16 MARINE CULTURAL HERITAGE

16.1 The table below provides a list of all the supporting studies which relate to the Marine cultural heritage impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Inner Sound, Caithness Marine Cultural Heritage Environmental Impact Assessment (ORCA, 2011a)	OFFSHORE\Marine Cultural Heritage
MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012)	OFFSHORE\Seabed interactions
Benthic survey for Phase 1 of the MeyGen Tidal Stream Energy Project, Inner Sound, Pentland Firth – Report (ASML, 2011)	OFFSHORE\Seabed interactions

16.1 Introduction

16.2 This section of the Environmental Statement (ES) addresses the potential impacts of the proposed Project on the marine cultural heritage. The assessment was undertaken by Orkney Research Centre for Archaeology (ORCA). A detailed technical Environmental Impact Assessment (EIA) report on marine cultural heritage is provided on the accompanying supporting studies CD (ORCA, 2011a).

16.3 As part of this assessment, Scientific Underwater Logistics And Diving (SULA Diving) was commissioned by ORCA to carry out a Desk Based Assessment (DBA) of relevant data sources. ORCA reviewed and interpreted remote sensing survey data obtained by IX Survey (2009), Environmental Research Institute (ERI) and Marine Scotland. Further seabed data was available from the benthic survey undertaken by Aquatic Survey and Monitoring Ltd (ASML, 2011).

16.4 Marine cultural heritage is considered to encompass man-made structures on the seabed including shipwrecks, piers, fish traps and anchor sites as well as submerged landscapes. The latter is where human beings and early hominids previously lived or hunted on terrain which was at that time dry land, or where they exploited fish and shellfish on the coast or in rivers, which are now submerged.

16.2 Assessment Parameters

16.2.1 Rochdale Envelope

16.5 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 16.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 16.9.

Project Parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbines	-	N/A	Turbine parameters do not directly influence marine cultural heritage, however potential effects on water flow from the presence of the turbines is considered under the physical processes and sediment dynamics impact assessment and the results of this impact assessment are used to inform the impact assessment.
Turbine support structure	Maximum amount of drill cuttings released into the marine environment	86 monopile Turbine Support Structure (TSS)	The drilled monopile TSS will result in the maximum release of drill cuttings to the marine environment. Assuming the maximum number of 86 TSSs, the maximum amount of drill cuttings that can be generated from turbine support installations is 17,200m^2 (total for 86 TSSs).
	Maximum seabed footprint	86 Gravity Based Structure (GBS) TSS	Each GBS TSS has a maximum footprint of 40m x 30m. The total footprint for 86 turbines is 0.103km^2.
	Operations and Maintenance	No removal of TSSs required for routine operations and maintenance	It is assumed that no replacement or major TSS overhaul involving removal is required during the operational life of the Project.
	Decommissioning	86 monopile	86 monopile TSSs will be cut at the seabed. The bottom on the piles below the seabed will remain in-situ.
Cable connection to shore	Maximum cable footprint on seabed	86, 120mm unbundled cables each 1,300m in length	The maximum physical area of the seabed occupied by the cables has been calculated as 0.027km^2. Based on a maximum 1.3km of cable from Horizontally Directionally Drilled (HDD) bore exit to turbine, and maximum cable diameter of 120mm (x2 to account for any armouring or weighting) for 86 turbines.
	Decommissioning	86, 250mm unbundled cables, each 1,300m in length	All cables laid on the seabed will be fully removed at decommissioning.
Cable landfall	Maximum drill cuttings released into marine environment	29, 0.6m HDD bores, drilled from either Ness of Quoys or Ness of Huna	The majority of drill cuttings generated from the drilling of the HDD bores will be returned to shore and not discharged to sea; however it is estimated that the contents of the last 10m of each bore could be discharged to sea and the seabed breakthrough. Of the two potential HDD scenarios, the greatest potential volume of cuttings discharged to sea at breakthrough will result from last 10m of 29 boreholes of 0.6m diameter 82m^2.
Onshore Project components	-	N/A	As there are no proposed works in the intertidal area along the coast the onshore aspects of the Project do not influence the benthic habitats and ecology impact assessment.

Table 16.1: Rochdale Envelope parameters for the marine cultural heritage assessment

16.2.2 Area of assessment

16.6 It is also important to define the geographical extent of the assessment area. The focus of the marine cultural heritage assessment is potential impacts on seabed of the offshore the Project area and adjacent seabed (Figure 16.1).

16.7 It should be noted that at the time of undertaking the assessment the exact distance from shore at which the HDD bores would emerge was considered to be between 700 and 2,000m, although the exact distance was unknown. The assessment here is based on the worst case where the cables emerge from shore at 700m.

16.3 Legislative Framework and Regulatory Context

16.3.1 Legislation

16.8 The United Nations Convention of the Law of the Sea (UNCLOS) was ratified by the UK in 1997. Article 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'.

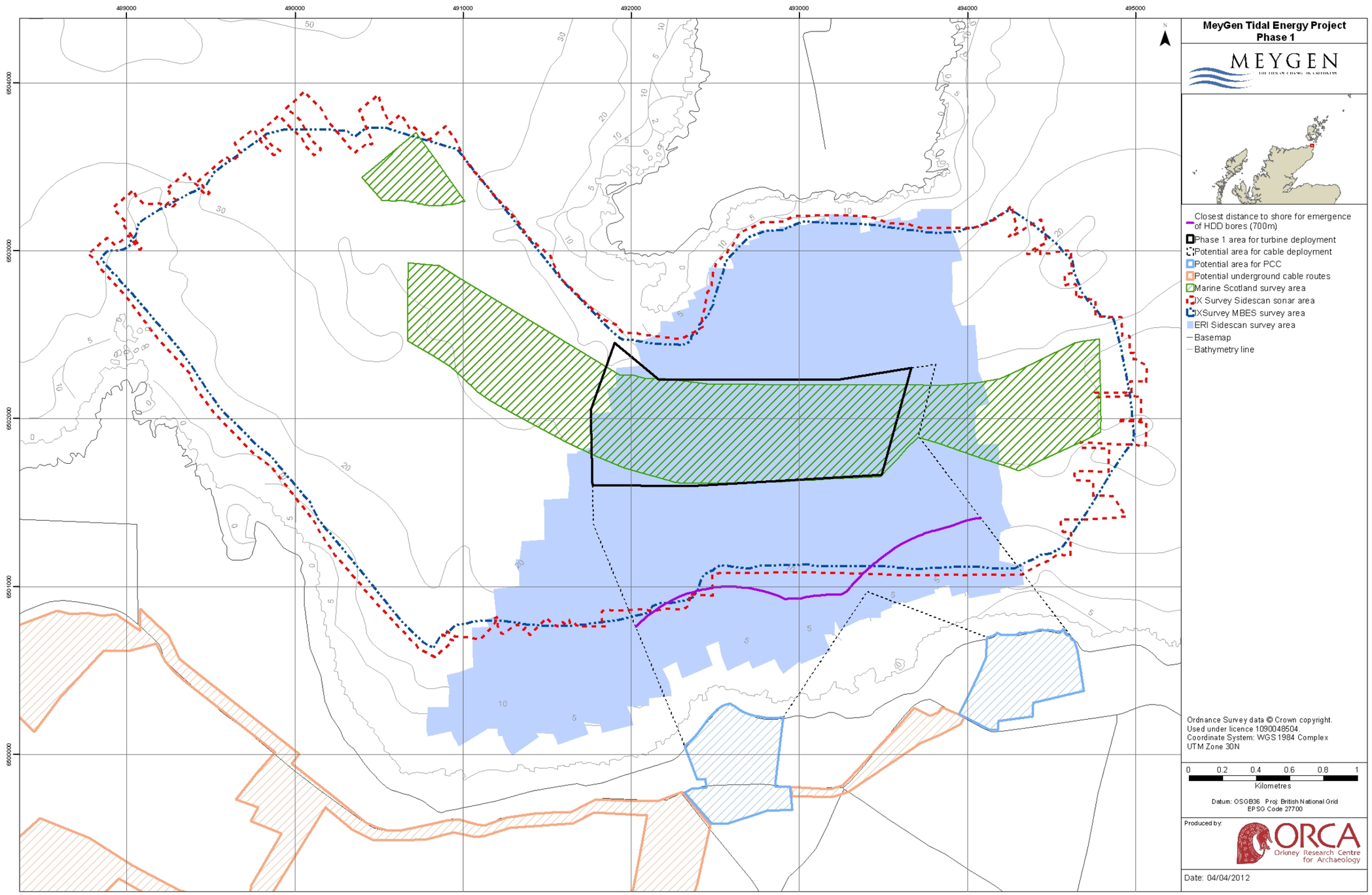

Figure 16.1: Map showing the coverage of the marine geophysical data sets

16.9 The European Convention on the Protection of the Archaeological Heritage (revised), known as the Valletta Convention, was ratified by the UK government in 2000. This contains provisions for the protection of archaeological heritage both under water and on land, preferably in situ, but with provisions for appropriate recording and recovery if disturbance is unavoidable.

16.10 Such definitions are included in national policy, such as Historic Scotland's Scottish Historic Environment Policy (SHEP) 2009, as well as international agreements such as the European Convention on the Protection of the Archaeological Heritage, ratified by the UK government in 2000, and guidance such as Wessex Archaeology's (2007) Historic Environment Guidance for the Offshore Renewable Energy Sector produced for COWRIE.

16.11 The Ancient Monuments and Archaeological Areas Act 1979 (AMAAA) Section 61(12) defines sites that warrant protection due to their being of national importance as 'ancient monuments'. A monument is defined as any building, structure or work above or below the surface of the land, any cave or excavation; any site comprising the remains of any such building, structure or work or any cave or excavation; and any site comprising or comprising the remains of any vehicle, vessel or aircraft or other movable structure or part thereof (Section 61 (7)).

16.12 Although primarily designed for land based structures the legislation was used in 2001 to designate the seven remaining wrecks of the scuttled German High Seas Fleet in Scapa Flow as Scheduled Ancient Monuments. Access to a marine scheduled monument is not restricted, but it is a criminal offence to demolish, destroy, damage alter or repair any part of a Scheduled Ancient Monument.

16.13 The Merchant Shipping Act 1995 requires that all recovered wreck landed in the United Kingdom is reported to the Receiver of Wreck, whether recovered from within or outside UK waters and even if the finder is the owner. The Receiver of Wreck will investigate ownership.

16.14 The Protection of Wrecks Act 1973 provides protection for designated wrecks which are deemed to be important by virtue of their historical, archaeological or artistic value. Approximately 56 wrecks around the coast of the UK have been designated under this section of the Act. Each wreck has an exclusion zone around it and it is an offence to tamper with, damage or remove any objects or part of the vessel or to carry out any diving or salvage operation within this exclusion zone.

16.15 The Protection of Military Remains Act 1986 has the principal concern to protect the sanctity of vessels and aircraft that are military maritime graves. In 2001 the Secretary of State for Defence announced that 16 vessels within UK jurisdiction would be designated as Controlled Sites, and 5 vessels in international waters would be designated as Protected Places. Any aircraft lost while in military service is automatically protected under this Act.

