

## ENVIRONMENTAL EFFECTS METADATA SURVEY FORM

Name

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Project name: MeyGen Tidal Energy Project – Phase I

Project description:

*Project Developer:* MeyGen

*Technology type:* Atlantis Resources' AR1000 and Andritz-Hydro's HS1000

*Resource (wave, tidal):* Tidal

*Project scale (test site, prototype, array, commercial):* Commercial array

*Installed capacity (MW):* 86 MW

*Project Website:* <http://www.meygen.com/>

*Launch Date:* Planned 2015

*Additional Description:* MeyGen are planning to install horizontal axis turbines at the Inner Sound site. The technologies that will be installed selected are:

- Atlantis Resources Corporation: AR1000 - The AR1000 features a single rotor set with fixed pitch blades. The AR1000 can be rotated in the slack period between tides using a yaw drive, and then fixed in place for the optimal heading for the next tide. The AR1000 is designed to produce 1MW in water flows of 2.65m/s and above<sup>1</sup>.
- Andritz Hydro Hammerfest: HS1000 - The HS1000 consists of a horizontal axis rotor, pitched blades and yaw feeding a variable speed conventional generator via a gearbox. Automatic control software governing a sensor-driven monitoring system adjusts the leading edge to capture optimum output from a given tidal environment. It is designed to handle flows between 1 and well above 4 m/s, in water depths down to 100m<sup>2</sup>.

Within the project Environmental Statement, it is stated that turbines at the site will have a rated power between 1.0 and 2.4MW. It is also stated that the turbines will have 2 or 3 blades.

A number of options are being considered with regards to the support structure(s) for the turbines, including:

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<sup>1</sup> Atlantis Resources Ltd., AR1000. Available online: <http://atlantisresourcesltd.com/technology/ar-series/ar1000.html>

<sup>2</sup> Andritz Hydro Hammerfest, Tidal current turbines. Available online: <http://www.andritz.com/hydro/hy-others-andritz-hydro/hy-tidal-current-turbine.htm>

- Gravity based structure (tripod)
- Drilled pin pile tripod
- Monopile

**Export Cables:** It is stated in the ES that each turbine will require its own cable to shore but that an option to use specifically manufactured cables with multiple circuits that allow power from more than one turbine to be exported through a single cable may be possible. It is anticipated that each cable will be brought to shore via horizontal directional drilled (HDD) bores through the bedrock and terminate in a Power Conversion Centre (PCC).

**Onshore Infrastructure:** MeyGen will require an onshore PCC, cable landfall and cable routes from the PCC to the grid connection location. At the PCC, the electricity will be transformed up to higher voltages for export to the national transmission grid. A further connection to the high voltage transmission network with Scottish Hydro Electric Transmission Ltd. has been secured, providing enough capacity to cover a large proportion of the remainder of the Project.

**Vessel Spread:** It is proposed that the following vessels will be required during construction and operation:

Vessel type	Activity	Comment
DP installation vessel	Installation of turbine support structures	Smaller vessels may be present for support services.
	Installation of export cables	
DP installation vessel (or tug)	Install turbines onto support structures	During year 1 and 2 of installation, only one DP vessel will be onsite at any one time. During year 3, two DP vessels may be on site during support structure installation.

**Location:** Inner Sound, Pentland Firth, Scotland.

Coordinates:

58 39 003 06.73' W	58 39 003 07.92'W
59 39 003 08.51 'W	58 39 003 08.52'W
58 39 003 08.38 'W	58 39 003 08.11'W
58 39 003 07.01 'W	58 39 003 06.55'W
58 39 003 06.40 'W	58 39 003 06.51'W
58 38 003 05.55 'W	58 38 003 06.08'W
58 38 003 06.82 'W	58 38 003 07.34'W
58 38 003 07.94 'W	58 39 003 08.51'W

**Process status:** MeyGen secured an Agreement for Lease (Afl) from the Crown Estate for the Inner Sound tidal development site in 2010. This Afl is for a tidal stream development with an installed capacity of up to 398 megawatts. MeyGen plans to consent the project in two phases and complete construction of Phase 2 by 2020.

