European Offshore Wind Deployment Centre
Environmental Statement

Appendix 9.2: Marine Ecology, Intertidal Ecology, Sediment and Water Quality EIA Technical Report

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1 MARINE ECOLOGY, INTERTIDAL ECOLOGY AND SEDIMENT AND WATER QUALITY

1 The Institute of Estuarine and Coastal Studies (IECS, University of Hull) was commissioned by Aberdeen Offshore Wind Farm Limited (AOWFL) to undertake the Environmental Impact Assessment (EIA) for the proposed European Offshore Wind Deployment Centre ("EOWDC"). The EIA process described in this report provides a description of the potential impacts of construction, operation and decommissioning upon the benthic ecology and fish communities within the proposed development area. A summary of the baseline data is also provided with detailed information presented in Section 1.1.1.

1.1 Information for the Non-Technical Summary

1.1.1 Background

2 This report assesses the possible environmental impacts of the proposed EOWDC off the coast of Aberdeen on the marine ecology of the area. The assessment process involves a review of the potential development options and assesses the option with the potential to have the greatest impact on each receptor, the 'worst case scenario'.

3 The various receptors that may be impacted by the development have been grouped into the following broad categories:

- invertebrates such as worms, shrimps and molluscs that live in the intertidal (beach) and subtidal (seabed) sediment;
- fish and shellfish (such as crabs and lobster) that live on the seabed and in the water column.

4 Potential impacts to these groups are considered in the context of the three main stages of the development – construction, operation and decommissioning.

5 The proposed development site contains physical, chemical and biological characteristics which resemble those of much of the surrounding area of Aberdeen Bay. These include a substratum of predominantly fine sandy sediment with no contaminants present at a level of concern and a generally good water quality. The animals living in the sediment of the beaches in the vicinity of the development are mostly mobile crustaceans which may provide food for fish living in the area. On the seabed, the main animals living in the sand are worms, with the most common species being *Notomastus latericeus*, and bivalves (mainly *Nucula nitidosa* and *Tellina fabula*). The community of animals living on the surface of the seabed is quite sparse but includes brittle stars and swimming crabs. The most common fish species using the area are flatfish such as dab and plaice, with hooknose and whiting also abundant. Fishing grounds are located outside the development area to the north and no specific spawning or nursery grounds have been identified in the development area.

6 A number of sites designated for their conservation importance (e.g. under European and UK law) occur along the coast in the Aberdeen Bay area.

None of these are located within the proposed development area (i.e. within the lease boundary). The closest Special Area of Conservation (SAC) to the site is the River Dee SAC, located 7.5 km south of the proposed EOWDC area, which supports three Annex II species, the freshwater pearl mussel, Atlantic salmon and otter.

1.1.2 Assessment of Impacts

7 Impacts on animals living in the beach sediment near the development are considered to be largely restricted to the construction phase when cable laying may disturb their habitat and lead to some small scale short-term direct habitat loss (from trenching) and indirect loss (from smothering by spoil). However, following cable installation, it would be expected that a rapid recolonisation of the habitat would occur. As such, the overall impact is assessed as being of minor to negligible significance. Decommissioning effects are expected to be similar, or below the level of those for construction. During the operation of the wind farm, it is probable that the cabling will increase the temperature of the surrounding sediment by a small amount. This is a very localised effect and, as the cable is likely to be buried at a minimum depth of 0.6m, well below the zone where most animals live (e.g. the top 15 cm of sediment), impacts would be of negligible significance.

