of 10m or less.

6.5.3 Potential Effects

6.5.3.1 Installation

<u>Collision Risk</u>
There is the risk of seals and cetaceans colliding with construction machinery and vessels present during the project installation phase. Shipping collision is a recognised cause of marine mammal mortality worldwide, the key factor influencing the injury or mortality caused by collisions being ship size and ship speed. Ships travelling at 14 knots (~7 m/s) or faster are most likely to cause lethal or serious injuries.

Vessels involved in the installation of tidal devices and export cables are likely to be either stationary or travelling considerably slower than this whilst involved in construction activities, and therefore the collision risk during construction is likely to be lower than that posed by commercial shipping activity.

Physical Disturbance

Physical disturbance of seals hauled out on land can occur during installation of devices and cables, as a result of the presence of installation vessels and equipment, and the noise they produce in the vicinity of operations. In addition, the physical presence of the installation vessels themselves can also cause a disturbance impact. In general, ships more than 1,500m away from hauled out grey or common seals are unlikely to evoke any reactions from seals, between 900 and 1,500m seals could be expected to detect the presence of vessels and at closer than 900 m a flight reaction could be expected as reported in the Scottish Marine SEA [(2)]. This would be most significant for breeding and moulting seals, hauled out on the coast and on intertidal banks. Breeding seals exhibiting flight reactions could temporarily abandon their young, causing a more significant disturbance impact during the breeding season**.** Moulting seals spend more time out of the water, and if they are scared into the water they may lose condition as a result of additional energetic costs. Physical disturbance of otters could also occur should disturbing works occur close to the coastal areas where they are present. As for seals, disturbance impacts would be greatest during the primary breeding seasons for otters of spring and late autumn.

Marine Noise

Acoustic disturbance of seal and cetacean species both in the water, and seals using haulout sites, can occur during installation of devices and cables. Should any piling be required for device installation, the noise generated by this activity is likely to have a greater disturbance impact than for developments where piling is not required. Whilst piling noise would only be produced over a temporary period, for the duration of construction activities, the impacts may continue for longer, as mammals may not immediately return to an area, particularly if they have been excluded for lengthy periods. This is particularly relevant in constrained areas (such as mouths of sea lochs) where loud noise sources may prevent transit, effectively trapping individuals. However, given the open nature of the proposed development site on Islay this is considered to be unlikely.

The key sources of device construction noise related to site preparation and device installation include shipping and machinery, dredging, and pile driving or drilling. In addition, cable burial requires the use of trenching or jetting machinery in soft sediments, rock cutting machinery in hard sea-beds, or rock or concrete mattress laying may be used to protect cables in areas where they cannot be buried. Noise emitted during pile driving is understood to have the greatest potential effects on marine wildlife as reported in Thomsen *et al*, (2006). Effects of Offshore Wind Farm Noise on Marine Mammals and Fish [20] Recent research work has suggested that detection of sound or pressure changes may play an important role in assisting seals to sense their environment and to hunt efficiently. Initial research reported in the Strangford Lough MCT ES (Royal Haskoning, 2005), suggests that seals may rely upon a form of passive sonar through which they sense the environment and form sound "maps" of their seabed surroundings, whilst relying on vision and vibrissae for "close work" associated with hunting.

Acoustic disturbance in the marine environment is an important cause of behavioural disturbance in cetaceans because they use acoustics to navigate, locate prey and maintain social contact and marine noise produced during construction could potentially interfere with these signals through masking of communication calls, or disruption of foraging clues. This impact should be considered in the context of the many other sources of both natural and anthropogenic noise in the marine environment which could also cause masking effects.

Seals and cetaceans could both be generally expected to be able to hear piling noise up to a distance of 80km, and behavioural responses could be expected up to 20km (Thomsen *et al*, 2006 [20]). In addition, physiological impacts on both seals and cetaceans could include temporary or permanent hearing damage or discomfort. Permanent hearing damage may be a concern at a distance of 400m from any pile driving activities for common seal, and 1.8km for harbour porpoise (Thomsen *et al*, 2006 [20]). However, these figures are likely to vary, depending on site characteristics (e.g. shielding affects of islands and affect of water depth). There is also a risk of injury of death associated with exposure to loud noise sources such as close proximity to piling operations.

<u>Increased Turbidity (Reduced Visibility)</u>

This can occur during seabed disturbing installation activities, as fine particles travel further from the disturbed area, swept by tidal currents. Increased turbidity can have effects on foraging, social and predator/prey interactions. However, given that the tidal turbines will be placed in high energy environments, it is likely the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed and will have a negligible impact on background suspended sediment and turbidity levels.

Grey and common seals have been identified as having a high sensitivity to reductions in visibility, whilst cetaceans are generally considered to have a moderate sensitivity to this impact.

Disturbance of Contaminated Sediments

This is possible during cable and device installation, which may cause potential detrimental impacts on species that are sensitive to contamination and is discussed in detail in section 5.3.

6.5.3.2 Operation

Collision Risk

Collision risk is considered to be a key potential effect during device operation, and it is considered that, bearing in mind the wide range of devices that may be deployed, all species of marine mammals are at some risk of collision impacts. Whilst a distinction can be drawn between species that forage in the water column, or at the seabed, they all breathe at the surface and so regularly transit the water column. Certain parallels can be drawn between known collision risks and response of mammals encountering existing hazards (shipping, fishing gear interactions, killer whale tail swipes), and a review of this information has been undertaken by The Scottish Association for Marine Science (SAMS).

Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column. Cables, chains and power lines extending up through the water will have smaller cross-sectional area than vertical support structures and so produce reduced flow disruption and fewer sensory cues to approaching mammals. Instead of being swept around these structures, mammals are more likely to become wrapped around or entangled in them. Being highly mobile underwater, marine mammals have the capacity to both avoid and evade turbines. This is as long as they have the ability to detect the objects, perceive them as a threat and then take appropriate action at long or short range. However there are several factors that compromise this ideal scenario.

Detection Failure:
The broad acoustic, visual and hydrographic signatures of turbines are at present poorly understood. Other than the visual appearance of devices, the need for efficient energy conversion will encourage the development of devices that produce as little extraneous energy signatures as possible. This is in direct contrast to any warning stimuli required by the animals at risk. There is therefore a key conflict between the stimulus output from the devices and perceptual acuity of the animals at risk. The distances that animals perceive, and hence can take avoiding/evasive action will therefore depend on this ratio. Environmental circumstances such as darkness, turbid water, background noise from rough weather or ship noise may all impact perception distances and hence escape options.

Diving Constraints:
Marine mammals are accomplished divers and typically dive close to aerobic dive limitations. This means that animals do not have unlimited time and manoeuvrability underwater and may have few options other than upwards at the end of a dive. In addition to this, buoyancy varies among marine mammals from negative to neutral to positively buoyant. Irrepressible positive buoyancy is a particular problem for whales when surfacing from depth and therefore constrains manoeuvring options.

Group Effects:
Whales and dolphins travelling or feeding together may be at greater risk than those with a solitary habit. A group could be regarded as a large “super organism” rather than behaving as individuals. Responses may lead to some individuals evading contact with turbine blades; whilst others could be directed into the path of a blade.

Attraction:
It is quite possible that turbines will not be perceived as a threat but instead attract marine mammals as a result of devices acting as Fish Aggregating Devices (FADs) or artificial reefs. It is also possible that species such as seals and small delphinids will be attracted to the devices should they injure or disorientate their prey. Certain more “curious” species, such as common and grey seals may actually be

attracted to devices, whilst other more timid species (such as harbour porpoise) tend to be more wary. The age of individuals may also be relevant, as juveniles may also be more likely to investigate novel features. It is therefore likely that the more timid species or individuals that have had previous negative interactions with devices will show the strongest avoidance reactions.