16.16 The Marine (Scotland) Act 2010, Section 73, concerns Historic Marine Protected Areas (HMPA). The Act defines a marine historic asset as any of the following:

- A vessel, vehicle or aircraft (or a part of a vessel, vehicle or aircraft);
- The remains of a vessel, vehicle or aircraft (or a part of such remains);
- An object contained in, or formerly contained in, a vessel, vehicle or aircraft;
- A building or other structure (or a part of a building or structure);
- A cave or excavation; and
- A deposit or artefact (whether or not formerly part of a cargo of a ship) or any other thing which evidences, or groups of things which evidence, previous human activity.

16.17 Historic Scotland recently consulted (consultation closed on 27th January 2012) on the proposed process for the selection, designation and management of HMPAs. It is expected that the final guidelines on selection, designation and management of HMPAs will be published in March 2012. Initial candidate sites are likely to be sites already protected under the Protection of Wrecks Act 1973 and Ancient Monuments and Archaeological Areas Act 1979. There are no sites protected under this legislation in the Inner Sound.

16.18 Scotland's National Marine Plan, which closed for consultation in 2011, recognises that there are environmental and economic impacts along with spatial constraints caused by the existence of marine cultural heritage. Environmental impacts include shipwrecks, which provide habitats for wildlife as well as being a pollution risk. There is an economic value from tourists visiting coastal and underwater heritage sites. It is recommended that Historic Marine Planning Partnerships (HMPP) and licensing authorities should seek to identify significant historic environment resources at the earliest stages of the planning or development process and preserve them in situ wherever feasible. Where this is not possible licensing authorities should require developers to archaeologically record the asset before it is lost, which can result in significant financial and time constraints on development. The sea and coast also help to define the setting of many important historic buildings and monuments, aiding their understanding and appreciation. In accordance with Scottish Planning Policy, proposals should also seek to avoid or mitigate detrimental impacts on the setting of these assets. Due to cultural material in this marine report being submerged the setting issues are not visual but involve indirect impacts such as scouring on the seabed caused by the development construction.

16.3.2 Policy and guidance

- The Joint Nautical Archaeology Policy Committee and The Crown Estate's (2006) *Maritime Cultural Heritage & Seabed development: JNAPC Code of Practice;*
- Wessex Archaeology Ltd's (2009) UKCS Offshore Oil and Gas and Wind Energy Strategic Environmental Assessment: Archaeological Baseline Ref: 68860.03;
- Wessex Archaeology Ltd's Historic Environment Guidance for the Offshore Renewable Energy Sector (2007), commissioned by COWRIE Ltd;
- COWRIE Ltd's (2008) Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy by Oxford Archaeology & George Lambrick Archaeology and Heritage;
- Gribble, J. and Leather, S. for EMU Ltd. (2011) Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector. Commissioned by COWRIE Ltd (project reference GEOARCH-09); and
- DTI (2003) Strategic Environmental Assessment Area North and West of Orkney and Shetland. Report to the Department of Trade and Industry.

16.4 Assessment Methodology

16.4.1 Scoping and consultation

16.19 Since the commencement of the Project, consultation on marine cultural heritage issues has been ongoing. Table 16.2 summarises all consultation relevant to marine cultural heritage. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 16.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholders	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and Scottish Natural Heritage (SNH)	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non-statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
26th August 2011	Historic Scotland	Submission of document for	Copy of marine cultural heritage baseline report provided for comment.

Date	Stakeholders	Consultation	Topic/specific issue
		comment	
14th September 2011	Historic Scotland	E-mail	Confirmed proposals do not appear to raise significant issues for HS statutory historic environment interests.
31st September 2011	Marine Scotland, The Highland Council (THC), statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress and presentation of key findings of the impact assessment.
6th – 7th December 2011	Local stakeholders	Public Event – pre-application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 16.2: Consultation undertaken in relation to marine cultural heritage

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Historic Scotland	Without prejudice and on the basis of the information supplied, we can indicate at this stage that we consider that it may be possible to locate such a development in this location without it raising significant issues for our historic environment interests.	Comment noted.	Section 16 Marine Cultural Heritage
Historic Scotland	We would however expect certain aspects of the proposal to be assessed and we provide further details about this below. Notwithstanding this, please note that our comments here are provisional and we would need to see any Environmental Statement (ES) to give our final view on the proposals.	This section of the ES presents the results of the marine cultural heritage impact assessment.	Section 16 Marine Cultural Heritage
Historic Scotland	We generally advise for such developments that the following issues are taken into account in the assessment of potential impacts: • on-shore effects • off-shore effects (including potential effects outside the development site).	This section of the ES presents the results of the marine cultural heritage impact assessment. The impact assessment has included consideration of a buffer around the Project area in order to ensure inclusion of potential effects outside the development site.	Section 16 Marine Cultural Heritage
Historic Scotland	Impacts are assessed with the appropriate involvement of archaeological expertise and in consultation with The Highland Council's conservation and archaeological service.	This assessment has been undertaken by Orkney Research Centre for Archaeology (ORCA) and has included consultation with The Highland Council's conservation and archaeological service.	Section 16.4.1 Scoping and Consultation
Historic Scotland	The potential for the discovery of unknown sites and artefacts be assessed.	Mitigation measures address the potential for discovery of unknown artefacts.	Sections 16.6, 16.7 and 16.8 Impact Assessment sections
Historic Scotland	Assessment should consider the significance of potential direct impacts by the development on any archaeological features, such as direct impacts to marine historic features within the proposed development site which could result from the construction, operation and decommissioning of the tidal array and associated operations, such as the laying of power and control cables.	Direct and indirect impacts have been considered.	Sections 16.6, 16.7 and 16.8 Impact Assessment sections
Historic Scotland	Assessment should consider the significance of indirect impacts to historic features on the seabed or at the coast edge within the proposed development area, and possibly beyond, which may be caused by alteration to tidal currents and sedimentary regimes, and by changes to the chemical balance of the water and seabed sediments.	Indirect impacts have been considered.	Section 16.7 Impacts during Operations and Maintenence
Historic Scotland	The cumulative impacts of this development proposal in combination with other proposed and consented schemes.	Potential cumulative impacts have been assessed.	Section 16.10 Cumulative Impacts
Historic Scotland	Specific advice on the treatment of cultural heritage in the marine environment can be found in The Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development. This can be found at: http://www.thecrownestate.co.uk/jnapc_code_of_practice_2	This guidance has been referenced.	Section 16.3.2 Policy and Guidance
Historic Scotland	The developer may also find the following sector-specific guidance useful, particularly in respect of approaches to mitigation where the ES identifies effects to a marine historic features within the development area: Historic Guidance for the Offshore Renewable Energy Sector: http://www.offshorewindfarms.co.uk/Assets/archaeo_guidance.pdf	This guidance has been referenced.	Section 16.3.2 Policy and Guidance
Historic Scotland	In addition, the Royal Commission of Ancient and Historical Monument's (RCAHMS) Canmore database provides an extra source of data to PASTMAP for the marine historic environment in addition to the SEA study for the area undertaken by Wessex Archaeology. Just look at the map provided on this page and click on the relevant SEA area: http://www.offshore-sea.org.uk/site/scripts/sea_archive.php	SEA studies by the Department of Trade and Industry on the area north and west of Orkney, Wessex Archaeology on the UKCS Offshore Oil and Gas and Wind Energy and Dr N. Flemming on the potential for prehistoric archaeological remains have been considered.	Section 16.3.2 Policy and Guidance
Historic Scotland	The developer may also wish to refer to the relevant industry guidance on cumulative impacts on cultural heritage features matter in the Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy: http://www.offshorewindfarms.co.uk/Pages/Publications/Archive/Cultural_Heritage/Guidance_for_Assessmen642afc68/	This guidance has been referenced.	Section 16.3.2 Policy and Guidance

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Historic Scotland	I wish to draw the developer's attention to some new guidance produced by COWRIE entitled Offshore Geotechnical investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (January 2011). This is mainly for offshore wind farms in respect of geotechnical surveys and archaeology, but is of interest for EIA work and something we are encouraging developers to consider. It is particularly relevant in relation to prehistoric submerged landscapes: http://www.offshorewind.co.uk/Pages/Publications/Latest_Reports/Cultural_Heritage/Offshore_Geotechnical_b6715e61/	This guidance has been referenced.	Section 16.3.2 Policy and Guidance
Historic Scotland	Enquired about the longevity of marine geophysical survey data in terms of cultural heritage analysis.	HS responded that the baseline information was not expected to have changed much in relation to cultural heritage.	NA
Marine Scotland	The ES should address the predicted impacts on the historic environment and describe the mitigation proposed to avoid or reduce impacts to a level where they are not significant. Historic environment issues should be taken into consideration from the start of the site selection process and as part of the alternatives considered.	Potential impacts have been assessed.	Sections 16.6, 16.7 and 16.8 Impact Assessment sections

Table 16.3: Scoping comments relevant to marine cultural heritage

16.4.2 Desk based assessment

16.20 The DBA covered the Project area. Any items identified outside but close to the Project have been included in this report. This was to identify any sites that might be directly affected by the proposed development and their immediate context.

16.21 The principal reference sources examined for this assessment were:

- The National Monuments Record of Scotland (NMRS), using the Canmore database website; http://www.rcahms.gov.uk/;
- The local Sites and Monuments Record using The Highland Council website; http://her.highland.gov.uk/;
- Statutory lists, registers and designated areas, including List of Scheduled Ancient Monuments, Designated Wrecks and Historic Marine Protected Areas;
- UK Hydrographic Office (UKHO) wreck register and relevant nautical charts;
- Marine Scotland Science includes data from marine surveys and laboratory work;
- DEFRA (Department of Environment, Food and Rural Affairs) funds, commissions and manages research relating to the marine environment;
- Heath/Ferguson private wreck database, which contains material not published by Ferguson (see Ferguson, 1991) and has been added to by Heath and Ferguson as new discoveries of wreck sites have been made;
- Larn, R. & Larn, B. (1998) *The Ship Wreck Index of Great Britain & Ireland* Vol.4 Scotland (SIBI);
- Whittaker I.G. (1998) Off Scotland: a comprehensive record of maritime and aviation losses in Scottish waters, Edinburgh;
- Flemming, N.C. (2003). The scope of Strategic Environmental Assessment of Continental Shelf Area SEA 4 in regard to prehistoric archaeological remains. Available at http://www.offshore-sea.org.uk/site/scripts/sea_archive.php;
- The Bulletins of the Caithness Field Club, available at http://www.caithness.org/caithnessfieldclub/bulletins/linkindex.htm; and
- Other readily available archaeological and historical reports, databases and publications (such as Houston, 1996; Omand, 1989) and, where used, will be cited in the report.