In 2013, MeyGen was awarded consent from the Scottish Government for the installation and operation of Phase 1 (up to 86MW) and plan to commence construction in 2014. Phase 2 will take place after a

two year 'deploy and monitor strategy' on Phase 1 turbines and will see the build out of the remainder of the project subject to a separate consent application<sup>3</sup>.

A press release on the 2nd February 2015<sup>4</sup> confirmed that the onshore construction of the development has begun with the creation of the 340-metre access road to the onshore site in Caithness. Completion of the access route is expected to take three months, with all onshore construction work being finished by the end of 2015. Additionally a project office in Scrabster harbour is expected to open shortly. The first phase of array construction is planned to be complete and delivering electricity to the grid by the end of 2016. These first phase turbines will consist of four 1.5MW turbines, three supplied by Anritz Hydro Hammerfest and one by Atlantis.

**Licensing Information:** Consent was granted by the Scottish Ministers under section 36 of the Electricity Act for the construction and operation of the development, consisting of 61 turbines with a permitted capacity of up to 86MW. This consent is conditional upon the Company deploying the turbines in stages with Stage One of the development being limited to a maximum of 6 turbines and with all subsequent stages of the development being subject to the prior written approval of the Scottish Ministers.

Licence	Competent Authority	Reference	Date issued	Expiry date
Section 36 (Electricity Act) Consent	Scottish Ministers	TBC	2013	TBC
Marine Licence (Marine (Scotland) Act) Consent	Marine Scotland	04577/14/0	31 January 2014	31 December 2020
Licence to Disturb Marine Species	Marine Scotland	TBC	TBC	TBC
Licence to Disturb Basking Shark	Marine Scotland	TBC	TBC	TBC
Controlled Activities Regulations (CAR) Licence	Scottish Environment Protection Agency	TBC	TBC	TBC
Planning permission (onshore)	Highland Council	TBC	TBC	TBC

**Licensing conditions:**

The following Licence Conditions specific to the Works were listed in the Marine Licence issued<sup>5</sup>:

5.2.1 Prior to the commencement of the works

5.2.1.1 Shielding or burial of cables

The licensee must, no later than three months prior to the commencement of the works, provide the licensing authority for their written approval a report detailing current 'best practice' relating to the attenuation of field strengths of cables by shielding or burial designed to minimise effects on electro-sensitive and migratory fish species. Such 'best practice' guidance as is identified must be incorporated

<sup>3</sup> MeyGen, The project. Available online: <http://www.meygen.com/the-project/> Accessed 31/01/14

<sup>4</sup> Tidal Today. (2015) Tidal industry gets boost from MeyGen kick-off. Available [Online] [http://social.tidaltoday.com/installation/tidal-industry-gets-boost-meygen-kick?utm\\_campaign=TID%2004FEB15%20Newsletter&utm\\_medium=email&utm\\_source=Eloqua&utm\\_source=Newsletter&utm\\_medium=eshot&utm\\_campaign=Tidal&elq=8f7ac3b425fe4c74a6a6a48f24d2e1df&elqCampaignId=852](http://social.tidaltoday.com/installation/tidal-industry-gets-boost-meygen-kick?utm_campaign=TID%2004FEB15%20Newsletter&utm_medium=email&utm_source=Eloqua&utm_source=Newsletter&utm_medium=eshot&utm_campaign=Tidal&elq=8f7ac3b425fe4c74a6a6a48f24d2e1df&elqCampaignId=852). Accessed 05/02/2015.

<sup>5</sup> Marine Licence: <http://www.scotland.gov.uk/Topics/marine/Licensing/marine/scoping/MeyGen/MeyGenMarineLicence>

into the Construction Method Statement, in respect of which condition 9 of the section 36 consent relates.

#### 5.2.1.2 Third Party Verification

The licensee must, no later than three months prior to the commencement of the works, provide the licensing authority with a covering certificate of Third Party Verification of the tidal turbines, sub-structures and all associated ancillary works. Commencement of the works must not occur until the licensing authority has been provided with the covering certificate detailing Third Party Verification.

#### 5.2.1.3 Marine Pollution Contingency Plan

The licensee must, no later than three months prior to the commencement of the works, submit in writing to the licensing authority for their written approval, a Marine Pollution Contingency Plan (MPCP).