Confusion:
It is not known how marine mammals will respond to perceiving a turbine. It is quite possible that they will simply swim around it but it is also possible that they will respond in an inappropriate way. This is particularly likely for devices with gaps that move relative to the animal's trajectory such as ducted / shrouded turbines. Alternatively, in arrays, an escape response from one device may put the animal into a collision path with another.

Distraction:
Marine mammals undertake a variety of activities underwater from simple transits, social interactions to complex foraging tactics. It is likely that during some of these occasions the animals' awareness of objects in the water column will be compromised. A particular example is the range detection problem encountered by echolocating cetaceans. When acoustically locked onto prey they reduce the interpulse intervals of their echolocation clicks such that they become acoustically blind to objects at greater distance than their intended prey. Therefore cetaceans feeding around submerged devices run an increased risk of close encounters without active acoustic detection.

Illogical Behaviour:
It is commonly believed that marine mammals have a high capacity for intelligent behaviour and as such would act logically when faced with a threat. However, there are many examples where this is not the case. The reticence of dolphins to leap the head line of tuna nets is a prime and ecologically significant example.

Disease and Life Stage:
It is likely that most collisions will involve young, old, diseased or disorientated individuals. As long as turbines do not significantly attract marine mammals for enhanced foraging opportunities, juveniles are likely to be more at risk than adults because of reduced sensory and mobility abilities and/or experience, whilst old, ill or disorientated

individuals will have reduced abilities to detect the threat or escape from it once perceived.

Size:
Smaller mammals (such as grey and common seals) are more likely to follow the flow streamlines around moving parts and thus avoid collision. The collision risk increases with increasing size.

Season:
Collision risk will also vary with season, due to seasonal change in migrations and pupping periods. Some species, such as the baleen whales and warm water dolphins typically increase in abundance during the summer and autumn, whilst most other species are resident and show only local changes in distribution.

Open Water:
Deployment of devices in the open sea will present the least risk unless the spacing between devices increases the risk of encounter. The impacts of devices on marine mammal habitat exclusion are likely to be localised to the area of placement.

High Flow Environments:
High flows can combine with swimming speeds to produce high approach velocities with consequently reduced avoidance or evasion response times. Many marine mammals (particularly harbour porpoises and bottlenose dolphins) are attracted to areas of high flow to forage.

Water Quality:
Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines increase turbidity, because of their reduced visibility.

Marine Noise
As for construction, noise produced during operation of devices could also potentially disrupt prey location, navigation and social interaction behaviour in marine mammals, or result in temporary or permanent hearing damage. Whilst the noise levels likely to be generated during device operation are currently not known, operational noise is predicted to be considerably less in magnitude than construction noise.

The potential noise sources during device operation include: rotating machinery, flexing joints, structural noise, moving water, moorings, electrical noise, and instrumentation noise.

Marine life may exhibit avoidance reactions to underwater noise at levels much lower than the permanent and temporary hearing damage thresholds described above. It should therefore be noted that arrays of devices may appear as impenetrable barriers to an animal, perhaps separating them from feeding grounds, even though there may be plenty of room between devices for the animal to pass without experiencing damaging noise levels. In addition, noise produced during operating devices has the potential for "masking effects" disrupting prey location, navigation and social interaction.

Barrier to Movement

There is the potential that device arrays may form a barrier to the usual migration and transit patterns of marine mammals, either because of collision risk, aversive reactions to operation noise or perceptions of devices and associated infrastructure. This is particularly relevant in constrained areas (such as mouths of sea lochs) loud noise sources may prevent transit, effectively trapping individuals.

Habitat Exclusion

The presence of tidal arrays may cause loss of habitat during device operation. Devices may exclude mammals from a suitable habitat (both marine foraging habitats and, in the case of seals, terrestrial breeding habitats) by providing a physical or perceptual barrier or producing noise that results in avoidance behaviour. Cetaceans may also be excluded from areas used as nursery or breeding areas, migration/travelling routes and socialising areas. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat. The array size is likely to be up to 8.5km^2 for the proposed Islay tidal farm.

Decrease in Water Flow

A decrease in water flow resulting from extraction of tidal energy will potentially impact on species which are sensitive to changes in tidal flows. Seals have been shown to use their vibrissae to sense small-scale hydrodynamic vibrations and flow vortices in the water column. They are thought to use this sense to track the wake of prey organisms swimming through the water column. Its use for navigation or detecting larger objects is unknown. The existence of a similar sense in cetaceans is unknown.

Changes in Suspended Sediment Levels and Turbidity
This may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. Grey and common seals have been identified as having a high sensitivity to reductions in visibility, whilst the cetaceans in the study area have a moderate sensitivity to this impact. However, many seals live in areas of almost persistent turbidity e.g. the southern North Sea, The Wash, Thames Estuary etc. It is therefore unlikely that increased turbidity would be a significant issue, although the impacts for a Scottish West Coast seal encountering suddenly or persistently turbid water is not known.

Contamination
Leaching of toxic compounds from sacrificial anodes, antifouling paints or leakage of hydraulic fluids (if present) from the device is a potential effect during device operation. It is expected that most tidal devices will use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. Seals and cetaceans in the study area generally have a low sensitivity to contamination, although the sensitivity rises to medium around seal breeding sites. However, as top predators, seals and cetaceans are more susceptible to various substances building up to higher levels in their bodies.

As previously discussed, the quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small, and it is therefore considered that this potential effect will be of negligible significance. Accidental leakage of hydraulic fluids may be more significant, should they occur through storm damage, device malfunction or collision with navigating vessels. Devices which use hydraulic systems will normally be designed such that at least two seal or containment failures are required before a leaking fluid reaches the sea.

Potentially more significant are the possible impacts that could result from leakage of cargoes or fuel carried by a vessel involved in a collision with a tidal turbine.

Electric and Magnetic Fields (EMF)

Electric fields are produced but are almost completely blocked from emanating externally by the shielding effect of a cable's structure. Magnetic fields are produced from AC or DC current passing through the conductor. Magnetic field strength generated during electricity cable operation is variable, and dependent on a number of factors including cable alignment and configuration. In the same way as electric fields are produced as a result of seawater passing through the earth's geo-magnetic field, electric fields can be produced in water passing through the magnetic field surrounding a cable. These are generally dependent on seawater chemistry and velocity in the area, the strength of the cable's magnetic field and its orientation relative both to the water flow and the geo-magnetic field.

The strength of both magnetic and electric fields decreases with distance from the source, and field strength at the seabed surface would therefore be dependent on the depth to which export cables are buried. Although there is circumstantial evidence, the underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength, remains unproven as reported in Basslink, (2001) Draft Integrated Impact Assessment [(21)].

There is no apparent evidence that existing electricity cables have influenced migration of cetaceans. Migration of the harbour porpoise in and out of the Baltic Sea necessitates several crossings over operating subsea HVDC cables in the Skagerrak and western Baltic Sea without any apparent effect on its migration pattern (Basslink, 2001 [(21)]). However, matrices of cables within arrays may produce a more concentrated EMF effect than individual export cables.

There is no evidence that seals are sensitive to electromagnetic fields.

Further details on electromagnetic fields are provided in section 7.9.

Haulout Sites

If surface structures have horizontal surfaces near water level then there is potential that seals will use them as haulout sites. Whilst this could be viewed as a positive impact, increasing the area available for seals to haul out, it is considered that there is already sufficient terrestrial haulout sites available to seals in the study area, and there may be risks of injury associated with getting onto/off the structures and any contact with exposed moving or articulated parts.