8 Potential impacts to animals living on and in the seabed are expected to include temporary loss of and damage to the seabed soft sediment habitat (and associated animals) from the construction of foundations and associated scour protection and 'habitat loss' during the operational phase. The area of loss will be relatively small in the context of the development area, and partially offset by the creation of new hard substratum habitat associated with the new structures. The habitat which would be lost is not of a particularly high conservation value, and is characteristic of much of the wider Aberdeen Bay area. As such, habitat damage and loss are considered likely to be localised and of low magnitude and the impact has been assessed as minor at a habitat scale. Other minor issues with regard to sediment re-suspension during construction may occur, but given that the communities in the area are likely to be adapted to naturally high levels of such conditions, impacts are considered to be negligible. Similar types of impact have been identified for the decommissioning phase, although a lower significance is anticipated. The operational phase could also create potential impacts from the effects of underwater noise pressure and vibration, electromagnetic fields (EMF) and a temperature rise in the sediments around the cables. The effects on fauna are anticipated to be extremely localised and thus negligible. A potential impact from noise and vibration could also occur, particularly during construction works, but this has been assessed as of negligible to minor significance, due to the low magnitude of the effect and the low to medium sensitivity of the receptor.

9 Fish and shellfish in the development area are potentially going to be affected by noise and vibration generated during wind farm construction work (mainly from piling). However, these effects are likely to be short-term and intermittent, and their magnitude is expected to decrease with distance from the noise source. The most abundant species in the proposed development area tend to be less sensitive to noise and vibration than many species, and no significant sensitive fish habitats (spawning or

nursery grounds) occur in the proposed development area. Furthermore, most fish are able to move out of an area when conditions become unsuitable. However, due to sound propagation towards deeper waters, this impact might affect spawning populations of herring along the coast in Aberdeen Bay, even if no important spawning grounds of the species are present directly on the proposed development site. Due to the paucity of presence/absence data of herring spawning grounds in the wider area of influence of noise disturbance around the proposed EOWDC site, a precautionary approach has been adopted. As such, worst case impacts from construction noise on fish are considered to be of minor to possibly moderate significance, but with a strong likelihood that they are of no more than a minor significance. Other potential impacts on fish and shellfish during construction may arise from sediment re-suspension, contaminant release from construction works and loss of key habitats, but these have been assessed as of negligible to minor significance. Similar types of impact to those described above have been identified for the decommissioning phase, although a further lower significance is assessed due to the absence of a permanent habitat loss. Potential impacts on fish during the operational phase mainly arise from electromagnetic emissions associated with cabling. Research, e.g. through COWRIE, has identified Elasmobranchs as having a medium to high sensitivity to EMF. However, whilst they may occur within the development site, data would indicate their presence to be in low numbers and as such, the magnitude of the effect is considered to be low and the significance of the impact minor.

1.1.3 Cumulative & In-Combination Effects

10 Potential cumulative impacts arising from the possible presence of other activities and installations in the proposed development area have been assessed. The only plan or project identified near the proposed development area is the proposed Ocean Laboratory which, if approved, would be installed in close proximity to turbine location 1. Impacts arising from the construction, operation and decommissioning of this structure are likely to be broadly similar (in type) to those assessed for an individual turbine located within the proposed EOWDC. However, these impacts are likely to be of lower significance compared to those caused by the wind farm development, given the smaller scale of the Ocean Laboratory. As such, most effects would be masked by existing operations and any additive effects are considered to be minimal in the context of existing predicted impacts.

11 As the status of the freshwater pearl mussel is dependent upon the presence/absence of salmonids, the potential direct and indirect impacts of the proposed development on this species have been addressed within the salmon and sea trout assessment for the proposed EOWDC. The Habitats Regulations Assessment has also been addressed in this way. The Assessment should conclude no impact other than that consistent with impacts to the salmonid population.

1.2 Introduction

12 The Environmental Impact Assessment (EIA) process seeks to identify those impacts associated with the development through all phases of its evolution. These are based on knowledge of the existing environment (baseline conditions), the definition of the project proposed and the response of the environment to the potential changes. Where possible, mitigation is built into the project design to reduce impacts "at source", and where this is not possible a range of mitigation measures may be applied to reduce any residual impacts which might arise, often with a monitoring condition attached.