16.4.3 Subsea survey methods and resolution limitations

16.22 Coverage of geophysical surveys is shown in Figure 16.1. Although, not every data set covers the entire offshore footprint, the combined datasets cover the area of impact. IXSurvey were contracted in 2009 to undertake a geophysical site survey in the Inner Sound in the Pentland Firth using a multi-beam echosounder, a hull mounted sub-bottom profiler, and a side-scan sonar interfaced with a magnetometer. The objective of the surveys was to provide geophysical data to determine geological conditions and hazards affecting the planning, design and installation of an offshore marine tidal energy project in the Inner Sound.

16.23 Multi-beam echosounder data collected by Marine Scotland in the Pentland Firth was also viewed. This data included areas to the east and west of the Island of Stroma and part of the Inner Sound. It was collected with a Reson 7125 (http://www.scotland.gov.uk/Topics/marine/science/MSInteractive).

16.24 Further side-scan sonar data was collected by the Environmental Research Institute (ERI) in Thurso in October and November 2010. This covered part of the potential cable deployment area linking the tidal array with the mainland. The data provided adequate survey coverage, so it will not be necessary to carry out any further survey work between the Agreement for Lease (AfL) area and the cable landfall.

16.25 All geophysical data was inspected systematically by an experienced marine archaeologist. Points of interest or anomalies where marked on the mapping software and assigned high, medium and low potential.

16.26 A coastal processes modelling study investigated how sediments would be affected by the introduction of turbines in calm and storm conditions (Section 9). The model resolution did not allow investigation of the effect of individual turbines on turbidity in the water column and the surrounding seabed. It discussed the larger-scale affect of the turbine array on the Inner Sound.

16.27 Reports on the seabed sediment types in the Inner Sound (AMSL, 2011) were made available for the assessment.

16.28 IX Survey (2009) exported sounding data to ESRI ArcGIS Mapping software in which a Terrain was created and used as the modelling surface for production of Contours, Slope and Aspect, Hill-Shade, Shaded Relief and 3D modelling (IX Survey, 2009).

16.29 IX Survey (2009) provided the side-scan sonar in .xtf format and as a Mosaic which could be imported into GIS ArcMap. Locations of all contacts were verified against the MBES data, which was also imported into ArcMap as a geotiff and placed as a background to the side-scan sonar image.

16.30 ERI data was provided as a georeferenced mosaic and as individual georeferenced survey tracks. These were viewed on GIS ArcMap. Overlaps with the IX Survey data (IX Survey, 2009) were used to verify the existence of anomalies.

16.31 The sub-bottom profiler data was provided as raw Coda files and was viewed on Coda GeoSurvey software. The tracks of the sub-bottom profiler were the same as that covered by the side-scan sonar.

16.32 IXSurvey (2009) state that ground truthing would be required to positively identify and classify sub-seabed sediments. It is also possible that sub-seabed features between survey lines may not have been detected.

16.33 The magnetometer data was gridded using Surfer10 software and compared with the anomalies identified by IX Survey. Each line was analysed for spikes and anomalies and these were referenced against multi-beam echosounder, side scan sonar and sub-bottom profiler data sets for confirmation and interpretation of anomalies.

16.4.4 Significance criteria

16.34 The assessment of impact significance approach used for this impact assessment varies slightly from the core methodology in Section 8; specific details are provided in the following sections.

Importance of cultural heritage assets

16.35 The impact assessment of the potential of the Project on the marine cultural heritage will be assessed taking into account the importance attributed to each identified marine cultural area, site or feature and the magnitude of the impact. The importance of an asset or feature will be determined using the criteria in Table 16.4, which incorporate general guidelines used by statutory agencies such as Historic Scotland, outlined in Scottish Historic Environment Policy (SHEP) 2009, Scottish Planning Policy (February 2010), with the companion Planning Advice Note (PAN 2/2011): Planning and Archaeology, the Marine (Scotland) Act 2010, Historic Scotland's Managing Change in the Historic Environment Guidance Notes and Wessex Archaeology's (February 2011) Assessing Boats and Ships.

16.36 The importance given to historic environment considerations will depend on a number of factors[1], including:

- the relative rarity of the feature concerned;
- the completeness of the feature / whether it is a particularly good example of its type;
- the historical or cultural associations of the feature;
- the value given to the feature by the local community;
- the potential value of the feature as an in situ educational or research resource; and
- the potential value of retaining the feature for tourism or place-making.

16.37 It should be noted that a site that has not been statutorily designated can still be of high significance. Features that would require considerable further work to interpret them are recorded as of uncertain importance.

16.38 Anomalies recorded in the analysis of geophysical data were initially assigned an 'uncertain' importance because very little is known about them without further investigation. They have also been assigned a rank of importance in Table 16.5. This additional ranking was used to place the geophysical anomalies within the criteria in Table 16.4. Geophysical anomalies of the first and second ranking were considered to be of uncertain importance in Table 16.4. Geophysical anomalies of the third ranking were considered to be of negligible importance in Table 16.4. The criteria acts as an additional qualification on what risk could be associated with an uncertain geophysical anomaly, which is discussed in Section 16.5.2.

Level of importance	Criteria
Very High	▪ Archaeological and historical sites or areas of international importance such as World Heritage Sites, and may also include some Scheduled Ancient Monuments, Historic Naval Battles, Designated Wrecks or Historic Marine Protected Areas (MPA).
High	▪ Archaeological and historical sites or areas of national importance such as Scheduled Ancient Monuments, Historic Naval Battles, Designated Wrecks and Historic MPAs.
Medium	▪ Sites, wrecks and areas of regional importance.
Low	▪ Locally important sites, wrecks or areas.

[1] PAN 2/2011, paragraph 6

Level of importance	Criteria
Negligible	▪ Features that have been recorded but assessed as of no archaeological or historical interest, such as modern clearance cairns or recent wrecks, or have been so damaged they no longer have any historic merit.
Uncertain	▪ Features that cannot be identified without detailed work, but potentially may be of some interest. Also, for example, if the date of construction and rarity of a vessel is not known, but potentially may be of some interest. Findspots, which may represent an isolated find, or could represent the location of a hitherto unknown site. Unidentified geophysical anomalies are also of uncertain importance and have been divided up further in Table 16.5.

Table 16.4: Definitions of importance of cultural heritage assets

Level of geophysical anomaly ranking	Criteria
1	▪ Geophysical anomaly: if the feature is shaped like a shipwreck; or there is identifiable cultural material; or it is in the area of a known archaeological site, or another anomaly identified to be of a high ranking.
2	▪ Geophysical anomaly: If there is an uncertain determination that could be anthropogenic. It would be considered for where an anomaly lies in an area of intensive human activity such as near ports. It could also be used for submerged terrestrial deposits such as peat on the seabed due to possibility of cultural material relating to submerged landscapes.
3	▪ Geophysical anomaly: If the feature is probably a rock or bedrock formation such as sand dune.

Table 16.5: Definitions of importance for geophysical anomalies

Criteria for assessing magnitude of impact

16.39 The magnitude of any potential adverse direct and indirect impacts on submerged cultural heritage caused by the development proposals will be determined using the criteria in Table 16.6.

16.40 Direct impacts predominately occur during the construction phase of a project, but may to a lesser extent occur during maintenance or decommissioning, e.g. a maintenance vessel dropping anchor on a site.

16.41 Indirect impacts predominately occur during the operational phase of a project, but may to a lesser extent occur during construction, maintenance or decommissioning, e.g. propeller wash on seabed sediments. Potential indirect impacts include the disturbance and redeposition of sediments around and forming the context of a site, dispersal of the debris field around a site, or further erosion of a site, perhaps caused by scouring, propeller wash, vibration and the changing of water flow. It should be noted that the categories are guideline criteria only, since assessments of magnitude are matters of professional judgement.

Magnitude of impact	Direct impact criteria	Indirect impact criteria
Severe	Works would result in the complete loss of a site.	An irreversible and radical change to the context of a highly sensitive or valued underwater cultural heritage asset or environment, which removes or prevents appreciation of key characteristics of the asset, or permanent change to or removal of surroundings of a less sensitive or valued asset.
Major	Works would result in the loss of an area, features or evidence fundamental to the historic character and integrity of the site. Severance would result in the complete loss of physical integrity.	A fundamental or key change to the context of a highly sensitive or valued underwater cultural heritage asset or environment, or intensive change to less sensitive or valued asset.
Moderate	Works would result in the loss of an important part of the site or some important features and evidence, but not areas or features fundamental to its historic character and integrity. Severance would affect the integrity of the site, but key physical relationships would not be lost.	A material but non-fundamental change to the context of an underwater cultural heritage asset or environment, but not key or highly valued, and tolerant of moderate levels of change.
Minor	Works or the severance of the site would not affect the	A detectable but non-material change to the

Magnitude of impact	Direct impact criteria	Indirect impact criteria
	main features of the site. The historic integrity of the site would not be significantly affected.	context of an underwater cultural heritage asset or environment, resulting in minor changes to an underwater asset or environment considered tolerant of change.
Negligible	Works or the severance of the site would be confined to a relatively small, peripheral and/or unimportant part of the site. The integrity of the site, or the quality of the surviving evidence would not be affected.	N/A
Uncertain	Works over features that have not been fully interpreted would reduce the chance of interpretation in the future. In the event of significant features this would constitute impact of high magnitude; for sites of lesser significance it is less problematical. Nevertheless, it remains an issue where features have not been or could not be interpreted.	N/A
None	N/A	No detectable change.

Table 16.6: Definitions of magnitude of direct and indirect impact

Significance of impacts

16.42 The importance of the marine cultural heritage asset or geophysical anomalies are combines with the magnitude of impact to define the significance of impact (Table 16.7).

16.43 The significance of any potential adverse direct impacts from the development proposals on archaeological and historic sites will be determined by comparing the magnitude of the impact with the importance of each area, site or monument.

16.44 In order to evaluate how important the indirect impact really is, the importance of the site with which the effect is associated must be related to the impact, otherwise a major impact on the surroundings of a site of low or negligible importance would take on more significance than it merits

Magnitude of impact	Asset importance					
	Very High	High	Medium	Low	Negligible	Uncertain
Very High	Severe	Severe	Major	Moderate	Minor	Uncertain/ Severe
High	Severe	Major	Moderate	Minor	Negligible	Uncertain/ Major
Moderate	Major	Moderate	Moderate	Minor	Negligible	Uncertain/ Moderate
Minor	Moderate	Minor	Minor	Negligible	Negligible	Uncertain/ Minor
Negligible / none	Minor	Negligible	Negligible	Negligible	Negligible	Uncertain/ Negligible
Uncertain	Uncertain/ Severe	Uncertain/ Major	Uncertain/ Moderate	Uncertain/ Minor	Uncertain/ Negligible	Uncertain/ Negligible

Table 16.7: Determination of impact significance

Impact significance (with regards to EIA Regulations)

16.45 The significance of impacts in relation to the EIA Regulations are defined in Table 8.2.

16.46 Significance of moderate or higher are considered to be significant effects under the EIA Regulations that may require consideration by the regulatory authorities and will require control, management and mitigation. However, it should be noted that significance of minor may still require some management or mitigation to remain within acceptable levels.