The MPCP must make provision in respect of spills and collision incidents occurring during the construction and operation of the works and where such spills or collisions occur then the MPCP must be adhered to in full. The MPCP must take into account existing plans for all operations, including offshore installations that may have an influence on the MPCP. Practices used to refuel vessels at sea must conform to industry standards and to relevant legislation. The MPCP must set out how any oil leaks within the turbine nacelle are to be remedied and that such relevant repairs are required to be undertaken without undue delay. Commencement of the works must not occur until the licensing authority has given its written approval to the MPCP.

#### 5.2.1.4 Commencement date of licensed activities

The licensee must, prior to and no less than one month before the intended commencement of the works, notify the licensing authority, in writing, of the date of commencement of the works authorised under the licence and confirm the date no less than 24 hours before commencement of the works.

#### 5.2.1.5 Ecological Clerk of Works

The licensee must ensure that a suitably qualified and experienced Ecological Clerk(s) of Works (ECoW) / Environmental Manager(s) is, or are, appointed prior to the commencement of the works primarily, but not exclusively, for environmental liaison to establish and maintain effective communications between the licensee, contractors, stakeholders, conservation groups and other users of the sea during the period in which licensed activities authorised under this licence are undertaken. Prior to the commencement of the works the licensee must notify the licensing authority in writing of the identity, contact details and qualifications of the appointed ECoW / Environmental Manager(s).

The licensee must ensure that the ECoW / Environmental Manager(s) environmental remit includes monitoring compliance with the commitments made by the licensee in the Environmental Statement, Supplementary Environmental Information Statement and all plans or programmes required under this licence or the section 36 consent.

#### 5.2.1.6 Navigational safety

The licensee must, as soon as practicable prior to the commencement of the works, notify the UK Hydrographic Office to permit the promulgation of maritime safety information and updating of nautical charts and publications through the national Notice to Mariners system.

The licensee must, as soon as reasonably practicable, prior to commencement of the works, ensure that local mariners, fishermen's organisations and HM Coastguard, in this case Shetland Maritime Rescue Coordination Centre, are made fully aware of the activity through local Notice to Mariners or any other appropriate means.

The works must also be promulgated in the Kingfisher Fortnightly Bulletin to inform the Sea Fish Industry of the vessel routes, the timings and the location of the works and of the relevant operations. All navigational marking and lighting of the site or its associated marine infrastructure will require the Statutory Sanction of the Northern Lighthouse Board prior to deployment.

The licensee must prior to, and no later than one month before the commencement of the works, notify the Clyde Cruising Club to permit the updating of their Sailing Directions and Anchorages publications.

#### 5.2.1.7 Monitoring of marine mammals

Prior to the commencement of the works the licensee must agree in writing the details of the appointment of a Marine Mammal Observer (MMO) with the licensing authority. The MMO must, as a minimum, maintain a record of any sightings of marine mammals and maintain a record of the action taken to avoid any disturbance being caused to marine mammals. The licensee must provide the licensing authority with the MMO's records no later than six months following commencement of the works, and at six monthly intervals thereafter.

#### 5.2.1.8 Cable Installation Plan

The licensee must submit a detailed Cable Installation Plan (CIP), including landfall works for the approval of the licensing authority in consultation with Scottish Natural Heritage, Scottish Environment Protection Agency, the Local Authorities and any other advisors as required by the licensing authority. The CIP must be submitted to the licensing authority at least three months prior to the commencement of the works. The CIP shall include:

- a) The use of geotechnical data to ascertain optimal cable burial depth along the length of the export cable (including works in the intertidal zone);
- b) The methods used for laying the cables minimising, where possible, the use of jetting in the intertidal area;
- c) Detail of cable burial depths;
- d) A burial risk assessment;
- e) The need, type, source quantity and installation method for any scour protection.

The CIP must be incorporated into the Construction Method Statement, in respect of which condition 9 of the section 36 consent relates. Cable installation must not take place until such time as the licensing authority has approved the CIP in writing.