Increased Foraging Opportunities

Turbines with associated seabed moorings and vertical structures will potentially function as artificial reefs or fish aggregating devices. In changing the habitat they therefore have the potential to also change the distribution of marine mammals. Their structures may offer enhanced opportunities for foraging for some species. This could occur because, in tidal flows these structures will produce eddies and areas of slack water which predators could use to shelter when ambushing prey. Otherwise the action of moving parts may scatter schooling prey or injure fish or squid and thus draw in opportunistic foragers such as seals and small cetaceans. There is, however, no guarantee that animals will be able to take advantage of this, as it will depend on their feeding techniques, prey choice and adaptability. Therefore, whether these opportunities would enhance the foraging prospects for such species for the better or attract them into otherwise dangerous situations is not yet clear.

6.5.3.3 Decommission

Potential effects are predicted to be similar to installation except that since much of the foundation will be left insitu the amount of sediment release is likely to be significantly lower than that released during construction. This is clearly dependent on the depth of excavation required.

7.0 Scope of Work – Human Environment

7.1 Commercial Fisheries and Mariculture

7.1.1 Introduction

Commercial fishing is an important industry in Scotland, both in coastal areas and further offshore with species caught including mackerel, herring, haddock, cod, whiting, saithe, monkfish, lobster and scallops.

Mariculture, in the form of fish and shellfish farms has grown in Scotland over the last twenty years with species such as Scottish salmon considered to be a quality product internationally.

7.1.2 Current Knowledge

A preliminary desk based assessment has gathered data from the Scottish Marine Executive SEA (2) which in turn has referenced data from the following sources.

- Fisheries Research Service (FRS) "Fish and *Nephrops* Stocks Information: 2006".
- The Scottish Fisherman's Federation has provided some information which shows plots of fishing vessel movements in the SEA study area based on vessel monitoring system (VMS) data. However the available information only gives a partial snapshot (for certain periods in 2005) of fishing activity in the SEA study area, and is only available for vessels over 15 m in length.

In addition local consultation with skippers of vessels actively working the sea areas off the Islay coast has provided further information. Much of this fishing is for scallops and there appears to be little or no fishing activity in and around the area of the proposed development.

A review of the drop down video camera survey also indicated little presence of fish or the presence of habitats likely to attract them to the area.

Further consultation and assessment will take place throughout the course of the EIA process.

7.1.2.1 Commercial Fishing

Large scale commercial fishing for Mackerel, Herring, Haddock, Cod, Whiting, Saithe and monkfish tends be carried out in the North Sea and the northern and western isles.

Nephrops (Norway Lobster) tend to be located in muddy sediment where they can locate their burrows. The main area of exploitation relevant to the proposed development is The Sound of Jura to the east of Islay.

Flat fish (including skates, rays, plaice, flounder, turbot, brill, sole, halibut) are to be found in the Solway Firth and in the northern part of the North Channel in the waters between Kintyre and the Rhinns of Galloway.

Common lobster grounds tend to be found along rocky shores, reefs and cobble and boulderfields. and fisheries occur wherever suitable habitat is found. It is known that common lobster is exploited by small inshore local fisheries around the Orkney and the Shetland Islands, the Western Isles and the Inner Isles as reported in Chapman, (2006). Coastal Shellfish Resources and Fisheries in SEA 7 [(22)].

Cockles are found in sandy and muddy intertidal areas. Cockle fisheries are known to occur in the Solway Firth as reported in CEFAS, (2005) Provision of Fishing Activity Data for the DTI Strategic Environmental Assessment No 6. [(23)], Sanday in the Orkney Islands and on the beaches of Barra as reported in Chapman, (2004) Northern North Sea Shellfish and Fisheries [(24)]. Cockles can be harvested by hand or by dredging – although dredging is not permitted in some areas.

Scallop fishery (King, Great and Queen) occurs in Orkney and Shetland and also in coastal waters along the western seaboard of Scotland, including the North and South Minches, the Western Isles, Skye, Mull, Islay, and Jura. They are typically caught by mechanical scallop dredge gear from large vessels which range in length from 10 – 30m. Islay is known for its scallop fishing and a number of the vessels operating out of Port Ellen are actively engaged in this form of fishing activity.

Edible and Velvet Swimming crabs occupy the same types of habitat as the common lobster, as well as less coarse sediments such as gravel, sand and sometimes mud. The shore crab can be found in the intertidal zone and in water depths between 5 and 30m. Crabs are typically caught by fleets of creels. The main grounds are understood to be in inshore waters around Orkney, Shetland, Skye, Mull, Islay and Western Isles with some large fishing vessels operating in the waters to the west of the Western Isles.

7.1.2.2 Mariculture

Fish

There are over three hundred fish farms in Scottish coastal waters the bulk of which produce salmon. The nearest finfish farms to the proposed development are on the island of Gigha approximately 60km directly to the east.

Shellfish

Shellfish including mussels, oysters and scallops are cultivated in Scottish inshore waters. The closest shellfish harvesting area is located in Loch Gruinart in the north of the island approximately 30km direct to the north-east.

7.1.3 Potential Effects

7.1.3.1 Commercial Fishing - Installation

The potential effects of the installation on fish species has been highlighted in previous sections of this scoping document (sections 5.2 and 6.3) and clearly effects on fish species will also potentially have an impact on commercial fishing. Beyond the species effects the key effects identified relating to commercial fisheries during installation is the direct disturbance and potential exclusion from traditional fishing grounds which may be more pronounced during installation than during operation.

7.1.3.2 Commercial Fishing – Operation

Potential operational effects on fish species have been highlighted previous sections of this scoping document (sections 5.2 and 6.3) and clearly any operational effects on fish species such as collision or avoidance will also potentially have an impact on commercial fishing.

In respect of commercial fishing activity within a tidal farm area there are two specific areas of potential impacts i.e. those associated with the cables and the devices themselves.

Snagging a cable represents a safety hazard for the fishing vessel and damaging a cable is an offence under the United Nations Law of the Sea. Therefore it is reasonable to assume that the area in which the cables are installed will not be attractive for mobile, invasive fishing methods (i.e. beam trawls, bottom otter trawls and Scottish seining) once the cable has been installed.

It is understood that DECC are currently considering a proposal that a 50m safety zone be utilised for wind farms and other offshore devices, (reported in Consultation on the Implementation of the Provisions of the Energy Act 2004 Relating to the Establishment of Safety Zones around Offshore Renewable Energy Installations [(12)]). Fishing with pots within the tidal energy farm might be possible provided a sufficient buffer is given to each device; however, any type of net fishing in the vicinity of the tidal devices is potentially hazardous both to the device and to the fishing vessel. The torque developed by these devices is significant and snagging a rotor could result in loss of gear or if the gear cannot be cut free loss of the vessel. What, if any, fishing might safely take place within a tidal farm is a question which requires further discussion and consultation.

For the purposes of the EIA it is assumed that all fishing vessels but particularly those operating trawl and seine nets will be displaced from the entire area. This will be reviewed as the consultation proceeds.

7.1.3.3 Commercial Fishing – Decommissioning

The same potential effects are considered to occur as per installation.

7.1.3.4 Mariculture

Given the distances from the proposed development to mariculture sites, there are not considered to be any potential effects.

7.1.4 Scope and Methodology – Commercial Fisheries and Mariculture

The interactions between the proposed development and the commercial fishing industry will be examined for the purpose of:

- Identifying the economic importance of species caught in the vicinity of the proposed development;
- Identifying the types and nationalities of fishing vessels likely to be affected;
- Assessing the operational characteristics of fishing vessels;
- Examining the commercial exploitation patterns of these vessels; and
- Assessing the potential economic disruption/benefits in loss/gain in income.