16.47 Where the significance of an impact on a geophysical anomaly includes the ranking 'uncertain', if it cannot be avoided, further survey work is proposed as mitigation to investigate the anomaly.

16.4.5 Data gaps and uncertainties

16.48 The limitations to the subsea surveys in terms of methods and the identification and interpretation of items of potential cultural heritage interest are included in Section 16.4.3. The DBA sources reviewed for this report were extensive but not exhaustive, and there remains the possibility that there may be sites or features of archaeological or historical significance that have not been recorded in this report.

16.49 RCAHMS, the Royal Commission for Ancient and Historical Monuments for Scotland, runs a Maritime Project of the National Monuments Record of Scotland (NMRS), which seeks to document maritime sites, defined as ships, boats, and crashed aircraft, but not built structures or prehistoric sites. The information in the archive record is largely drawn from Whittaker (1998) and Larn and Larn (1998). These books contain some inaccuracies in locations of wreck sites that have been duplicated into the NMRS. If any of these are relevant to this report, they are noted and are corrected as far as possible.

16.50 There are 32 wrecks listed in the reference sources where they are categorised as PA (Position Approximate). Their location, or if they survive at all, is not known.

16.5 Cultural Heritage Baseline Description

16.5.1 Historic landscape and setting

Potential for submerged landscapes and prehistoric sites

16.51 Hominids and humans have occupied the UK Continental Shelf at various times for more than 700,000 years. The recovery of Palaeolithic stone artefacts and Pleistocene faunal remains in the North Sea has a long history predominantly associated with the fishing and dredging industries. Although a number of apparently isolated artefacts, without stratigraphic context, have been retrieved in the North Sea, there are relatively few examples of known submerged Palaeolithic and Mesolithic sites (Tizzard *et al*., 2011). However, evidence of the glaciations and interglacials over this period, of the palaeo-environment, of relative sea level changes, and of palaeo-landscapes and -seascapes, all indicate that in general terms, the potential for submerged prehistoric archaeology and landscapes across wide areas of the UK continental shelf is high (Wessex Archaeology, 2009). Our knowledge and understanding is changing rapidly as a result of new discoveries and research. Many of the new discoveries have been made as a (positive impact) result of seabed development, and more will be made through archaeological assessment and analysis of geophysical, geotechnical and other survey data (ibid., 74).

16.52 At 22000BP (before present) Scotland was covered by the ice sheet, with Caithness and Orkney just on the edge (Woodcock and Strachan, 2000). By 18000BP Caithness to Shetland was dry land, with a glacial sea area linking that shelf to the main North Sea exposed shelf. This sea would have been covered in floating ice. By 14000BP the ice cap retreated almost completely to the modern coastline of Scotland, and by 12000BP the ice has entirely melted, although there is a brief period of renewed ice cover, the Loch Lomond stadial, around 10000BP. The sea level was about 40-50m lower relative to the land around the Western Isles and Shetland when the first documented sites were occupied about 9000BP (Flemming 2003).

16.53 There is evidence for early humans living in Arctic polar conditions, such as the environment around the Pentland Firth prior to 9000BP, as excavations at the Mamontovaya Kurya site on the Usa River, inside the Arctic circle, revealed stone tools and carved mammoth tusks nearly 40000BP (Pavlov *et al*., 2001). Orkney was separated from Caithness by about 13000 years BP (Ritchie 1995), and several small mammals already lived on the islands. Fish, shellfish, seals, and whales were abundant. The exploitation of marine mammals, especially seals, walruses, and cetaceans must be considered for peoples living in circum-polar conditions. Walruses would have been easy and attractive prey, lying on the beach, for any peoples who chose to live on the northern or north-west margins of Europe during glaciations 12-14000BP (Flemming 2003).

16.54 In the submerged environment Dutch fishermen have recovered walrus bones showing signs of cut-marks and butchery from 56°N in the central North Sea strongly suggests this possibility (Flemming 2003). This type of culture may correlate with the retrieval of a lithic artefact off the Viking Bank from a depth of 145m (Long *et al*., 1986).

16.55 Where relative sea level was constant for hundreds or thousands of years, rivers and the sea would erode stable river valleys, estuaries, barrier bars, and lagoons. Waves would erode rock terraces, cliffs, and caves. At the present time with sea level now risen, one would expect to find submerged caves off the coasts (Flemming 2003, 14-15).

16.56 The earliest inhabitants of the Scottish continental shelf may have been living in a culture similar to that of the Inuit peoples of Greenland and northern Canada and Alaska. Therefore, environments where marine mammals would have prospered such as submerged sheltered sea bays and gulfs, which may have been covered by sea ice, would be areas of human activity (Flemming 2003). In near Arctic conditions settlements would have been in the lee or shelter of ridges and headlands. The ice caps had melted completely by 9000BP, but even as the climate ameliorated and vegetation and forests covered the land, the attraction of the coast would persist into the Mesolithic (Flemming 2003).

16.57 The sill of the Pentland Firth is at a depth of 70m, and the channel is 25km wide. Currents through the Firth are 1.0-1.5m/sec. The bottom of the Firth is bare rock. Areas of bare rock with gently sloping or horizontal surfaces swept by waves and currents would have a minimal chance of preserving bones or artefacts. However, where such surfaces have been exposed after the erosion and removal of late Quaternary deposits or post-Devensian material it is possible that artefacts may have been trapped in cracks and gullies. Artefacts from shipwrecks have frequently been found in such locations (Flemming 2003). Low gradients within the Pentland Firth mean that wave action during transgression will have been heavily attenuated, and depressions in the shelf could have acted as traps for slowly moving large particles (Flemming 2003).

16.58 There are sands and gravels recorded on the IX Survey (2009) data at the northeast and northwest sides of the Inner Sound within which there is the possibility of embedded stone tools and bones. The ASML survey (ASML, 2011) conducted in the MeyGen AfL area collected sediment samples. The results of the particle size analysis (PSA) suggest that the sediment at the sites is largely composed of very coarse sand or very fine gravel, with three of the four sites showing a predominance of gravel over sand. From observations made during sampling, the sediment collected for this analysis was made up completely of shell material (carbonate) and appeared devoid of organic matter (ASML, 2011). These marine sediments are different to the Quaternary deposits recorded by Flemming (2003) to the east and west of the Pentland Firth, consisting of pebbly clays, glacial till, and patches of sandy gravel, which date to just after deglaciation (*c*. 12400BP). The modern marine sediments recorded in the ASML survey are generally less than 1.5m thick and have a low potential for the survival of submerged landscapes and prehistoric sites. It should be noted that the majority of the turbine deployment area is scoured bedrock and turbines will not be installed in areas of sediment.

Shipwreck sites

16.59 The Pentland Firth lies between the northern Scottish mainland and the islands of Orkney and has a well-deserved reputation among the world's mariners as a channel to be navigated with great care. Tides surges through the Firth from the Atlantic to the North Sea and back again, and can reach up to 12 knots (22km/h). In the past many captains and ship owners preferred to make long detours north of Orkney or south by the English Channel to avoid the tides and eddies in the Firth. However, through history it has been the primary passage between the North Sea and the Atlantic. Consequently losses are recorded for the area.

16.60 The strong tides and severe storms in winter significantly impacts on the survival of wreck sites in the area, particularly in shallow waters.

16.61 UKHO have only two wrecks and one obstruction in the Inner Sound area (Table 16.8):

- The MV Bettina Danica, 1354 gross tonnage, was stranded in 1990 and is just outside the area, being on the west side of Stroma. A portion of this vessel shows at all states of the tide;
- SS Malin Head (UKHO wreck number 1117), 3467 gross tonnage, struck on the reef at Quoy Ness on 21 October 1910. The vessel was then reportedly refloated and towed into Gills Bay where she was beached (Whittaker, 1998). The UKHO put the wreck in very shallow water in Gills Bay but position quality is classed as ''unreliable''. Crawford (2002) in her book ''Deep Water'' mentions salvage attempts by her husband on the wreck so the wreck must be in water deep enough to get a salvage boat over the top. It is recorded that divers were employed to recover the cargo after the SS Malin Head had sunk, and also that a boat put marker buoys on the wreck which vanished after a while (Houston 1996: 357). UKHO has no information relating to the buoys; and
- A submerged obstruction (UKHO wreck number 930) was located in 1949 by the MV Actuality and charted, but then removed and classed as ''dead' when not mentioned in a subsequent survey by BUE Subsea in 1983. This obstruction is listed as possibly SS Malin Head in ''Off Scotland'' (Whittaker, 1998). However, it is unlikely to be SS Malin Head as this was refloated and put into Gill's Bay. Therefore, this obstruction is unknown and until identified has been listed as of high potential significance.

16.62 In addition to the charted wrecks the sources list 32 wrecks where the position is only approximate (PA). These are listed in Table 16.9. Ships that were wrecked pre-1914, involved a loss of life or have evidence of international activity have been assigned higher significance.

Aircraft crash sites

16.63 Whittaker (1998) cites a Spitfire (*R6974)* lost on 18/07/1941 400 yards off Mell Point, the south-western head of Stroma (Table 16.9). Both Air Britain & the Spitfire Production List (http://www.spitfires.ukf.net/p010.htm) show it as lost off Duncansby Head. 124 Squadron lost no pilots that day so he must have survived. It is not known if the aircraft ditched or crashed into the sea. However, due to the strong tides and severe storms in winter it is unlikely that such a fragile structure would remain intact. Irrespective, the site would be protected under the *Protection of Military Remains Act 1986.*

16.64 An A.M. Form 1180 (accident report) was obtained for this aircraft, showing that the incident happened in the sea off Duncansby Head. The report says *'insufficient height to make land might have turned back sooner (co) Inexperience'*. The pilot's name was Dabrowsri. As the incident was off Duncansby Head it is outside of the development area.

Other marine cultural features

16.65 There is a charted spoil ground on the east side of the turbine deployment area (Figure 16.2). The UKHO have no information relating to the spoil ground. The area around Orkney and the Pentland Firth is regulated by Marine Scotland (MS), who have indicated the previously licenced spoil ground is used by dredgers as a dumping ground for spoil from the Gills Bay Harbour. It is however no longer licenced. It is regarded as of low significance. The site has not been used for at least seven years and is listed as ''closed'' by MSS, although. DEFRA have the site still listed as ''open'' (DEFRA and MS, personal communication).