#### 5.2.1.9 Cable Protection Plan

In the event that cable protection is required the licensee must submit a Cable Protection Plan (CPP) for the approval of the licensing authority in consultation with Scottish Natural Heritage, Maritime and Coastguard Agency, Northern Lighthouse Board and any other advisors as required by the licensing

authority. The CPP must be presented in conjunction with work undertaken to identify scour protection /armouring works required to protect the cable. The installation of any cable protection must not commence until the CPP has been agreed in writing by the licensing authority. The CPP must be incorporated into the Construction Method Statement, in respect of which condition 9 of the section 36 consent relates.

#### 5.2.1.10 Pre construction survey

Prior to the commencement of the works, the licensee must undertake a side scan sonar survey in grid lines (within operational and safety constraints), across the area of the works to include the tidal array and cable route. The results of this survey must be made available to the licensing authority within 3 months of the completion of the survey, or as otherwise agreed in writing with the licensing authority, and will be used as the baseline survey should a further side scan sonar survey be necessary in accordance with condition 3.2.2.1.

#### 5.2.2 During the works

##### 5.2.2.1 Transportation audit sheet

The licensee must, on the first working day of the month, create, maintain and submit to the licensing authority a detailed transportation audit sheet for each month during which construction associated with the works takes place. The audit sheet must include information on the loading facility, vessels, equipment, shipment routes, schedules and all materials listed in the licence to be deposited (e.g. piles, pipelines, turbine components, chemicals). Where, following the submission of an audit sheet to the licensing authority, any alteration is made to the component parts of the sheet the licensee must notify the licensing authority of the alteration as soon as practicable following the making of the alteration.

If the licensee becomes aware of any materials on the audit sheet that are missing, or an accidental deposit, they shall contact the licensing authority as soon as practicable after becoming aware to advise the licensee on the appropriate remedial action. If the licensing authority is of the view that any accidental deposits associated with the construction works are present then the deposits must be removed by the licensee as soon as is practicable and at the licensee's expense.

##### 5.2.2.2 Nature and quantity of deposited substances and objects

In addition to the audit sheets required to be submitted to the licensing authority under condition 3.2.2.2, the licensee must, following the commencement of the works, submit audit reports to the licensing authority stating the nature and quantity of all substances and objects deposited below MHWS under the authority of the licence. Such audit reports must be submitted by the licensee at six monthly intervals, with the first such report being required to be submitted on a date no later than six months following the commencement of the works.

##### 5.2.2.3 Navigational safety

The licensee must ensure the UK Hydrographic Office is notified of the works to permit the promulgation of maritime safety information and updating of nautical charts and publications through the national Notice to Mariners system. The licensee must notify local mariners, fishermen's organisations and HM Coastguard, in this case Shetland Maritime Rescue Coordination Centre, of the

progress of the works through local Notice to Mariners or any other appropriate means. The licensee must ensure that the progress of the works are promulgated in the Kingfisher Fortnightly Bulletin to inform the Sea Fish Industry of the vessel routes, the timings and the location of the works and of the relevant operations. The licensee must ensure the Clyde Cruising Club is notified of the progress of the works to permit the updating of their Sailing Directions and Anchorages publications.

#### 5.2.2.4 Markings, lighting and signals of the works

The licensee must ensure that the works are marked and lit in accordance with the requirements of the Northern Lighthouse Board at all times and such marking and/or lighting must be continued unless and until such time as the licensing authority, by notice, relevantly varies this licence under section 30 of the 2010 Act.

The licensee must ensure that no marks or lights, other than those required by virtue of this licence, may be displayed unless they have been approved, in writing, by the Northern Lighthouse Board and the licensing authority.

#### 5.2.2.5 Radio beacon and radar beacon

The licensee must ensure that no radio beacon or radar beacon operating in the marine frequency bands may be installed or used on the works without the prior written approval of the licensing authority.

#### 5.2.2.6 Emergencies

If the assistance of a Government Department (to include departments of Devolved Administrations) is required to deal with any emergency arising from:

- a) the failure to mark and light the works as required by the licence;
- b) the maintenance of the works; or
- c) the drifting or wreck of the works, to include the broadcast of navigational warnings, then the licensee is liable for any expenses incurred in securing such assistance.