Continued consultation with Marine Scotland, CEFAS, The Scottish Fishermans Association (SFA) and local fishing communities will be undertaken. Analysis of catch data will be assessed in order to establish a comprehensive overview of fishing patterns and species in the area concerned.

Discussion with the local fishermen will also be undertaken to gain a better understanding of the local fishing grounds and record their views on the development of the fish stock in the area during construction and operation.

On the basis of a good understanding of fishing patterns and species present in the area, and on a dialogue with local fishing industry representatives and SFA, further steps will be taken to come to an understanding on future co-existence between fishermen and the proposed development.

7.2 Marine and Coastal Historic Environment

7.2.1 Introduction

The historic environment in the vicinity of the proposed development can be broken down into two sections:

- The marine environment including archaeological remains and wrecks (tidal farm and subsea cable); and
- The coastal environment including archaeologically designated areas, scheduled ancient monuments (SAM), listed buildings and archaeological remains (control building and onshore grid connection).

7.2.2 Current Knowledge

7.2.2.1 Marine Environment

There is no information available regarding submarine archaeology with regards to the site or proposed cable route.

With respect to wrecks, not surprisingly, there are a significant number of wreck sites around the Islay coastline. However, none of these sites have been identified as sites designated as military remains, ancient monuments or protected wrecks in the UK.

There is evidence of one wreck on the proposed development area identified as the SS Norman, which reportedly sank on the 25th May 1900. The positional accuracy of the ship is said to be unreliable.

7.2.2.2 Coastal Environment

There is no current information on the coastal historic environment for the potential cable landfall and substation/control building location.

7.2.3 Potential Effects

7.2.3.1 Marine Environment

Installation – Tidal Devices and Subsea Cable

During installation of devices and cables, submarine historic sites, wrecks and remains in the vicinity of installation operations could be impacted in the following ways:

Major Operations (piling, dredging, placing structures on seabed) - There is a potential for significant impact causing destruction of sites and artefacts, both surface and buried.

Displacement/dumping of Waste Material - While most dumped material is unlikely to cause damage to any but the most fragile artefacts, there is a risk of damage when large fragments are displaced. Displaced sedimentary material might bury a site delaying or preventing discovery.

Cable Laying Operations (trenching) - There is a potential for impact, causing damage to sites and destroying artefacts, along the line of trenches.

Exploratory operations (coring) - There is possibility of damaging artefacts. Cores should be inspected for presence of archaeological material.

Operation
None predicted

Decommissioning
Cables will not normally be removed as part of the decommissioning process. The same ground will be disturbed for removal of devices so no potential impacts are predicted.

7.2.3.2 Coastal Environment

Installation – Cable Trench and Substation/Control Building
Construction work involving groundbreaking has the potential to damage or destroy sites of cultural heritage interest, both known and unknown. In addition, sites, in particular those with upstanding elements are vulnerable to accidental damage by uncontrolled activities, such as the movement of plant.

Operation
Once constructed, there is the risk of potential impact from a visual perspective from scheduled ancient monuments (SAM) and designed gardens and landscapes.

Decommissioning

Underground cables will not be removed as part of the decommissioning process. The same ground will be disturbed for removal of the control building so no potential effects are predicted.

7.2.4 Scope and Methodology – Marine and Coastal Historic Environment

7.2.4.1 Marine Environment

The exact location of wrecks within the search area and along the subsea cable route will be identified and mapped during the EIA.

The following sources will be consulted to determine the presence of wreck sites and other submarine archaeological material:

- UK Hydrographic Office; and
- The Receiver of Wrecks (Maritime and Coastguard Agency).

The Bathymetric Survey, side-scan/ Geophysical Survey will be discussed with an appropriate qualified archaeologist and the results will be archaeologically assessed.

The assessment will identify direct and indirect potential impacts in terms of the sensitivity of the location, predicted magnitude of the impact and potential significance on the feature.

7.2.4.2 Coastal Environment

A desk based study will be conducted along potential route corridors to identify potential cultural heritage impacts and an optimum route. The following sources will be consulted to determine the presence of cultural heritage features:

- The Schedule of Ancient Monuments (SAM), The Statutory List of Buildings of Special Architectural or Historic Interest and the Inventory of Historic Gardens and Designed Landscapes (HGDL) maintained by Historic Scotland;
- The National Monuments Record of Scotland (NMRS);
- The Argyll and Bute Council Sites and Monuments Record (SMR);
- The Aerial Photographic Collection of the Royal Commission for the Ancient and Historical Monuments of Scotland (RCAHMS);

- Superceded Ordnance Survey maps and pre-Ordnance Survey maps held in the Map Library of the National Library of Scotland; and
- The National Archives of Scotland.

The assessment will identify direct and indirect potential impacts in terms of the sensitivity of the location, predicted magnitude of the impact and potential significance on the feature.

7.3 Cables and Pipelines

7.3.1 Introduction

In addition to international submarine telecommunications and major electricity interconnector cables, there are a number of smaller submarine telecommunications and power cables linking island communities to the systems of the Scottish mainland.

Oil and gas pipelines are less frequent and are typically confined to areas of high oil and gas productivity.

It is assumed that devices would need to be installed away from any active cables or pipelines.

7.3.2 Current Knowledge

From the Scottish Marine SEA (2), three data sources have been used to identify the location of cables and pipelines in the search area. The location of cables and pipelines formed part of the initial constraints pre-scoping assessment undertaken specifically for the site as reported in the Extended Tidal Technology Constraints Assessment – South West Islay, July 2008 [(6)].

7.3.2.1 Kingfisher Cable Awareness Charts (KISCA).

These charts show the locations of, and give the co-ordinates for, a number of national and international cable systems. Cable owners subscribe to KISCA to include details of their cables on these charts. The aim of this initiative is to reduce the risk of fishing vessel/cable interactions that can cause damage to the cable system and present a health and safety risk to fishing vessels.

7.3.2.2 UK Digital Energy Atlas Library (UKDEAL)

Data is recorded that gives the location of oil and gas installations around the UK including pipelines.

7.3.2.3 SeaZone Digital UK Hydrographic Office Digital Charted Data.

This gives the locations of cables shown on Admiralty Charts. This data does not indicate the status (i.e. whether it is active or out of use) of the cables.

For the purpose of this assessment it will be assumed that those cables identified are still located in their reported positions on the seabed and are active.

From the information reviewed to date, there are no cables or pipelines in the vicinity of the proposed development or subsea cable corridor to Islay.

7.4 Military Exercise Area

7.4.1 Introduction

The assessment of military activities in the study area is informed by the distribution and classification of Practice and Exercise Areas (PEXA). The PEXA information is produced by the UK Hydrographic Office and shows areas around the UK which are in use or available for use by the MOD for practice and exercises – which may be with or without the use of live ammunition.

7.4.2 Current Knowledge

Much of the west coast of Scotland (and the north coast of the mainland including the Pentland Firth) lies within a military exercise area. This area includes the proposed development site. Within this area Figure C13.2 of the Scottish Marine SEA (2) indicates defined areas which are likely to have varying degrees of significance on military activities. Major or Not Significant sites are indicated (although none are identified in the intermediate categories of Moderate or Minor). However, by far the largest area is indicated as of Unknown significance. The Islay proposal falls within this area.

For obvious reasons military information is often sensitive and therefore published datasets are general in nature. This means that it will always be necessary to consult with the Ministry of Defence (MoD) about any precise deployment locations and consider how the installation, operation and decommissioning of the development may be affected by military activities.

7.4.3 Potential Effects

7.4.3.1 Installation

Temporary disruption to military exercises and activities during installation of devices and subsea cable connections may occur as there will be safety areas around activities which may cause military vessels to have to modify their routes and activities around the installation area.