Name	Description	Circumstance of loss	Date lost	Importance of cultural heritage asset	Reason
Malin Head	Steamship registered in Belfast. Built 1892. Length 105m, beam 13m. Cargo 2500 pig iron.	Stranded on an outlying reef at Ness of Quoy then refloated and beached at Gills Bay.	21/10/1910	High	Pre-1914
MV Bettina Danica	Motor vessel, Danish cargo vessel, 1354 grt, 69.8x11x4.3m, builder Sakskobing Mast, Skibsvaerft, Sakskobing.	Went aground on rocks on W side Stroma Island in good weather conditions, while on passage Greenore to Oslo. Salvage attempts proved unsuccessful.	13/02/1993	Low	Post-1913
Obstruction	Reported in 1949 at depth 18m. Not reported in 1985 survey, amended to ''dead''.	-	-	Low	SSS shows rise in bedrock at this location

Table 16.8: UKHO listed shipwrecks designated as within the Inner Sound area

Name	Description	Circumstance of loss	Date lost	Importance of cultural heritage asset	Reason
Thetis	Captain: Robinson, Registration: Hull.	Sailing from Hull to Quebec. Stranded south end of Stroma.	09/04/1830	High	Pre-1914, international trade
Blue Bonnet	Wooden schooner of Leith, Grandison, in ballast.	Route: from Lerwick to Scrabster, Stranded SE corner of Stroma, got off and sunk in deep water.	25/05/1857	High	Pre-1914, national trade
Clarence G Sinclair	19 years old, of Wick. Wooden schooner. 78 ton. 5 men. Master J. Sutherland. Owner G. Stark, Edinburgh. Cargo of paving stones.	Route: Castlehill, near Thurso to S. Shields. Stranded at Mell Head, Stroma.	15/06/1897	High	Pre-1914, national trade
Golden Eagle	Brigantine? Capt. Gordon, Registration: Belfast. 174 tons.	Stranded near the beacon, Stroma, crew saved and materials secured.	24/11/1859	High	Pre-1914, national trade
Eagle	Possibly same vessel as Eagle above.	Swilkie Point; Stroma.	19th century	High	Pre-1914
Andrew Longmore	Schooner. 26 years, of Banff. Built 1874. 143 grt. Length: 28m. Beam: 7m. 125 ton. 5 men, master W. Angus, owner J.W. Simpson, Banff. Cargo of salt.	Route: Weston Point to Banff. Stranded on rocks near the beacon, Stroma.	29/06/1899	High	Pre-1914, national trade
Lord Suffield	Of Carlill, sailing from Hull to Quebec.	Ran on shore near Huna and became a complete wreck.	10/04/1832	High	Pre-1914, international route
Percy	9 yrs old, of Newcastle-on-Tyne, wooden schooner, cargo of salt, 58 tons, 4 crew, Master A. Miles, Owner M. Pearson, South Shields.	Departed Runcorn for Fraserburgh, wind N. to NW 8, stranded with total loss at Huna, Caithness.	10/08/1883	High	Pre-1914, national trade
Pheasant	Brig of Sunderland, sailing from Shields to Barbadoes, cargo of coal.	Went on shore at Duncansbey [Duncansby] and became a total wreck: three of the crew drowned, materials and part of cargo expected to be saved.	10/01/1849	Very High	Pre-1914, international trade, loss of life
Brothers	Brigantine of Milford, captain Evans, sailing from Westport to Hartlepool, cargo of oats.	Came ashore at Ness of Hun, drifted off and sank in deep water. Part of materials and a small portion of cargo saved.	17/10/1856	High	Pre-1914, national trade
Science	Snow (type of brig), cargo of timber, Captain Whitfield. Registration: Sunderland. Built 1819. 160grt. Length: 22m. Beam: 7m.	Wrecked at Huna.	22/08/1833	High	Pre-1914
St Martin	Whaler with cargo of fish and whale oil. Registration: Bayonne.	Stranded near Huna, Caithness.	Dec 1674	High	Pre-1914, international fishing
Hector	Brig with cargo of iron. Captain: Prentiss, Registration: Providence (Rhode Island, USA).	Route: Stockholm to Providence. Wrecked near Huna.	10/07/1822	High	Pre-1914, international trade
Abiding (BCK449)	Iron steam trawler, Registration: Buckie.	Stranded at Ness of Quoys.	15/07/1927	Low	Post 1913
Hudson	Barque. Built 1825. 380 tons Length: 34m. Beam: 9m. Captain Donaldson, from Dundee, bound to Quebec.	Stranded at Ness of Quoys.: driven on shore in the Pentland Frith [Firth], during a severe gale: crew saved, totally wrecked.	23/09/1829	High	Pre-1914, international trade
Bittern	Brig, Captain Wall, sailing from Yarmouth NS to Sunderland, cargo of timber, registration Yarmouth NS.	Stranded at Quoys, near Gill Bay, and was expected to become a wreck.	1/12/1825	High	Pre-1914, international trade
Scotia	Schooner, of Inverness, Captain Campbell, from Liverpool to Arbroath, cargo of salt, Built 1842. 112 grt. Length: 22m. Beam: 6m.	Stranded at Gills Bay and is a wreck, crew saved.	18/12/1866	High	Pre-1914, national trade
Glasgow packet	Schooner of Wick, Captain Leith, from Stromness to Scrabster, in ballast, Built 1831. 78 nrt.	Stranded at Gills Bay near Dunnet [?Duncansby] Head during a gale, and was thrown on her beam ends, and will probably become a total wreck.	13/12/1859	High	Pre-1914, regional importance
Margaret Gunn	Lugger, 5 yrs old, not registered, wooden lugger, 25 tons, 7	Wind S. by E.10, stranded, total loss, Gills Bay, near Duncansby Head, crew	19/01/1883	High	Pre-1914, regional importance

Name	Description	Circumstance of loss	Date lost	Importance of cultural heritage asset	Reason
	crew, Captain J. McLean, Owner G. Doull, Wick, departed Wick for fishing, in ballast, Built 1878. 25 tons.	saved.			
Northumbrian	Barque, cargo of coal, Capt. Tait. Registration: Glasgow. Built 1832. 351 tons burthern. Length: 32m. Beam: 8m.	This vessel stranded on Quoys Ness [Ness of Quoys], and was expected to become a total loss.	13/04/1836	High	Pre-1914
Minna	Iron steamship with a cargo of coke. 438 ton. 16 men. Built 1875. 811grt. Length: 73m. Beam: 9m. Master T.J. Snelling. Owner R. Grandidge, Chester.	Stranded at Quoy Ledge, Gills Bay.	20/11/1889	High	Pre-1914
Elizabeth	Of Montrose, Captain Morgan, sailing from Alloa to Oban, cargo of coal.	Struck on the Skerry of Stroma, Pentland Frith [Firth], considerably damaged, with her keel broken, and likely to become a wreck. Not cited by I G Whittaker (1998), possibly suggesting her successful recovery.	15/06/1854	High	Pre-1914, national trade
Louisa	Capt. Saadman, wooden schooner, with cargo of coal. Registration: Barth. Built 1861. 117 tons.	Stranded on the SE side of Stroma.	23/12/1876	High	Pre-1914
Anna Maria	Wooden schooner, cargo of coal for Stromness.	South end of Stroma.	20th century	Uncertain	Needs further investigation to identify
Mary	Wooden schooner. 110 ton. 5 men. Master J. Christie. Owner J. Mitchell, Montrose. Cargo of coal. 110grt. Length: 26m. Beam: 7m.	Route: Shields to Stornoway. Wind SW8. Stromacan's Bay, Stroma Skerries, Caithness.	16/12/1892	High	Pre-1914, national trade
Unknown				Uncertain	Needs further investigation to identify
Unknown		Off Stroma.	31/09/1868	High	Pre-1914
R6974	Supermarine Spitfire aircraft of 124 sqdn [RAF]. Registration: British.	Crashed 400 yrds off Mell Head.	18/07/ 1941	High	Protected under Military Remains Act
Edwin and Lizzie	Registered N. Shields, wooden barquentine, 372 tons, 9 crew, Master R. Cowell, Owner H. Campbell. Departed the Tyne for Bona carrying coal.	Wind SSE2, stranded Stroma Island, Caithness.	05/07/1884	High	Pre-1914
Victor and Louis	French lugger, laden with fishing materials, Captain Claeysen, bound to Iceland.	Got ashore at Huna, Pentland Firth: the crew landed in safety: the cargo is being saved, but the vessel will probably break up. The loss of this vessel is not cited by I G Whittaker (1998), possibly suggesting that she was successfully recovered.	14/03/1874	High	Pre-1914, international fishing
North Sea	15 years old, of Dundee. Iron steamship. 96 ton. 17 men. Master J. Craig. Owner J.P. Bruce, Dundee. Cargo of coal.	Route: Glasgow to Copenhagen. Wind SE3. SW end of Stroma Island, Caithness.	08/05/1896	High	Pre-1914, international trade
Cairn Glen	Steamer, 5119 ton, of Newcastle, Captain Miller. No loss of life, 48 persons on board. General cargo.	4 miles from Duncansby Head Lighthouse. Daylight. SW light breeze, sea calm, cloudy.	23/03/1904	High	Pre-1914

Table 16.9: List of recorded shipwrecks and aircraft wrecks in the Inner Sound area

16.5.2 Marine geophysical data analysis

16.66 The survey data was studied in detail. The interpretation is based upon all available data and is illustrated with location maps of features. The interpretation combines data from the remote sensing surveys and the IX Survey (2009) report. In the technical report (Inner Sound, Caithness Marine Cultural Heritage Environmental Impact Assessment (ORCA 2011a)) provided on the accompanying CD, the results of the analysis are presented as images of anomalies followed by summaries of anomalies.

16.67 Whilst the following sections provide an interpretation of the geophysical anomalies, it should be noted that the impact assessment is based on the asset importance not the geophysical importance; in most cased this is considered 'uncertain' without further investigation.

Multi-beam echosounder (MBES) anomalies

16.68 In total there are 13 MBES anomalies in the proposed turbine deployment area and potential cable deployment area (Figure 16.2). Five are of rank 3 (MB16, MB24, MB25, MB30 and MB45). The rest are rank 2 (MB19, MB20, MB22, MB23, MB28, MB41, MB44 and MB47). Rank 2 anomalies have been summarised in Table 16.10.

16.69 The MBES data shows bedrock exposed on the seabed over most of the survey area with the exception of sand waves and gravel ridges to the SE and W of the Island of Stroma. The extent of the exposed bedrock indicates a high-energy environment causing scouring. This leaves low potential for the survival of in situ cultural material apart from heavy materials such as large iron shipwrecks, cannons or anchors. This explains the relatively low amount of anomalies in the tidal turbine deployment area. However, there are many gullies present which could act as sediment traps into which cultural material could have accumulated. IX Survey (2009: 22) records these fissures as up to 18 metres deep and they are at their most extensive towards the centre of the survey area south of Mell Head, Stroma (i.e. within the Project area).

Anomaly ID	Description	Geophysical rank	Easting	Northing	Proximity
MB19	6.5m x 3m rectangular feature amongst bedrock.	2	493541.829935	6502233.48931	Within turbine deployment area.
MB20	21m wide circular feature on edge of gully amongst bedrock.	2	492501.221604	6501933.84808	Within turbine deployment area.
MB22	10m x 4m rectangular feature amongst bedrock.	2	492289.28993	6501335.75626	63mS of cable corridor to Ness of Huna.
MB23	8m long triangular feature amongst bedrock, up to 6m wide.	2	492333.343143	6501465.93152	78mN of cable corridor to Ness of Huna.
MB28	16m x 0.5m curved feature higher than surrounding bedrock.	2	493505.317362	6501320.67498	10mE of cable corridor to Ness of Quoys.
MB41	3m x 2.5m circular feature raised above sand and boulders.	2	494176.666579	6501149.32887	82mW of cable corridor to Ness of Huna.
MB44	12m x 2.5m rectangular feature amongst sand and boulders (same as SS20).	2	494166.040891	6501425.82166	89mE of cable corridor to Ness of Huna.
MB47	5m diameter circular feature amongst bedrock.	2	491793.195188	6502419.75635	87mW of turbine deployment area.