13 The construction, operation and decommissioning of an offshore wind farm will inevitably have some impact upon the physical properties of the seabed and the quality of the overlying water with consequent impacts upon the benthic communities and fish present and, ultimately on their predators (sea mammals and birds). Although these impacts have been widely monitored (see CEFAS, 2010a for a recent review), a certain degree of uncertainty still occurs, particularly in relation to the long-term and cumulative impacts of a proposed development and any other licensed and proposed activities within the area (CEFAS, 2010a). However, with respect to the benthic environment, many of the impacts of construction and estimated recovery times are expected to be similar to those associated with other anthropogenic activities, such as dredging, which are well documented (e.g. Kenny and Rees, 1994, 1996; Newell *et al*., 2004; Cooper *et al*., 2006, 2007, 2011).

14 This document provides information on the impacts of the proposed development on different aspects of the marine environment, namely intertidal benthos, subtidal benthos and epibenthos, and fish and shellfish communities. Potential effects on plankton assemblages have not been assessed in detail, as they are not considered to be an important issue in the impact assessment of offshore wind farms (Wilson *et al*., 2010). In addition to the absence of any substantive conservation reasons of targeting plankton within the EIA process, potential impacts on this group are unlikely due to its high natural spatial and temporal variability.

15 Where specific life stage aspects have been identified then these have been considered in the appropriate section (e.g. spawning areas and larval fish stages).

16 The EIA process has been carried out for individual components of the construction, operational and decommissioning stages and the potential impacts and their severity and permanency are characterised and discussed.

1.2.1 Methodology Consultation

17 Information on the EIA methodology and on the issues to be addressed during this process has been derived from relevant consultation responses such as:

- Sue Lawrence, Area Officer – City of Aberdeen and Aberdeenshire Central, Scottish Natural Heritage (10/09/29);

- Robert Forbes, Senior Planning Enforcement Officer, Aberdeen City Council (10/09/23);
- Nicola Abrams, Senior Planning Officer, Scottish Environmental Protection Agency (10/09/24);
- Fiona Thompson, Marine Scotland (10/12/15);
- Fiona Thompson, Marine Scotland (Scoping Opinion, and Consultee comments therein, in particular comments from Scottish Natural Heritage, Scottish Environmental Protection Agency, Marine Scotland, Association of Salmon Fishery Boards) (11/02/24).

18 The main points provided in the above consultation responses were:

- to consider onshore elements as part of the EIA process;
- to address aspects like the duration of impacts and timing of works;
- to take into consideration impacts on elasmobranchs other than basking and porbeagle sharks;
- to make appropriate links to fish and shellfish where there are strong habitat associations for certain species.
- to account for potential indirect impacts on pearl freshwater mussels and to make explicit reference also to River South Esk SAC when considering potential in-combination impacts.

All of these comments have been addressed within the EIA process.

1.2.2 Key Guidance Documents

A number of guidance documents are available to inform and direct the impact assessment process:

- IEEM, 2010. *Guidelines for ecological impact assessment in the United Kingdom*. Final document.
- *Environmental impact assessment: guide to procedures* http://www.communities.gov.uk/documents/planningandbuilding/pdf/157989.pdf
- *Guidelines on information to be contained in Environmental Impact Statements (EIS)* http://www.epa.ie/downloads/advice/ea/guidelines/EPA_advice_on_EIS_2003.pdf
- CEFAS, 2004. *Offshore wind farms: guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements.* Version 2. Prepared by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) on behalf of the Marine Consents Unit (MCEU). 45pp.
- EMEC, 2008. *EIA guidance for developers at the European Marine Energy Centre*. GUIDE003-01-03 20081106 21

- European Commission, 1999. *Guidelines for the assessment of indirect and cumulative impacts as well as impact interactions*. Document no. NE80328/D1/3.

- Metoc Plc., 2000. *An assessment of the environmental effects of offshore wind farms.* Report prepared for the Department of Trade and Industry/ETSU by Metoc Plc. [ETSU W/35/00543/REP].