It is also possible that other activities such as firing practice could be disrupted although it is noted that the Islay is not one of the sites indicated as a Danger Area for live firing or bombing.

7.4.3.2 Operation

It is not expected that cables from the array to the shore will have any noticeable long term effect on military activities. However, if a device array is located close to or within a practice or exercise area this could potentially have a long term effect on military activities.

7.4.3.3 Decommissioning

As per section 7.4.3.1 except that subsea cables will be left in situ following decommissioning.

7.4.4 Scope of Work – Military Exercise Area

DPEM will consult closely with the MoD to enable military activities in the development area to be assessed as part of the EIA process.

7.5 Disposal Sites

7.5.1 Introduction

The deposit of substances or articles in the sea or under the sea-bed within UK territorial waters or controlled waters is regulated by licensing under Part II of the Food and Environment Protection Act 1985 (FEPA) (as amended). The main purposes of Part II of FEPA are the protection of the marine environment, the living resources that it supports and human health; and to prevent interference with other legitimate sea users. In Scotland, Marine Scotland is the licensing authority, on behalf of the Scottish Ministers, with regard to activities below the tidal level of mean high water springs (MHWS).

7.5.2 Current Knowledge

Based on information provided from the FRS (now Marine Scotland) to inform the Scottish Executive Marine Renewables SEA, there are no disposal sites in the vicinity of the proposed development site. There are several silt, sand, gravel or rock disposal sites identified off the south tip of the Rhinns of Islay but these are considered to be at least 5km from the tidal farm location. They are however in close proximity to the subsea cable route to a coastal area in the vicinity of Portnahaven.

7.5.3 Potential Effects

7.5.3.1 Installation – Subsea Cable

Direct disturbance of previously disposed material where the subsea cable is located. The effects of disturbing contaminated sediments are discussed further in section 5.3. Strictly speaking, this is not an effect on the activities associated with the disposal site, but it is relevant in terms of potential effects on marine wildlife located in the vicinity of any disturbed sediment. These effects are discussed in section 6.2 – Benthic Ecology, section 6.3 – Fish and Shellfish, section 6.4 – Marine Birds and section 6.5 – Marine Mammals.

7.5.3.2 Operation

The only potential impact considered during operation is the exclusion to disposal that the tidal farm and subsea cable will create.

7.5.3.3 Decommissioning

The only potential impact considered during decommissioning is the exclusion to disposal that the tidal farm and subsea cable will create.

7.5.4 Scope and Methodology – Disposal Sites

Consultation will take place with Marine Scotland to enable a detailed assessment of the exact location and type of disposal site for optimum routing of the subsea cable corridor.

7.6 Commercial Shipping and Navigation

7.6.1 Introduction

This section gives information on current commercial shipping movements in and around the proposed development and considers the sensitivity of shipping and navigation before considering the potential significance of effects on shipping and navigation. Movements of recreational vessels are considered within section 7.7 Socioeconomic Impacts.

7.6.2 Current Knowledge

Recognising that there is considerable scope for interaction between tidal energy farms and all forms of shipping, a detailed study into shipping traffic movements and potential risk to navigational safety was commissioned by the Scottish Executive to inform the SEA. The full report on shipping and navigation is presented in the SEA under Appendix C15.A – Study 3: Shipping and Navigation, Marine and Risk Consultants Ltd, February 2007 [(25)].

Many of the identified key tidal areas of Scotland occupy locations are constrained by landform (which in essence is why they have tidal resource). Thus where these areas provide important passage routes for shipping the traffic is also similarly constrained and traffic density can be significant. Figure C15.9 of the Scottish Marine SEA [(2)] indicates defined routes and the routes are classified Major to Minor (and Not Significant) where they are likely to have varying degrees of significance on vessel movements.

The Islay proposal falls on the edge of a corridor defined as of Major Significance. This corridor indicates the approach (and exit) routes for vessels lining up to enter the North Channel and the TSS and are based on existing AIS shipping tracks and therefore generally indicates a preferred route for vessels on this approach. In practice this would mean nominally taking the shortest route to the entry of the TSS commensurate with good seamanship (i.e. subject to sea state, weather and other traffic). Further west traffic density is clearly lower and impacts are defined as Minor. It is assumed that this reflects the relatively open nature of the waters off the Islay coast when compared for example with those of the Pentland Firth or the North Channel itself.

The main port on Islay is at Port Ellen some 28km to the southeast of the proposed development area. Port Ellen is used by fishermen (particularly for scallop, lobster and crab), some commercial shipping and the Kennacraig Ferry from the mainland.

The RNLI lifeboat is stationed at Port Askaig in the Sound of Jura some 60km from the site.

7.6.3 Potential Effects

Effects on shipping and navigation can be categorised as effects on safety, and effects on issues related to economics such as journey times and distances, and trade. In terms of safety it is important to note that there are various rules, regulations and guidelines that relate to safety of navigation with regards to any offshore development that are in place to help prevent casualties and collisions.

7.6.3.1 Installation

Increased Journey Times and Distances
During installation there will be exclusion or avoidance zones in operation around activities for the purposes of safety. The introduction of installation vessels and equipment into the study area will require vessels to move around the construction activities potentially increasing journey times and distances.

Displacement of Shipping Density
The safety zones that will be in place during construction activities may affect shipping density although this will have the most significant effect in constrained waters.

Reduced Trade Opportunities
Temporary reduced access to ports and harbours may occur during construction activities in some island locations and this has the potential to have an adverse effect on trade and supplies.

Reduced Visibility
The presence of installation vessels, barges, jack-up rigs and other construction equipment has the potential to obstruct the view of other vessels, navigation features such as lights and buoys and the coastline. This could cause a hazard to shipping in areas where visibility is

particularly important for navigation or areas where the topography already constrains visibility.

Collision

The presence of slow moving or stationary installation vessels and equipment is likely to affect the probability of close quarter encounters and collisions with both vessels moving under power and drifting vessels. The presence of construction activities also has the potential to cause small and recreational vessels to modify their routes to use areas transited by larger vessels, which potentially increases the risk of encounter or collision. In the event of a collision occurring there is a risk of extensive and serious environmental impacts associated with the spillage of oil and hazardous cargo's.

Search and Rescue

Search and rescue exercises and operations may take place throughout the study area. The planning of such activities would need to be adapted to take into account the presence of installation equipment. In addition, the installation of marine renewable energy devices could impact on the use of radar for navigation due to the presence of construction equipment above the sea surface.

7.6.3.2 Operation

The effects of the operation of marine renewable energy devices upon shipping and navigation are very similar to the installation effects as it is assumed that the exclusion or avoidance zones defined as part of the consent will apply to operational activities as well as installation.

7.6.3.3 Decommissioning

The effects of decommissioning the tidal development upon shipping and navigation will be similar to those experienced during the installation.

7.6.4 Scope and Methodology – Shipping and Navigation

A review of shipping activities will be undertaken including consultation with local port and harbour authorities, the MCA and the Northern Lighthouse board. Once complete, a detailed survey and analysis will be carried out in accordance the DECC guidance and the MCA's MGN 275 to determine risks and impacts.

Up to date traffic survey in the area will be established. This should include all vessel types and will probably take at least four weeks, but also taking account of seasonal variations in traffic patterns. These variations will be determined in consultation with representative recreational and fishing vessel organisations. The survey will assess the proposed tidal development in relation to areas used by any type of marine craft:

- Numbers, types and sizes of vessels presently using the area including transit routes;
- Non-transit uses of areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc;
- Whether the nearby area contains prescribed or conventionally accepted separation zone between two opposing routes;
- Proximity of the site to areas used for anchorage, safe haven or port approaches, and fishing grounds;
- Proximity of the site to existing or proposed offshore oil or gas platforms, aggregate dredging or other exploration or exploitation sites; and
- Aids to navigate in the area.