Table 16.10: Rank 2 MBES anomalies within 100m of the Project

16.70 Anomaly MB19 is located within the sand wave area bordering the Project. It has the potential to be better preserved that the anomalies in the high-energy environment and to still be *in situ*. It is possible it may be intermittently uncovered and re-buried by mobile sediments on the seafloor. However, IX Survey (2009: 31) compared their data with a previous data set completed in 2008 that indicated the large sand body in the north east of the site had not migrated to any significant degree. Furthermore, the morphology modelling study predicted that there will be no significant impacts to the sediment dynamics and bedforms following the installation of the tidal array. Under calm conditions and with no turbines, the bedforms show evidence of movement, but not in a way which is significant. The addition of the array is predicted to make little or no difference to the existing bedform structures with small (±0.2-0.5 m) differences in bed height (DHI, 2011).

Side-scan sonar (SSS) anomalies

16.71 In total there are seven SSS anomalies within the Project (Figure 16.2). One is of rank 1 associated with a magnetic anomaly (SS36). None are of Rank 3. The rest are Rank 2 (SS14-15, SS18, SS20, SS24 and SS39). High and medium potential anomalies have been summarised in Table 16.11.

16.72 The area of the obstruction listed as UKHO reference number 930 (Table 16.8) was examined on the ERI SSS data. It was found to be an area of rising bedrock on the seabed. Therefore, its significance is low.

Magnetometer anomalies

16.73 Seven magnetometer anomalies were recorded by IX Survey in the turbine deployment and cable corridor area. On examination of the data this was narrowed down to two areas or clusters of anomalies (Table 16.12). These clusters may represent a single shipwreck with a large enough iron content to be picked up on successive transects, different shipwrecks collecting in the gullies (acting as sediment traps), or parts of a shipwreck breaking up and being dispersed on the seabed.

16.74 The cluster M/001-M/005 is within the turbine deployment area. It is probably associated with SSS anomaly SS36 (Figure 16.2). It is in the area of a deep, 30m wide gully at a water depth of up to 48m. It is an area where sediment and other material on the seabed would have accumulated. It is possible that some of this anomaly is buried within the gully sediment. IX Survey (2009: 41) record M/001 and M/005 as relatively small and perhaps constituting separate items.

Anomaly ID	Description	Geophysical rank	Easting	Northing	Proximity
SS14	Double mound feature on gully edge, 18 x 10m aligned SW-NE, 1m high, possible indication of features within the feature.	2	491836.089514	6502386.83095	45mW of turbine deployment area.
SS15	2m x 3m circular feature higher than surrounding sand and boulders (Same as MB41).	2	494169.877357	6501151.84507	70mSW of cable corridor to Ness of Huna.
SS18	6 x 6m circular area on bedrock.	2	493387.106	6501220.50458	105mW of cable corridor to Ness of Quoys.
SS20	35 x 6m rectangular feature amongst sand and boulders (same as MB44).	2	494160.220046	6501423.57269	80mN of cable corridor to Ness of Huna.
SS24	5 x 4m with shadow about 1.5m high circular feature amongst sand waves.	2	492751.883141	6502340.12096	103mN of turbine deployment area.
SS36	Rectangular block 2 x 2.5m, on bedrock 20m from M/001 to M/005.	1	492092.479246	6501792.19447	Within turbine deployment area.

Anomaly ID	Description	Geophysical rank	Easting	Northing	Proximity
SS39	22 x 8m boat-shaped feature on bedrock, sand area to SW.	2	492975.555038	6501139.20556	7mN of cable corridor to Ness of Huna.

Table 16.11: Rank 1 and 2 SSS anomalies within 100m of the Project

16.75 The cluster M/007-M/008 is within the turbine deployment area. The surrounding area is bedrock and there is little evidence of deep and wide gullies in this location, though the presence of bedding planes in the bedrock could allow for some sediment accumulation between them. IX Survey (2009) believes this to be a single small target though the double peak on the magnetometer trace suggested two sources.

Anomaly cluster	Anomaly ID	nT (Anomaly)	Easting	Northing	nT (Total field)	Proximity
1	M/001	nT=34	492082.15	6501839.74	50480.43	
	M/002	nT= 73	492098.02	6501813.72	50510.73	
	M/003	nT=100	492106.86	6501817.66	50560.92	
	M/004	nT=37	492111.70	6501808.66	50471.26	
	M/005	nT=12	492174.27	6501810.46	50437.27	Within turbine deployment area.
3	M/007	nT=7	492919.99	6501786.60	50479.93	
	M/008	nT=20	492933.20	6501793.89	50454.50	Within turbine deployment area.

Table 16.12: Magnetometer anomalies within 100m of the Project

16.76 The spoil ground contains material dredged from Gills Bay harbour. Some of this may contain anthropogenic material and could explain some of the magnetic anomalies caught in gullies in the turbine deployment area.

16.77 The magnetometer anomalies cluster in two locations and each of these clusters are probably the same anomaly, or associated anomalies, picked up on different transects. IX Survey concludes that these contacts were anthropogenic *'most probably debris from broken up wrecks or discarded fishing equipment'* that have become embedded in the bedrock features (IX Survey, 2009). It is concluded that the anomalies are unlikely to be igneous due to their concentration around gullies and no evidence of the magnetic anomalies forming a linear feature (which would indicate an igneous dyke or a sill). Therefore, these anomalies are anthropogenic and of geophysical Rank 1.

Sub-bottom profiler anomalies

16.78 The Project area was devoid of sediments with the exception of northern margin. The turbines and cables will not be placed in the areas of sand and gravel. The sediments include a coarse gravel veneer, gravel ridges and larger mobile accumulations of sand. There is no evidence of cultural material on analysis of the sub-bottom data. Large areas of the seafloor are uneven bedrock containing depressions and gullies. Gravel and sand deposits can be observed within these features. There is a high potential for these deposits to contain within them disturbed or redeposited cultural material from shipwrecks. Areas of deeper sediment above bedrock are located to the NW, E and N of the Project. These sediments of sand and gravel contained no evidence of a terrestrial deposit such as peat beds. There are depressions in the bedrock. However, no layering of sediments could be ascertained within these depressions to identify these features as palaeo-channels. Therefore, no evidence of submerged landscapes could be identified from the data. No geophysical anomalies were recorded in the sub-bottom profiler data.

16.5.3 Summary

16.79 Figure 16.2 shows the distribution of multi-beam echo sounder (MBES) anomalies in the whole of the MeyGen AfL area. Twelve anomalies have been identified from MBES data to be within the turbine deployment area and the cable deployment area or within 100m of these areas. 100m has been chosen as the cut off distance away from the development areas, due to issues of size of anomaly, accuracy in underwater location recording, and scouring on the seabed due to the strong tidal currents moving cultural material. Of the 12 anomalies, four are of Rank 3 importance, eight of Rank 2 and none of Rank 1 importance.

16.80 Figure 16.2 shows the distribution of side-scan sonar (SSS) anomalies. Seven SSS anomalies are in, or within 100m of the turbine deployment area and the cable deployment area. Six are of Rank 2 and one is Rank 1 importance.

16.81 Two of the magnetometer anomaly clusters are within the turbine deployment area (Figure 16.2). These are M/001-M/005 and M/007-M/008. M/001-M/005 is in the same area as SS36. Both of these magnetometer anomalies are Rank 1 importance because of the high probability of cultural material.

16.82 The Project area contains the former spoil ground (no longer licenced). This was used by dredgers as a dumping ground for spoil from the Gills Bay Harbour. Harbours have high potential for cultural material. No evidence of the dumping ground could be seen on the MBES or SSS data and it is probable that the high-energy environment dispersed this sediment. It is possible that the anomalies within the Project area may have originated from dredging in Gills Bay Harbour.

16.6 Impacts during Construction and Installation

16.6.1 Impact 16.1: Damage caused by placing turbine and cable over marine cultural material

16.83 During construction the direct impacts to cultural material on the seabed will be from the potential to place the turbines and cable over cultural material. The weight of the turbine and cable could have a damaging effect on cultural material exposed at the surface. A drilled Turbine Support Structure (TSS) pin pile or mono pile will not cause further damage to cultural material below the seabed surface as TSS are to be placed on a bedrock seabed and not areas of sand and gravel.

16.84 The direct impacts for each site have been shown in Table 16.13. The magnitude of direct impact is high for sites within the Project, and within 100m. The magnitude of direct impact was considered to be high rather than severe because although placing turbines and cables would result in the loss of some of the surrounding area and features at the site, it is unlikely to remove all evidence of cultural material. Twenty-three sites have been assigned a high magnitude of direct impact. Outside of that area the magnitude of direct impact is negligible.

16.85 Table 16.13 shows that there is a major significance of impact on sites with a magnitude of direct impact of major and if they have a Rank 1 or 2 geophysical potential importance ('uncertain' importance of site). If the sites have a Rank 3 geophysical importance ('negligible' importance of site) the impacts are of minor significance if the direct impact is minor. There are 20 sites with 'major' significance of direct impact. Outside of 100m of the Project area, the significance of direct impact is either negligible or uncertain/negligible.

16.86 The following sites, recorded in the Project area or within 100m of the area, are recommended to be either avoided or investigated by Remote Operated Vehicle (ROV):

- Three MBES anomalies (MB19, MB20 and MB47). These anomalies are possibly wreckage, lost cargo, or ballast;
- Two clusters of magnetic anomalies (M/001-M/005 and M/007-M/008). These anomalies may be anthropogenic: iron wreckage, lost marine equipment or iron material from spoil ground; and
- Three side-scan sonar anomalies (SS14, SS24 and SS36). These anomalies are possibly wreckage or lost cargo.