- Scottish Government, 2010. *Renewables Action Plan*. Renewable Energy Division, June 2009.

- Scottish Natural Heritage, 2004. *Marine renewable energy and the natural heritage: an overview and policy statement.* Policy Statement No. 04/01.

- Scottish Natural Heritage, 2010. *Renewable energy and the natural heritage.* Ref No. 2010/02.

1.2.3 Data Information and Sources

Baseline data for the EIA process for this development have been derived from a range of published and grey sources, primarily:

- *European Offshore Wind Deployment Centre (EOWDC) request for an Environmental Impact Assessment (EIA). Scoping Opinion.* August 2010 (referred to as Scoping Report 2010).

- *EOWDC Baseline technical report for the European Offshore Wind Development Centre* (referred to as Baseline Report 2011).

- Seazone Hydrospatial Data, 2011. Provided for use on the European Offshore Wind Deployment Centre (Aberdeen Bay) under Seazone Licence Number 012005.003.

- OSPAR, 2004. *Draft background document on problems and benefits associated with the development of offshore windmill farms (OWF).* Annex 1. Report BDC/03/4/2-E.

- OSPAR, 2006. *Review of the current state of knowledge on the environmental impacts of the location, operation and removal/disposal of offshore wind-farms*. Publication Number: 278/2006.

- OSPAR, 2008. *Assessment of the environmental impact of offshore wind-farms.* Publication Number: 385/2008

- OSPAR, 2009a. *Assessment of the environmental impacts of cables.* Publication Number: 437/2009.

- OSPAR, 2009b. *Overview of the impacts of anthropogenic underwater sound in the marine environment*. Publication Number: 441/2009.

- Bio/consult, 2006. EIA Report – Fish - Horns Rev 2 Offshore Wind Farm. Doc. No. 2676-03-001.

- CEFAS, 2010. *Strategic review of offshore wind farm monitoring sata associated with FEPA licence conditions*. Final Report. Project code ME1117.

- SCIRA, 2006. *Preliminary assessment of WTG foundation types and their influence on the seabed. SCIRA Offshore Energy Limited Sheringham Shoal Windfarm.* Document No. SCIRA-8-1-2-SS-RP-04385 Rev. A4.

1.2.4 Impact Methodology

19 The assessment methodology used in this document follows a broadly common approach based around the IEEM Guidelines (IEEM, 2010), but adapted to address issues in the subtidal environment.

20 Impacts were assessed separately for each component of the marine ecology (receptors) and for the different project phases. The criteria in the assessment were based on the combined evaluation of the magnitude of effects and the sensitivity of each receptor.

21 In order to assess the magnitude of an effect, its spatial extent, duration and scale were taken into account. This information was gathered from available literature and previous assessments of similar effects, taking into account the technical information on the development structures and methodologies (e.g. power and number of turbines, footprints of foundations, etc.).

22 The assessment of the sensitivity of a receptor was based on its importance and recoverability. This information was mainly derived from the baseline technical report and, where possible, from additional assessments of impacts on the same or similar receptor.

23 The evaluations of the magnitude of effect and of the sensitivity of receptor were then combined in a final assessment of the impact significance, following the matrix in Table 1.

Table 1. Matrix for Significance of Impact

	Sensitivity of Receptor (based on importance and recoverability)				
Magnitude of Effect (based on spatial, duration and scale of effect)		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

1.2.5 Implications of Significance

24 Where the significance is classified as moderate to major or major this is considered to be a potentially significant effect. It should be noted that significant effects need not be unacceptable or irreversible.

1.2.6 Cumulative and In-Combination Impact Assessment Methodology

1.2.6.1 Cumulative Impact

25 Schedule 3 of the Electricity Works EIA (Scotland) Regulations 2000 requires that the potential for cumulative impacts should be considered and, where appropriate, assessed.