#### 5.2.2.7 Ecological Clerk of Works

The Ecological Clerk(s) of Works (ECoW) / Environmental Manager(s) (in respect of which condition 3.2.1.5 relates) must provide regular (frequency to be agreed with the licensing authority) reports to the licensing authority as to the compliance with the commitments made by the licensee in the Environmental Statement, Supplementary Environmental Information Statement and the Project Environmental Monitoring Programme and all other plans and programmes provided by the section 36 consent to include the Vessel Management Plan and the Construction Method Statement.

#### 5.2.3 Conditions upon completion of the works

##### 5.2.3.1 Date of completion of the works

The licensee must no more than one month following the completion of the works notify the licensing authority, in writing, of the date of completion of the licensed activities.

### 5.2.3.2 Navigational safety

The licensee must notify the UK Hydrographic Office of the completion of the works to permit the promulgation of maritime safety information and updating of nautical charts and publications through the national Notice to Mariners system. The licensee must ensure that local mariners, fishermen's organisations and HM Coastguard, in this case Shetland Maritime Rescue Coordination Centre, are made fully aware of the completion of the works through local Notice to Mariners or any other appropriate means.

The licensee must ensure that the completion of the works is promulgated in the Kingfisher Fortnightly Bulletin to inform the Sea Fish Industry. The licensee must ensure the Clyde Cruising Club is notified of the completion of the works to permit the updating of their Sailing Directions and Anchorages publications.

### 5.2.3.3 Nature and quantity of deposited substances and objects

The licensee must, within 28 days of completion of the works or within 28 days of the date of expiry of the licence, whichever is the sooner, submit a written report to the licensing authority stating the nature and quantity of all substances and articles deposited below Mean High Water Springs under authority of this licence. Where appropriate, nil returns must be provided.

### 5.2.3.4 Markings, lighting and signals of the works

The licensee must ensure that the works are marked and lit in accordance with the requirements of the Northern Lighthouse Board at all times and such marking and/or lighting must be continued unless and until such time as the licensing authority, by notice, relevantly varies this licence under section 30 of the 2010 Act.

Key Environmental issues: There were a number of potential impacts that have been identified in the Environmental Statement, however only the following were deemed to be potentially significant:

- Collisions between marine mammals and installation vessels; and
- Disturbance to fish due to EMFs from subsea cables.

Environmental webpage: <http://www.meygen.com/environment/>

Mitigation measures: The following mitigation and best practice measures were outlined in the Environmental Statement:

- Where cables are not within boreholes they will be laid where possible within natural crevices and cracks within the seabed ensuring that the majority of the cable is below the seabed.
- The length of the drilled boreholes for the cable will, as far as possible, increase the length of cable under the seabed.
- Cables will be bundled into groups of 3 minimising the magnetic field by placing the cables close together, allowing the field vectors to cancel each other out.
- Ongoing research by Marine Scotland and their advisors will be monitored for further indications of successful mitigation strategies.

- MeyGen commit to undertaking frequent reviews of the literature regarding spiral injuries in seals and ducted propellers and to regularly discuss advances in understanding of this topic with relevant regulatory and advisory bodies. MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, should vessels with ducted propellers be used, to avoid any significant impacts.
- The turbines have been subjected to engineering design and third-party verification to ensure they are suitable for deployment in the Inner Sound.
- The Project will be using tried and tested equipment and techniques to minimise the risks associated with the high tidal flow environment.
- Turbine nacelle designs that use buoyancy as part of the installation and maintenance strategy have failsafe locking systems for the connection between the nacelle and the Turbine Support Structures (TSSs) to prevent accidental release.
- On-site monitoring via SCADA (Supervisory Control and Data Acquisition) will alert the 24-hour control room operations team of turbine failure or an object hitting the turbine.
- An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in Marine Guidance Note (MGN) 371. This will be submitted to the MCA for comment and approval. Emergency response would include informing HM Coastguard, Royal National Lifeboat Institution (RNLI), Harbours and local users (e.g., Pentland Ferries) so that vessels in the area are alerted to the potential hazard.