On such basis mitigation measures will be analysed and proposed in close dialogue with MCA and other relevant authorities.

Consultations will also take place with the local RNLI to assess possible risks and any potential conflicts associated with rescue activities within the local area.

7.7 Socio-Economics

7.7.1 Introduction

The EIA will consider the socio-economic context of the proposed development upon the local economy and Scotland as a whole. Potential impacts from the proposed development on human beings, focussing on issues such as existing economic activity, land use, tourism, amenity and health and safety will be examined.

Islay is an area of great natural beauty attracting visitors who enjoy pursuits such as walking and bird watching. The whisky industry is a major part of Islay's economy being the second biggest employer after agriculture. There are seven operational distilleries on the islands of Islay and Jura as well as one maltings.

7.7.2 Current Knowledge

7.7.2.1 Islay – General Statistics

The island of Islay lies off the west coast of Scotland at a latitude of 55 45N and a longitude of 06 16W in the council of Argyll and Bute. The island covers an area of around 600 square kilometres with the highest point at 491m (Beinn Bheigeir). The main settlements are at Bowmore, Port Ellen, Portnahaven, Bridgend and Port Askaig.

The population in 2002 (including Jura and Colonsay) was around 3700 occupying around 1700 households. These figures are projected to change to around 3600 people living in 1800 households over the coming year as reported in the Argyll and Bute Local Plan [(13)].

7.7.2.2 The Existing Economic Environment

The key elements, which might be used to describe the socio-economic environment, are linked primarily to employment and land use but also to the cultural history of the area and the people. With reference to the General Register Office for Scotland (2003), the following summary information is defined for Argyll and Bute:

- Administration, defence and social security – 17%;
- Health and Social Work – 12%;
- Wholesale and retail trade and repairs – 12%;
- Real Estate, renting and business – 8%;
- Hotels and restaurants – 8%

- Manufacturing – 7%;
- Construction – 7%;
- Transport, Storage and Communications – 7%;
- Education – 6%;
- Agriculture, hunting and forestry – 5%; and
- Fishing – 2%

Tourism is one of Scotland's largest business sectors with an estimated value of £4.2 billion per annum to the Scottish economy. In 2004, the tourism sector accounted for 8.8% of all employment in Scotland and in some regions much higher.

Scotland's coastline and islands play an influential role in attracting tourists and recreational users to the country through the provision of stunning scenery, wildlife, cultural assets and a wide range of organisations providing a variety of sports and activities. Some of these activities, and others, are offered in and around Islay and categorised as follows:

- Touring and Site Seeing (including whisky distilleries);
- Walking;
- Sailing;
- Golf;
- Water sports (including surfing, kayaking and swimming);
- Diving;
- Angling; and
- Bird & Wildlife Watching.

7.7.3 Potential Effects

The marine environment, landscape and resources play an important role in many tourism and recreation activities in Scotland. Therefore, any impact on the coastal or marine environment through the installation, operation or maintenance of tidal turbines could potentially have an effect on the tourism industry and recreation.

7.7.3.1 Installation

Noise

Noise generated during the installation of the marine devices will potentially have direct and indirect effects on recreation and tourism, although the effects will only be short term. The main sources of construction noise include:

- Vessels;
- Piling;
- Movement of machinery/device components;
- Installation of machinery/device components;
- Cable trenching; and
- Construction of Substation/Control Building.

The main direct effects of installation noise is related to general disturbance that will be experienced by visitors to key coastal attractions/locations e.g. beaches and coastal paths, and participants in key coastal and marine recreational activities e.g. golf, sailing, swimming and water sports. Installation noise may have adverse effects on the breeding, feeding and migratory patterns of marine wildlife and seabirds, leading to their displacement or avoidance of areas. This could potentially have an indirect effect on the marine wildlife watching industry and bird watchers. The effect of noise on marine wildlife is discussed in more detail in section 6.4: Birds, section 6.5: Marine Mammals and section 7.8: Noise.

<u>Transportation</u>
There will be a requirement, as part of the installation process, for the transportation of the various components of the marine devices. This will include the movement of device components from the point of production to a port or coastal location for transfer onto deployment vessels. The main effects associated with the transportation of large pieces of machinery include congestion caused by large, slow moving vehicles, increased noise, vibration, air pollution and general environmental disturbance. Due to the predicted size of the marine devices, most will require deployment from harbours that can accommodate vessels with sufficient loading capacity for device deployment. In most cases, access routes to these harbours have been designed to accommodate the movement of large vehicles. There is also potential that the marine vessels could disrupt sailing routes, fishing activities and other water sports.

Landscape, Seascape and Visual Amenity

The effects on landscape, seascape and visual amenity are discussed in section 7.10. The landscape, seascape and views around the Scottish coastline are intrinsic to the area's ability to attract tourists and visitors. Installation activities (including onshore connections) may temporarily affect the general attractiveness of certain areas which could potentially affect visitor's perceptions and enjoyment of an area.

Access Restrictions

In the interests of efficiency and safety, installation activities may involve some restriction of public access to areas where construction is underway. Depending on location, this may affect sailing activities, diving, open water swimming, water sports and wildlife watching.

Water Quality

The effects of the deployment of marine devices on water quality are discussed in section 5.3. In terms of the installation of devices there are a number of potential sources of water pollution including:

- Release of contaminated materials during piling, drilling or grouting;
- Fuel spillage;
- Leakage of device lubricants, hydraulic oils; and
- Antifoulants.

Any water pollution arising from the installation of devices could potentially affect bathing water quality and local beaches.

7.7.3.2 Operation

Noise

As with installation noise, operational noise may have an adverse effect on the breeding, feeding and migratory patterns of marine wildlife and seabirds, leading to their displacement or avoidance of areas. This will potentially have an indirect effect on the marine wildlife watching industry and bird watchers.

Landscape, Seascape and Visual Amenity

The effects on landscape, seascape and visual amenity are discussed in section 7.10. The landscape, seascape and views around the Scottish coastline are intrinsic to the area's ability to attract tourists and visitors. The presence of marine devices in certain locations may affect the people's perceptions and enjoyment of an area.

Safety and Collision Risk

The effect of marine devices in terms of safety and collision risk is discussed in section 7.6 in relation to shipping and navigation, section 6.5 with respect to marine mammals section 6.4 in relation to Birds. Submerged, partially submerged and sub-aerial devices all present a potential hazard to other users of the marine environment as collisions could cause damage to vessels and danger to the health and safety of people in the area. Increased risk of collision with structures at sea could act as a deterrent to recreational sailors or water sports enthusiasts.

Access Restrictions

In order to avoid potential collisions, areas in which devices are located may require access restrictions to be imposed. Such restrictions may have a negative effect should they prevent access to specific sites or areas of coastline which are of special interest. The Royal Yachting Association (RYA) has identified a number of potential effects associated with renewable energy projects including loss of cruising routes, being 'squeezed' into commercial navigation routes and effects on sailing and racing areas (RYA's Position on Offshore Energy Developments, December 2005). Informal activities such as kayaking may also be affected in similar ways.

Disturbance to Wildlife

As mentioned previously in terms of noise and vibration, the operation of marine devices may lead to the disturbance and potential displacement of marine wildlife or seabird. Other factors potentially affecting marine mammals and birds include: habitat loss; disturbance, disruption or loss of food sources and feeding areas; physical severance or obstruction of migratory routes; population pressures if certain species are forced into smaller areas or predator habitats. The displacement of marine wildlife or birds could have negative effects on marine wildlife watching operators and bird watchers. The effects of marine devices on marine mammals and birds are discussed in detail in section 6.4: Birds and section 6.5: Marine Mammals.