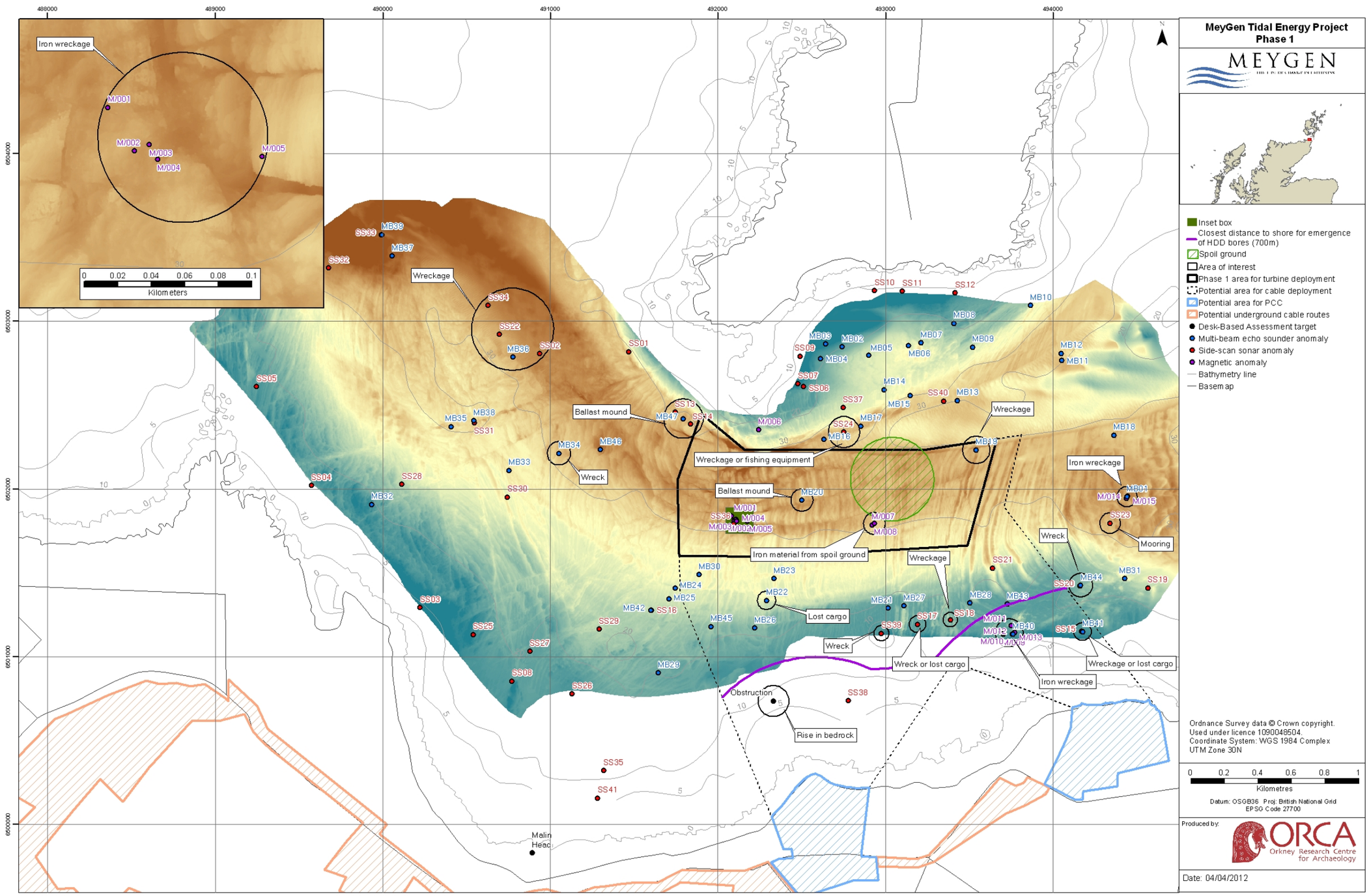

Figure 16.2: Overall map of survey anomalies over bathymetry survey data showing multi-beam bathymetry on top. Possible interpretations of geophysical anomalies included.

Site_No	Proximity	Importance of site	Magnitude of direct impact	Significance of direct impact	Mitigation for direct impacts	Residual direct impact[1]	Residual direct impact significance	Magnitude of indirect Impact	Significance of indirect impact	Mitigation for indirect impacts	Residual indirect impact	Residual indirect impact significance
MB13	260mN of turbine deployment area.	Uncertain	Negligible	Uncertain/ Negligible	No further rec.			Moderate	Uncertain/ Moderate	(1) avoidance (2) dive or ROV survey	Minor	Not Significant
MB19	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Major	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant
MB20	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB22	63mS of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB23	78mN of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB24	29mW of cable corridor to Ness of Quoys.	Negligible	High	Minor	No further rec.			Minor	Negligible	No further rec.		
MB25	69mW of cable corridor to Ness of Quoys.	Negligible	High	Minor	No further rec.			Minor	Negligible	No further rec.		
MB28	10mE of cable corridor to Ness of Quoys.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB30	65mS of cable corridor to Ness of Huna.	Negligible	High	Minor	No further rec.			Minor	Negligible	No further rec.		
MB44	89mE of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB45	105mE of cable corridor to Ness of Quoys.	Negligible	Negligible	Negligible	No further rec.			Minor	Negligible	No further rec.		
MB47	87mW of turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS14	45mW of turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS18	105mW of cable corridor to Ness of Quoys.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS20	80mN of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS24	103mN of turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Moderate	Uncertain/ Moderate	(1) avoidance (2) dive or ROV survey	Minor	Not Significant
SS36	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS39	7mN of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS40	269mN of turbine deployment area.	Uncertain	Negligible	Uncertain/	No further rec.			Moderate	Uncertain/	(1) avoidance	Minor	Not Significant

Site_No	Proximity	Importance of site	Magnitude of direct impact	Significance of direct impact	Mitigation for direct impacts	Residual direct impact[1]	Residual direct impact significance	Magnitude of indirect Impact	Significance of indirect impact	Mitigation for indirect impacts	Residual indirect impact	Residual indirect impact significance
				Negligible					Moderate	(2) dive or ROV survey		
M/001	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/002	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/003	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/004	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/005	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/007	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/008	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		

Note:
[1]If a potential impact was deemed to be not significant then no residual impact ranking has been applied

Table 16.13: Summary of geophysical anomalies; impact significance with and without mitigation

	Proximity	Importance of site	Magnitude of direct impact	Significance of direct impact	Significant	Magnitude of indirect Impact	Significance of indirect impact	Significant
Thetis	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Blue Bonnet	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Clarence G Sinclair	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Golden Eagle	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Eagle	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Andrew Longmore	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Lord Suffield	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Percy	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Pheasant	Unknown	Very high	Negligible	Minor	Not Significant	None	Minor	Not Significant
Brothers	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Science	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
St Martin	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Hector	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Abiding (BCK449)	Unknown	Low	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Hudson	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Bittern	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant

	Proximity	Importance of site	Magnitude of direct impact	Significance of direct impact	Significant	Magnitude of indirect Impact	Significance of indirect impact	Significant
Scotia	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Glasgow packet	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Margaret Gunn	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Northumbrian	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Minna	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Elizabeth	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Louisa	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Anna Maria	Unknown	Uncertain	Negligible	Uncertain/ Negligible	Not Significant	None	Negligible	Not Significant
Mary	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Unknown	Unknown	Uncertain	Negligible	Uncertain/ Negligible	Not Significant	None	Negligible	Not Significant
Unknown	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Edwin and Lizzie	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Victor and Louis	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
North Sea	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Cairn Glen	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant

Table 16.14: Summary of known wrecks that might be present in the area; impact significance with and without mitigation

16.87 The cable routes are in another high-energy environment area with exposed bedrock and gullies. The following sites, recorded in the cable deployment area or within vicinity (100-300m) of the area, are recommended to be either avoided or investigated by Remote Operated Vehicle (ROV):

- Four MBES anomalies (MB22, MB23, MB28 and MB44). These anomalies could be lost cargo, fishing equipment or wreckage; and
- Three SSS anomalies (SS18, SS20 and SS39) of uncertain potential were recorded or within 100m of the cable deployment area. These anomalies could be parts of a wreck or lost cargo and fishing equipment.

MITIGATION IN RELATION TO IMPACT 16.1

The following mitigations are proposed if practicable for sites of moderate and major impact significance within 100m of the development.

- Avoidance.
- ROV survey of the geophysical anomalies by Remote Operated Vehicle (ROV) in an appropriate manner by specialists in marine archaeology so they can be positively identified.
- Detailed wreck survey and salvage. If the ROV survey reveals cultural heritage, plans/elevations will be made with a full photographic record prior to impact. Wrecks should be recorded in an appropriate manner by specialists in marine archaeology. Attempts will be made to retrieve and conserve representative examples of the fabric. If the feature is of high archaeological potential the strategies below may be implemented.
- Intrusive archaeological assessment. This response will be implemented for all sites and wrecks with high archaeological potential and where there will be intrusive works. Intrusive assessments would groundtruth geophysical survey results and assess the nature, extent and preservation of identified remains.
- Full archaeological excavation. This level of mitigation may be deemed necessary as a result of evidence gathered by other levels and should be conducted by specialists in marine archaeology. Provision should be made for the examination and possible conservation of any artefacts recovered. Provision should be made for post-excavation work bringing the results together in a report of publication standard.
- Further documentary research and archiving. This response includes further detailed examination of unusual archival sources that would not routinely be consulted.
- No recommendations are made for anomalies of low potential. This is due to them being interpreted as natural features.

Residual impact

16.88 If the geophysical anomalies are identified by ROV survey and found to be either natural formations or recent anthropogenic debris, and are considered to have no or negligible significance, no further actions will be necessary. If a geophysical anomaly is identified as cultural material of low to very high importance it is proposed to avoid the site or implement further recording strategies. The residual significance of direct impact from both these scenarios is minor.

16.6.2 Impact 16.2: Damage to discovered marine cultural material Impact

16.89 The high-energy environment does not allow for much cultural material to remain except in the gullies in the bedrock. Therefore, recorded shipwrecks that only have an approximate position have been given a negligible allocation (Table 16.14). The shipwrecks of unknown location also have an impact significance of 'minor' with the exception of the Pheasant, which is internationally important and highly significant, thus having an impact of 'moderate' significance.

16.90 No known shipwreck locations are within 100m of the development. No known evidence of submerged prehistoric sites is located within 100m of the development. However, although the potential is low, there remains the possibility that unknown marine cultural material could be discovered during construction and installation.

16.91 There is low potential for significant prehistoric cultural material to have survived in areas sheltered from the current such as in gullies or any submerged caves, or in the western and eastern extents of the development area where gravel and sand seabed deposits could overlie submerged terrestrial deposits. Such areas are unsuitable for turbine deployment and therefore will not be directly impacted by the proposed Project.

16.92 Although there are no significant impacts, if marine cultural heritage material was discovered pre-construction or during construction, it would be recommended to avoid the site or the following procedures would be put in place.

MITIGATION IN RELATION TO IMPACT 16.2

- A reporting protocol will be instigated for the accidental discovery of marine cultural material during development, maintenance and monitoring.
- Avoidance. Should cultural material be accidentally discovered, it is proposed that the site be avoided.
- If it is not practicable to avoid the material a detailed wreck survey will be undertaken. If the ROV survey reveals cultural heritage, plans/elevations will be made with a full photographic record prior to impact. Wrecks will be recorded in an appropriate manner by specialists in marine archaeology. Attempts will be made to retrieve and conserve representative examples of the fabric. If the feature is of high archaeological potential the strategies below may be implemented.
- Intrusive archaeological assessment. This response will be implemented for all sites and wrecks with high archaeological potential and where there will be intrusive works. Intrusive assessments would groundtruth geophysical survey results and assess the nature, extent and preservation of identified remains.
- Full archaeological excavation. This level of mitigation may be deemed necessary as a result of evidence gathered by other levels and should be conducted by specialists in marine archaeology. Provision should be made for the examination and possible conservation of any artefacts recovered. Provision should be made for post-excavation work bringing the results together in a report of publication standard.
- Further documentary research and archiving. This response includes further detailed examination of unusual archival sources that would not routinely be consulted.
- No recommendations are made for anomalies of low potential. This is due to them being interpreted as natural features.