**Baseline studies and project effects studies: MeyGen Tidal Energy Project**

<b>General description</b>				
The following field surveys were undertaken (or commissioned by) the developer to inform baseline characterisation.				
<b>Receptor</b>	<b>Study description</b>	<b>Design and methods</b> (brief description)	<b>Results</b> (brief description)	<b>Status</b> (planned, underway, completed, with dates)
Physical Environment and Sediment Dynamics	Current profile of the water column by Atlantis	Atlantis survey: 300kHz Acoustic Doppler Current Profiler (ADCP) and moving vessel current transects measured the current speed and direction at 1m bins throughout the water column.	There are widespread and highly energetic tidal races, eddies and areas of general turbulence throughout the Pentland Firth. Just beyond the western end of the site off St John's Point on the Scottish mainland, the Merry Men of Mey is one of the most significant oceanographic features in the Pentland Firth. This is an area of tidal racing that occurs on the west-going ebb, particularly when opposed by westerly wind or waves. Currents within the Inner Sound have a clear flood ebb pattern, while the island of Stroma generates extensive eddies on its downstream side during both flood and ebb flows.	Completed 2009 (April)
	Current profile of the water column by ERI	ERI survey: Vessel mounted 300 kHz RDI ADCP to measure current speed and direction along transects.		Completed 2011(9 month survey beginning in October 2010 and finishing in July 2011)
	Bathymetric and geophysical survey by Atlantis	Multi-beam echo sounder, side scan sonar, pinger sub-bottom profiler and magnetometer used to determine water depths, seabed composition, bedform profiles, depth of seabed sediment type and presence of anomalies.		Water depths within the turbine deployment area vary between approximately 31m to 49m below LAT. The majority of the area is relatively flat having a water depth between 31.5 and 38m, but fissures in the bedrock up to 10m deep occur in the site,

			particularly at the western end south of Mell Head.	
	Coastal geology field survey by Atlantis	Visual survey	Much of the coastal section around the project area is marked by cliffs between 5 to 10m high, with a platform of nearly flat-lying slabs exposed in the littoral zone at the cliff foot. Beyond the eastern end of the project area on the mainland are the sheer cliffs at Duncansby Head, which are cut in Old Red Sandstone and rise up to 70m in height. Similar cliffs are seen to the west of the site at Dunnet Head, which reach over 90m in height. In areas where cliff exposures are absent, the back wall of the beach is formed by a usually steep, vegetated bank of between 2 and 15m in height.	Completed 2009 (November)
	Seabed structure investigation by ERI	Vessel mounted starfish 450F side scan sonar survey to gain an image of the seabed	Within the Inner Sound survey area 70% (7.8km) of the seabed is current scoured bedrock exhibiting a sawtooth profile, comprising folded and tilted sedimentary sandstone, flagstone and siltstone. Areas of shell sand accumulation are present in the north-eastern regions of the survey area as well as a localised area in the north-west. These regions commonly exhibit mega-ripples, of lengths up to 20m and heights of between 0.2 and 0.5m.	Completed 2011 (8 month survey beginning in November 2010 and ending in July 2011)
	Current wave and turbulence survey by MeyGen	Bottom mounted RDI 1200 kHz ADCP and bottom mounted Acoustic Wave and Current (AWAC) 600 kHz ADCP to measure current	Wave conditions are most severe (i.e. the wave field contains the greatest energy) in	Completed 2011 (July)

		speed and direction throughout water column and provide some quantification of turbulence and wave heights.	the exposed coastal areas to the west of the site, but although the highest and most frequent waves approach the Inner Sound from the west (UKHO, 2005) <sup>6</sup> , the coastal features and bathymetry of the Inner Sound are likely to cause these westerly waves to largely dissipate by the time they reach the Project site. Waves from the North Sea are less severe because a spit of shallower water extends north-east from Duncansby Head across the eastern end of the Inner Sound thus reducing their energy, but the open coastline on the eastern side of the Sound allows these waves to penetrate more	
	Seabed characterisation survey by MeyGen	Grab samples, water samples and drop down video/photography to gain an idea of sediment bedload, particle size distribution and amount of suspended sediment.	The Project area is generally devoid of superficial sediments, with the exception of the north-eastern and north-western regions of the site. Where found, sediments range from a coarse gravel veneer to larger mobile accumulations of coarse shell sand. At higher current speeds, and in coarser sediments, somewhat larger bed forms known as mega ripples are produced. Gravel waves are found where the currents are	Completed 2011 (July)