Energy Extraction and Effects on Coastal Areas and Beaches

The potential implication of energy extraction on recreation and tourism are associated with how energy extraction affects coastal processes and how these effect local beaches. The effects of energy extraction are discussed in section 5.3: Marine and Coastal Processes with regard to marine processes.

Creation of Tourist Attractions

There is potential that the marine devices themselves could have positive effect on recreation and tourism by becoming key tourist attractions. With increased awareness of climate change and the opportunities for gaining first hand experience of the evolution of new technologies, the attraction of marine devices which are accessible (and visible) could be potentially high in the short-term. Interest is likely to decrease as wave and tidal power become more commonplace.

7.7.3.3 Decommissioning

The effects of decommissioning the tidal development on the socio-economic environment are very similar to the installation effects.

7.7.4 Scope and Methodology – Socio-Economic

A detailed assessment will be undertaken focussing on Islay and Argyll and Butes economic status with desk based studies and interviews with key industries, organisations and individuals in the region. A tourism assessment will also be undertaken on Islay to provide a baseline and analysis of potential impacts associated with the proposed development.

Consultation will take place with key consultees including:

- Argyll and Bute Council;
- Visit Scotland;
- The Royal Yachting Association;
- Islay Community Council; and
- Relevant parties associated with recreation and tourism on Islay.

7.8 Noise

7.8.1 Introduction

Although noise is discussed within many of the chapters above there is little specific information pertaining to the potential effects of tidal device noise on its environment. As part of the Scottish Marine SEA [(2)], QinetiQ have undertaken a specialist study presenting findings on underwater ambient noise, underwater noise from the operation of marine renewable devices and the potential impact of this noise. However, a generic study was undertaken over the SEA area and is not specific to a particular area or type of tidal device.

Further studies may be required to characterise the baseline or ambient noise in the proposed development area, provide predictive noise propagation from a single and array of devices and to predict the potential impact to the environment (mainly mammals and fish).

7.8.2 Current Knowledge

As reported in the QinetiQ report Underwater Noise Study Supporting Scottish Executive Strategic Environmental Assessment for Marine Renewables [(26)] there is little historical information available on marine device noise and its effects.

7.8.3 Potential Effects

7.8.3.1 Installation

The key sources of noise related to site preparation and device installation are broadly similar to those investigated for offshore wind farm construction these are:

- Shipping and machinery;
- Dredging; and
- Pile driving or drilling.

Additionally, cable burial may require the use of trenching or jetting machinery in soft sediments, rock cutting machinery in hard sea-beds, or rock or concrete mattress laying may be used to protect cables in areas where they cannot be buried.

7.8.3.2 Operation

The dominant operational noise propagation will be from the rotating equipment through its blade interaction with the sea. Additional mechanical and electrical noise sources are likely to be transmitted to the sea via direct coupling and from the interaction of the device structure with tidal currents. Additional noise will be propagated from service vessels during operation and maintenance activities.

7.8.3.3 Decommissioning

The noise effects of decommissioning the tidal development upon the environment are very similar to the installation effects except that piling or drilling which have been identified as major sources or noise, will not be required.

7.8.4 Scope and Methodology

7.8.4.1 Recommendations

As part of the study conducted by QinetiQ, a number of recommendations have been made regarding specific detailed underwater noise studies including; baseline assessments and device predictive noise maps. Using these predictions the study proposed that where the predicted noise was expected to be in excess of local ambient noise levels then an impact assessment would need to be undertaken on marine receptors.

As part of the recommendations the QinetiQ study also proposed that continuous or routine *in-situ* underwater noise measurements be carried out at development sites, to monitor for increases in noise level due to the development of fault conditions in the deployed device(s) during operation. This would enable the early detection of potentially harmful levels of underwater sound as well as facilitating timely repair of mechanical faults. Mitigation measures should be in place, for example the facility to shut down the device(s) on detection of noise levels above some threshold.

7.8.4.2 Definition of Scope and Methodology

Consultation with statutory consultees will enable a detailed scope and methodology to be produced identifying the number and location of measurement sites, the data sample times and format for the ambient noise field. Additional consultation regarding a standard for noise propagation characterisation from a single tidal device and arrays will also need to be agreed.

7.9 Electromagnetic Field (EMF)

7.9.1 Introduction

Power cables for transmitting electricity produce electric and magnetic fields as a result of the current passing along the conductor and the voltage differential between the conductor and earth ground, which is nominally at zero volts. The nature and strength of the fields produced depends on the system voltage and current (AC or DC) passing through. The effects on the surrounding environment depend on the cable construction, configuration and orientation in space.

Electric fields produced around the conductor are effectively contained within the cable envelope by the screening effect of the cable sheath and armour wires. However the materials making up the cable are permeable to the magnetic fields, which will permeate into the surrounding environment.

7.9.2 Technical Definition

COWRIE (CMACS September 2005) proposes the following terminology, to standardise descriptions, which is adopted in this report.

EMF should be used to describe the direct electromagnetic field. The two constituent fields of the EMF should be clearly defined as the E (Electric) field and the B (Magnetic) field, whilst the induced electric field should be labelled (iE) field. In summary the E field will be retained within industry-standard cables. The B field is detectable outside the cable and induces an iE field outside the cable.

7.9.3 Background Information

As part of the SEA a requirement to consider EMF in a marine environment was defined. Research was undertaken by Cowrie in three phases to inform the SEA of the potential impacts of EMF on the environment.

7.9.3.1 Cowrie Phase 1 report (CMACS July 2003)

This report calculated the strength, frequencies and wavelengths of the electromagnetic fields produced by 33kV (EPR) and 132kV (XLPE) AC cables. The study also calculated the effects of burial and/or shielding on electromagnetic fields. The report concluded that the electric and magnetic fields generated by sub marine cables such as those associated with offshore wind farms are within the range of detection by certain aquatic species. However no clear scientific guidance on the effects on receptor species could be provided without further work. Best practice guidance for developers on the mitigation measures required for offshore and intertidal cabling was provided.

7.9.3.2 Cowrie Phase 1.5 report (July 2005).

This study explored whether the interaction between the fish and artificial fields will have any consequences for the fish. "The study found that there are fish species present at development sites which may respond to anthropogenic sources of E field. Although the information available on magnetosensitive species is limited, it does suggest that potential interactions with a number of UK coastal organisms could occur from the cellular through to the behavioural level. The study presents a list of species that are most likely to interact with offshore wind farm generated EMFs. It also offers practical guidance for developers in terms of suitable monitoring that may be undertaken and an overview of possible survey methods for electrically and magnetically sensitive species, their advantages and disadvantages"

7.9.3.3 Cowrie Phase 2 Consultation report (April 2006).

This report proposes a method for future studies on the characteristics of electromagnetic fields produced by windfarm power cables on the natural environment. Interim progress reports have been issued in January and June 2007, however, the final report is yet to be released.

7.9.4 Potential Effects

7.9.4.1 Introduction

The detailed electrical design is yet to be completed and consequently the following is based on a generic electrical design. Details will be considered further in the EIA as the design process develops.

7.9.4.2 Installation

Although there may be electrical/magnetic fields associated with installation equipment this is not expected to be significantly different than for normal vessels.

7.9.4.3 Operation

Inter-Device Cables

These cables collect the power from all of the turbines and bring it to one or more “collection” points from where it is transported to shore. Cables within the tidal farm arrays will generally be at lower voltages than the main export voltage. Around 33kV would be typical.