16.7 Impacts during Operations and Maintenance

16.7.1 Impact 16.3: Damage to marine cultural material from scouring caused by alteration of currents from placing turbine and cable on seafloor

16.93 There is the possibility of indirect impacts on marine cultural heritage assets and their associated environment caused by the development causing scour on the seabed. Scour occurs on the seafloor when sediment is eroded from an area in response to forcing by waves and currents (Quinn, 2006). It can be initiated by the introduction of an object to the seafloor such as a tidal turbine. Marine features such as shipwrecks and submerged landscape deposits are therefore vulnerable to erosion due to scouring by tidal currents, and scour processes can ultimately lead to the complete failure and collapse of structures on the seafloor.

16.94 The coastal processes modelling review revealed how current speeds through the Inner Sound, could be changed by the introduction of the tidal array (DHI, 2011). Current speeds are expected to increase to the north and south of the array, and decrease through the array itself. During calm conditions, the addition of 86, 1MW turbines is expected to reduce current speed through the array by up to 0.8m/s, and increase the current speeds by up to 0.8m/s to the north and south of the array. There are loose sediments on the seabed to the north east of the array. During storm conditions the current speed is predicted to change by between ±0.1 to ±1.2m/s in a similar pattern to that described for the calm scenario. These figures are based on an extreme scenario with a 14 day storm.

16.95 The modelling study predicted there would be no significant impacts to the sediment dynamics and bedforms near the site following the installation of the array. There is a natural movement of sediments as would be expected in a tidal flow receiving wave action, but the array is not predicted to affect these processes significantly. As the change in currents and seabed sediment is relatively minor there is expected to be no impact on any cultural material.

16.96 Table 16.13 and Table 16.14 summarise the potential indirect impacts. For the survey area it was considered that in areas of bedrock and subrock the development would have 'minor' magnitude of indirect impact on any cultural material due to the small amount of sediment that would be affected by scour. Any sediment that is present in gullies, in the areas of bedrock and subrock, is not expected to be affected by any changes in the currents. Beyond 100m of the Project in areas of bedrock and subrock the indirect impact is considered to be 'none'.

16.97 Where the cultural material is in an area of sand and gravel the magnitude of indirect impact would be 'major' within the development area, 'moderate' outside the development (up to 300m from the development limit) and 'minor' beyond 300m from the development. 300m, rather than the usual 100m buffer zone, has been chosen as a buffer zone for indirect impacts in sand and gravel areas. This is due to recognition of the indirect effect scouring caused by underwater structures could have on the seafloor sediments. The magnitude of indirect impact is higher due to the unconsolidated sediments being susceptible to scouring or other disturbance, which would affect the location and preservation of cultural material within and on top of the sediment.

16.98 The assessment has resulted in a 'major' magnitude of indirect impact on one site (MB19), 'moderate' magnitude of indirect impact on three sites (MB13, SS24 and SS40) and 'minor' indirect impact on 22 sites (Table 16.13). The significance of indirect impact is the same or less than that for the direct impacts (with the exception of MB13) and so they have been assessed in terms of impact together.

16.99 It is assumed that sites with a high and medium geophysical potential within 300m of the development in sand and gravel areas have the potential to be affected by scouring caused by the development.

16.100 The following sites, recorded in the turbine deployment area or within 300m of that area, are recommended to be either avoided or investigated by ROV:

- One MBES anomalies (MB19). This anomalies is a possibly wreckage, lost cargo, or ballast; and
- Two side-scan sonar anomalies (SS24 and SS40). These anomalies are possibly wreckage or lost cargo.

16.101 Both MB19 and SS24 are previously recorded in mitigation for impact 16.1. A 100m buffer has been allowed around the development areas due to issues of size of anomaly, accuracy in underwater location recording, and scouring on the seabed due to the strong tidal currents moving cultural material.

16.102 The potential cable deployment area is in another high-energy environment area with exposed bedrock and gullies. There were no sites recorded within 300m of this area.

MITIGATION IN RELATION TO IMPACT 16.3

- Although no significant impact have been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- Avoid placing the turbines on the sandy substrate on the northeast corner of the proposed turbine deployment area.

Residual impact

16.103 After implementation of the mitigation measures to address the significance of indirect impact on the geophysical anomalies that is currently assessed as major or moderate, the mitigated impact significant will be brought down to minor or negligible.

16.8 Impacts during Decommissioning

16.8.1 Impact 16.4: Damage caused by removal of turbine and cable to marine cultural material

16.104 The removal or cutting of the drilled piles, or the release of weight, from the TSS will impact the seabed affecting surrounding sediment or cultural material. The cables will be recovered to a vessel as the cables are moved over the seabed and the Horizontal Directional Drilling (HDD) bores filled at the breakthrough location. The TSS are to be installed on bedrock, therefore, this will not cause any damage to marine cultural material, which would have been examined prior to construction.

MITIGATION IN RELATION TO IMPACT 16.4

- No mitigation required.

16.9 Potential Variances in Environmental Impacts

16.105 This assessment has addressed the potential impacts associated with all potential offshore development areas; however, in reality it will only be certain areas within this footprint that will be developed. Therefore the actual impacts (both direct and indirect) will be less than those predicted here.

16.106 The majority of geophysical anomalies with uncertain/major significance of direct impact were located in the potential cable deployment area to the Ness of Huna. This involved five sites within 100m of this area (MB22, MB23, MB44, SS20 and SS39). The alternative cable route area to the Ness of Quoys involved two sites of uncertain/major significance of direct impact (MB28 and SS18) within 100m of the cable route.

16.10 Cumulative Impacts

16.10.1 Introduction

16.107 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

16.108 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 16.15 below indicates those with the potential to result in cumulative impacts from a marine cultural heritage perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	×	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	×
Pelamis Wave Power, Farr Point Wave Energy Project	×	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	×	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	×	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	×
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	×	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	×	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	×	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	×	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	×	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	×	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	×	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	×	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore Moray Firth)	×	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	×	Northern Isles Salmon, West Fara salmon cage site	×

Table 16.15: Summary of potential cumulative impacts

16.109 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

16.10.2 Potential cumulative impacts during construction and installation

16.110 Cumulative impacts arising from installation of multiple marine renewable projects at the same time as the proposed installation are not anticipated as the majority of impacts are expected to be localised. The Ness of Duncansby Tidal Energy project is the only project that may potentially be constructed at the same time as the MeyGen Tidal Energy Project, Phase 1 and would not act in combination to cause significant impacts.

16.111 The MeyGen Project, Phase 2 will require additional seabed within the AfL with the potential to increase the direct impacts (damage to cultural heritage assets exposed on the surface), although wherever possible cultural heritage assets will be avoided.

16.10.3 Potential cumulative impacts during operations and maintenance

16.112 The operation of both Phase 1 and Phase 2 of the MeyGen Project are likely to increase the likelihood of indirect impacts (by changes in bedload transport or erosion and deposition) on cultural heritage assets and geophysical anomalies. However the magnitude of impact is likely to be low as no turbines will be places on areas of sediment.

16.113 The operation of the Ness of Duncansby project is considered not to have cumulative impacts on the marine heritage as none of the modelling results for the Project show any changes that extend to the Ness of Duncansby site.

16.10.4 Potential cumulative impacts during decommissioning

16.114 Cumulative impacts arising from the decommissioning of multiple marine renewable projects at the same time as the Project are not anticipated as the majority of impacts are expected to be localised. There is limited scope for cumulative decommissioning impacts, since it is highly unlikely that the Ness of Duncansby development would be decommissioned at the same time as this development.

16.115 The MeyGen Phase 2 development (which would likely be decommissioned at the same time as the proposed development) may increase the likelihood of impacts from decommissioning as it will cover a greater area of the seabed. However the removal of turbines, TSS's and cables is not likely to cause any damage to marine cultural material, which would have been examined prior to construction.

16.10.5 Mitigation requirements for potential cumulative impacts

16.116 No mitigation is required over and above the Project specific mitigation.

16.11 Proposed Monitoring

16.117 A reporting protocol will be put in place in the event of discovery of previously unknown marine cultural heritage material. Depending on the significance of the find there may be a requirement for further investigation and recording in line with the mitigation proposed in this section.

16.12 Summary and Conclusions

16.118 There is no evidence of and low potential for, submerged landscapes, prehistoric cultural materials and wrecks, as large areas of the seabed have been scoured down to bare rock. There are 35 recorded wrecks (shipwrecks, aircraft and obstructions) in the general area. The position of 32 shipwrecks is approximate and none has been identified in the geophysical survey data. Therefore, it is assessed that the development may have direct and indirect impacts of negligible significance on this potential resource. The two shipwrecks with known locations, MV Bettina Danica and SS Malin Head, are outside of the offshore Project area (760m and 1450m away respectively). It is assessed that they may sustain direct and indirect impacts of negligible significance at most. A Spitfire lost in the general area in 1941 has been shown to have been lost in the sea off Duncansby Head, so is outside of the development area. There are no other areas, sites or wrecks protected, designated or controlled under the *Ancient Monuments and Archaeological Areas Act* 1979, the *Protection of Wrecks Act* 1973, the *Protection of Military Remains Act* 1986 or the *Marine (Scotland) Act* 2010, or potential Historic Marine Protected Area, within the proposed lease area.

16.119 Geophysical anomalies were identified in the overall survey area. Geophysical anomalies with Ranks 1 and 2 have uncertain potential of being cultural remains (those of Rank 3 are interpreted as natural). They could be wreckage, fishing material, anchors, or cargo lost overboard. There may be direct impacts of 'major' significance on 20 geophysical anomalies within 100m of the turbine deployment area and cable deployment area. There may be indirect impacts of 'major' significance on three geophysical anomalies within 100m of the development and indirect impacts of uncertain/moderate significance on three geophysical anomalies within 100 to 300m of the development, all in a sand or gravel sediment area.

16.120 If avoidance of potential cultural heritage features is not possible, it is recommended that geophysical anomalies of high and medium potential within 100m of the development are investigated by ROV methods in an appropriate manner by specialists in marine archaeology so they can be positively identified. This will be done before offshore construction commences. If the anomalies are identified and found to be either natural formations or recent anthropogenic debris they would have no or negligible significance and no further actions will be necessary. If a geophysical anomaly is identified as cultural material of low or higher significance it is proposed that they are avoided. If this is not practicable, mitigation or managements strategies such as wreck survey, salvage or intrusive archaeological evaluation will be undertaken. A reporting protocol will be instigated for the accidental discovery of marine cultural material during development, maintenance and monitoring. The implementation of the recommended mitigation strategies will result in the development having a minor or negligible residual impact on marine cultural heritage.

16.13 References

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