<sup>6</sup> UK Hydrographic Office (UKHO) (2005). Admiralty Tide Tables, Volume 1 – United Kingdom and Ireland (including European Channel Ports). NP 201-09.

			very strong, typically 1.5ms.	
Benthic habitats and ecology	Geophysical survey by iXSurvey Limited	Geophysical site survey to provide an indication of the seabed substratum present in the area.	The Inner Sound is composed largely of exposed Devonian Old Red Sandstone bedrock. The majority of the seabed is comprised of current scoured bedrock with patches of sand, mega rippled sand and sandbanks with coarse gravel in isolated patches both directly south and southwest of Stroma.	Completed 2009
	Benthic seabed survey by Aquatic Survey and Monitoring Ltd	Drop down video and photographic survey was used to note seabed type and biotopes present. Grab sample survey to determine the infaunal community types in any sediment that exists in the area and to determine baseline sediment particle size distribution. Additional grabs taken to collect sediment for analysis of radioactivity.	The largest biotope by area in the offshore Project development area is CR.HCR.FaT.BaTub ( <i>B. crenatus</i> and <i>T. indivisa</i> on extremely tide-swept circalittoral rock), which is very similar to the CR.HCR.FaT.CTub ( <i>Tubularia indivisa</i> and cushion sponges on tide-swept turbid circalittoral bedrock) biotope found in the area by the Marine Scotland surveys. CR.HCR.FaT.CTub ( <i>Tubularia indivisa</i> and cushion sponges on tide-swept turbid circalittoral bedrock) was also recorded by the ASML survey. SML (2011) report that the observations made from the five Marine Scotland surveys by Moore & Roberts (2011) tallied very closely with those of the present survey.	Completed 2011

Marine Mammals and Basking Sharks	Vessel and shore based visual surveys by RPS	The boat-based surveys involved two approaches to data gathering; firstly, boat transect surveys based on modified European Seabird at Sea methods (Tasker <i>et al.</i> , 1984) collected distributional data and secondly, stationary boat surveys at fixed locations were used to collect behavioural data. Land-based vantage point survey methods were adapted from approaches to terrestrial vantage point surveys; three vantage point locations on the Caithness coastline were selected and observations made during two to three visits each month over the same time period as the boat-based surveys.	10 cetacean species are either casual or regular visitors to the Pentland Firth; these are the mysticete (baleen whale) the common minke whale, the odontocetes (toothed whales and dolphins) sperm whale <i>Physeter macrocephalus</i> , killer whale <i>Orcinus orca</i> , long-finned pilot whale <i>Globicephala melas</i> , Risso's dolphin, bottlenose dolphin, Atlantic white-sided dolphin <i>Lagenorhynchus acutus</i> , white-beaked dolphin <i>Lagenorhynchus albirostris</i> , short-beaked common dolphin and harbour porpoise and the two pinniped species the grey seal and the harbour seal.	Completed 2011 (2 year survey beginning in October 2009 and ending in September 2011)
	Acoustic detection survey by Ecologic UK	Acoustic survey across the Inner Sound to trial the performance of PAM systems in the site conditions. Outputs used to qualitatively assess the likely efficiency of the visual surveys for harbour porpoise detection. PAM was deployed on the final 3 marine mammal surveys.	The overall acoustic detection rate for harbour porpoise was higher than the visual detection rate. This could suggest that the visual sightings rates may not accurately reflect actual levels of harbour porpoise activity in the Inner Sound.	Completed 2011 (between May and August 2011)
Ornithology	Vessel and shore based visual surveys by RPS	This survey was conducted in conjunction with the marine mammal survey. The same methods were used.	During the 22 boat surveys, a total of 13,248 individuals comprising 19 species were recorded on the sea within the transect area. During land-based surveys a total of 21,568 individuals were recorded during distribution scans, comprising 24 species and 2 species groups.	Completed 2011 (2 year survey beginning in October 2009 and ending in September 2011)
Shipping and Navigation	Radar survey by MeyGen	42 days of data from an existing radar scanner at Sandy Hill South Ronaldsay was gathered and analysed (along with other data sources such as AIS). Visual logs of small vessel activity	Visible during all the periods are the tracks of the <i>Pentalina</i> ferry, operated by Pentland Ferries between Gills Bay and Saint	Completed 2011 (1 year survey beginning in