Export Cables from Device Array to Shore

The array-to-shore cables transmit the power to shore. The electrical parameters of these cables depend on whether the power is transmitted directly to shore or if the power produced by the device array is transmitted to shore at a higher voltage than the collection voltage. In the latter an offshore substation is required, which acts as the collection point within the device array, from which an export cable (or cables) runs to the shore. It has been assumed that export cable voltages will be either 33kV or 132kV (i.e. as for the smaller wind farm projects).

7.9.4.4 Decommissioning

Although there may be electrical/magnetic fields associated with decommissioning equipment this is not expected to be significantly different than for normal vessels.

7.9.5 Scope and Methodology - EMF

In order to assess the impacts of electric and magnetic fields from a device array it is necessary to have specific details of the project in order to determine electric and magnetic field strength e.g.

- the power output of the devices and of the total array;
- the planned operational voltages of the cables;
- the shape of the array and the cabling between the devices;
- the characteristics of the planned cable and burial profile; and
- speed of water movement across the cable (to calculate iE fields).

With this information field strengths will be calculated. Then an assessment of the potential impact on species specific to the areas in question can be undertaken. Mitigation methods may be employed to reduce the potential impact if species sensitive to induced EMF are identified in the area.

7.10 Landscape and Seascape

7.10.1 Introduction

The substation/control building and the potential deployment of surface piercing tidal turbines at sea (seascape) are two distinct areas where potential visual effects may result from the proposed development and therefore require assessment.

7.10.2 Current Knowledge

7.10.2.1 Landscape

SNH Landscape Assessment of Argyll and the Firth of Clyde [14] describes Islay as having a "diverse landscape character" due in part to the complex geology of the island.

7.10.2.2 Seascape

In 2005, SNH published a report titled "An Assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Windfarms", commissioned report no 103. With reference to Area 22 West Islay, the report identifies the seascape character type as "Predominantly Type 13 – Low Rocky Island Coasts with areas of Type 12 – Deposition Coasts of Islands".

The Scottish Marine Renewables SEA describes the west facing coastline on Islay as "Rugged Coastal Shelf and Headlands with Open Views to Sea" and has assessed the proposed development area as of moderate potential impact for surface point structures on seascape at distances greater than 5km from the shore.

7.10.3 Potential Effects

7.10.3.1 Installation

This is a temporary effect for both the marine farm and onshore infrastructure associated with the presence of construction vehicles and equipment.

7.10.3.2 Operation

Substation/control building

There may be visibility of the substation/control building from potentially sensitive viewpoints.

Marine Farm

There may be visibility of the Marine Farm from potentially sensitive viewpoints and there is the potential for the proposed development to influence the seascape.

7.10.3.3 Decommissioning

Decommissioning effects are likely to be as per installation though over a shorter period of time.

7.10.4 Scope and Methodology – Landscape and Seascape

7.10.4.1 Landscape (Grid Connection)

A detailed assessment of the substation location options will be carried out as part of the LVIA. This will include a baseline study of the landscape character, identification of both landscape and visual amenity receptors and assessment of potential impacts leading to recommendations for a preferred location and related configuration. This will be supported by illustrations showing the preferred location on photographs of existing views from receptors.

7.10.4.2 Seascape (Tidal Farm)

Although it is possible that non surface penetrating devices may be selected for the development, a Seascape EIA is proposed.

The assessment will be undertaken as defined in section C19.2.3 of the Marine SEA and following consultation with SNH. However, the following summary methodology and approach are proposed.

Seascape effects will be assessed within a 15km radius study area. A seascape character assessment will establish the baseline conditions, and examine the sensitivity of the seascape and surrounding study area to change associated with the development of a tidal farm.

Visual effects will be assessed using a Zone of Visual Influence (ZVI) map and a viewpoint analysis. A draft ZVI will be prepared to a 15km radius, which will indicate the theoretical visibility of the proposed tidal farm. The visibility from receptors will be described and a viewpoint assessment carried out to determine the effect of the tidal farm on specific receptors and viewpoints in the study area.

- Desk Study;

- Initial Field Survey;
- Preliminary Identification of Viewpoints to be Included in the LVIA;
- Confirmation of the Scope and Methodology with SNH and A&BC;
- Detailed Field Survey and Photography;
- Seascape Character Assessment;
- Seascape and Visual Impact Assessment;
- Identification of Mitigation Measures Including Design Layout;
- Reporting on Residual Seascape and Visual Impacts and their Significance;
- Confirmation of Layout with Representatives from SNH and A&BC prior to Submission of a planning application.

The LVIA will be supported by a series of illustrations including a Seascape Character Assessment Plan, ZVI's, photomontages and wireline diagrams showing existing and predicted views of the proposed tidal farm at specific locations in the study area.

8.0 Environmental Management Plan

Summary findings of the EIA which might have an effect on the environment will be reported in the Environmental Statement (ES). DPEM will ensure that actions are taken to minimise any possible effect during monitoring and liaise with other relevant users of the area.

The ES will detail proposals and procedures for environmental management during construction, operation and decommissioning of the tidal energy farm. This will include proposed mitigation measures and additional post construction monitoring as required.

The project will be operated in a responsible manner consistent with the high standards set by DPEM with respect to quality, health, safety and the environment (QHSE).

9.0 List of Consultees

The following preliminary list of statutory and non-statutory consultees will be updated as the EIA process is developed.

Argyll and Bute Planning Authority
Association of Salmon Fisheries Boards
British Telecom
British Ports Authority
Civil Aviation Authority Directorate of Airspace Policy
Clyde Fishing Association
Crown Estates
Defence Estates (MoD)
Health and Safety Executive
Fisheries Committee
Islay Community Council
Local Councillors
Marine Safety Forum
Marine Scotland
Maritime and Coastguard Agency
National Air Traffic Services
Northern Lighthouse Board
Royal National Lifeboats Institute (RNLI)
Royal Society for the Protection of Birds (RSPB)
Royal Yachting Association (Scotland)
Scottish Environmental Protection Agency
Scottish Fishermans Federation
Scottish Natural Heritage
Scottish Canoe Association

Scottish Government:
Road Network Management and Maintenance
ACEU – Climate Change Team
Water Environment Unit
Planning and Building Standards
Ecology, Research and GIS Unit
Marine Scotland
Historic Scotland
BEER
Marine Nature Conservation & Biodiversity

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2 Scottish Marine Renewables Strategic Environmental Assessment Environmental Report March 2007.

3 www.wavegen.co.uk

4 Tidal Stream Energy Resource and Technology Report (2005)

5 The Highland Renewable Energy Strategy

6 Extended Tidal Technology Constraints Assessment – South West Islay, July 2008

7 Subtidal Survey of Rhinns of Islay, Argyll for DP Energy, September 2008: Final Report.

8 The Benthic Environment of the N and W of Scotland and the Northern and Western Isles

9 CCW Handbook for marine intertidal Phase 1 survey and mapping (Wyn et al. 2000)

10 The Marine Life Information Network for Britain and Ireland (MarLIN).

11 www.snh.org.uk

12 Consultation on the implementation of the provisions of the Energy Act 2004 relating to the establishment of safety zones around offshore renewable energy installations.

13 Argyll and Bute Finalised Local Plan 2006

14 SNH Landscape Assessment of Argyll and the Firth of Clyde: Review No 78, 1996.

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26 Underwater Noise Study Supporting Scottish Executive Strategic Environmental Assessment for Marine Renewables” by S D Richards, E J Harland and S A S Jones: QINETIQ/06/02215/2, dated January 2007

27 Scotland’s Renewable Resource 2001 by Garrad Hassan.