		were kept during other offshore and onshore projects surveys.	Margaret's Hope with three return trips per day. All the periods also showed consistently heavy east-west traffic via the Outer Sound between the islands of Stroma and Swona. The number of vessels using the Outer Sound averaged 14 per day, with around 11 per day heading east-west. The east-west traffic transiting the Inner Sound is low-to-moderate by comparison, averaging less than 1 vessel per day (approx. 4% of the Outer Sound traffic). The sizes of vessels in the Inner Sound also tended to be smaller.	June 2010 and ending in August 2011)
<b>Reports or papers</b>	<ul style="list-style-type: none"> <li>• MeyGen Tidal Energy Project – Phase 1: Environmental Statement</li> </ul>			
<b>Research projects</b>				

**Monitoring and adaptive management: MeyGen Tidal Energy Project**

**General description** The following mitigation and monitoring measures are proposed within the project ES. The project team, along with Marine Scotland and other key stakeholders are currently preparing a Preliminary Environmental Monitoring Plan (PEMP) which will outline the proposed monitoring strategy in more detail.

<b>Receptor</b>	<b>Monitoring program description</b>	<b>Design and methods</b> (brief description)	<b>Results</b> (brief description)	<b>Status</b> (planned, underway, completed, with dates)
Physical environment and sediment morphology	Validation of hydrodynamic model	Post installation deployment of an ADCP with the initial turbines to validate the hydrodynamic modelling undertaken to inform the EIA and to validate the erosion/deposition and bedload transport results.	TBC	Planned
Benthic habitats and ecology	Monitor the dispersion of drill cuttings from potential TTS pile installation and HDD bore breakthrough	Benthic monitoring will be primarily based on drop down video upstream / downstream of the project such that potential changes to the biotope mosaic in the area could be detected. Reference areas to either side of the turbine array and cable routes could also be sampled.	TBC	Planned
	Undertaken surveys (post-installation and post decommissioning) to detect any significant changes in habitats due to the presence of the turbines		TBC	Planned
Commercial fisheries	Vessel traffic monitoring	Vessel traffic behavior will be monitored on AIS during construction and operation to assess the effect the project has on passing traffic and the proportion of vessels that re-route within the Inner Sound or via the Outer Sound.	TBC	Planned
	Long term impacts upon local fisherman	Consultation with local fishermen will be maintained throughout the project to aid the assessment of any long term impacts and to inform the decommissioning phase.	TBC	Planned
Fish	Collision monitoring	Collision risk will be monitored by the installation of	TBC	Planned

		one or more active monitoring systems on one of more of the tidal devices.		
		Collection of underwater noise measurements of candidate prototype tidal turbines. Data collected will be used to validate the underwater noise modelling completed to inform the impact assessment.	TBC	Planned
Marine mammals and Basking Sharks	Acoustic monitoring of operational noise	Collection of underwater noise measurements of candidate prototype tidal turbines. Data collected will be used to validate the underwater noise modelling completed to inform the impact assessment.	TBC	Planned
	Post deployment survey to assess possible displacement	Targeted observation of marine mammals is proposed, as is acoustic monitoring of harbor porpoise using static loggers to with determining area use.	TBC	Planned
Ornithology	Monitoring of potential displacement and disturbance of birds	Disturbance and displacement of birds at sea will be monitored from targeted land and boat based surveys to determine any behavioral changes. Collision risk will be monitored by the installation of one or more active monitoring systems on one of more of the tidal devices; this will assist in the understanding of near field bird interaction with devices. Birds will also be fitted with geo locators and dive loggers will provide information on any correlations between the site and breeding grounds.	TBC	Planned
<b>Reports or papers</b>	<ul style="list-style-type: none"> <li>• MeyGen Tidal Energy Project – Phase 1: Environmental Statement</li> </ul>			
<b>Research projects</b>				