26 Guidance for the assessment of cumulative impacts is given in the guidance note for EIA in respect of FEPA and CPA requirements (CEFAS, 2004), which states that assessment must cover the potential impacts of any development cumulatively with those of all adjacent wind farm consented and proposed sites.

27 Cumulative impact assessment should include impacts that arise from any reasonably foreseeable project/development activities in the area, such as for example other wind farms, aggregate extraction and dredging, navigation and shipping, established fishing activities, existing and planned construction of subsea cables and pipelines, potential port/harbour developments, oil and gas installations.

28 As such the cumulative assessment addressed where predicted impacts of the EOWDC construction and operation could interact with impacts from other industry sectors within the same region and impact sensitive receptors. This may be through direct effects or spatially/temporally separated impacts on the same population of a receptor.

29 Broad scale information was gathered from the recently published Scotland's Marine Atlas (Scottish Government 2011) and from Seazone Hydrospatial Data (2011). No active international and inshore telecommunications cables are present within or close to the proposed development site (one international cable, CNS FIBRE OPTIC, is present, and approximately 20km north of the development area). An out of use BT submarine cable is present, laid from the shore to the proposed EOWDC area, but this is expected to remain *in-situ*, hence no additional impacts are anticipated to occur.

30 Similarly, no additional potential port/harbour development is present in the area.

31 With regard to renewable energy installations and power cables, no other wind farms are sited or planned for development near the proposed development site. The closest wind farm developments to the EOWDC site are the proposed Firth of Forth developments 58 km to the south and the Moray Firth developments 117 km to the north.

32 In addition, no oil and gas installations were identified near the proposed development, nor any aggregate extraction sites. On the north-east coast, the St Fergus gas terminal is the largest single gas importing facility in the UK, receiving gas from a large number of North Sea fields. However it is located far north of the proposed development area (approx. 40 km). Oil production from a number of central and northern North Sea fields feeds into the main pipeline at the Forties Charlie platform from where it is transported 175 km to Cruden Bay. These installations are located well to

the north of the proposed EOWDC area, hence no cumulative impacts are likely to occur.

33 No important fishing grounds are present within the proposed development area as confirmed by the baseline data. This is also supported by the results of a shipping activity survey carried out in 2009-2010, highlighting the presence of very few fishing vessel routes crossing the proposed EOWDC area (Scoping Report, 2010).

34 The proposed installation of an Ocean Laboratory on the wind farm site has also been considered as a source of additional impact. This particular development will be subject to a separate consent application which would be discussed with the relevant consenting authorities. The impacts of the construction, operation and decommissioning of the Ocean Laboratory are likely to be similar (in type) to those derived from the wind farm development, given that similar foundation type and installation methodologies will be used, but of a smaller magnitude given the developemnt size. Cumulative impacts with the Ocean Laboratory are considered for each impact.

1.2.6.2 In-Combination Impacts

35 The assessment of in-combination impacts considers any other industrial activities or plans or projects which could in-combination have an impact upon species and areas protected under the Habitats Directive. The main industries that have been considered for potential in-combination impacts are the aggregate industry, oil and gas and shipping.

36 The only species protected by the Habitats Directive and with the potential to be subject to significant in-combination effects, is the freshwater pearl mussel which is a qualifying feature of the River Dee SAC. The fresh water pearl mussel is a long-lived filter feeding species, which only lives in rivers and streams. Scottish populations of this species are of world-wide importance as half the world's known breeding population of pearl mussels are found in Scotland. Besides requiring clear and fast flowing waters and gravelly-sandy bottoms, the species is highly dependent on the presence of salmon and trout in the river. In summer (July to September), after reproduction, pearl mussel pelagic larvae are released; most of them are swept away downstream, whereas some are inhaled by juvenile Atlantic salmon and sea trout and they encyst onto their gills. This allows larvae to be retained in the freshwater environment and be transported upstream, where they drop off the gills the following spring (May to early June) and, if settling in clean, sandy or gravelly substrates, they settle and start to grow (Skinner *et al*., 2003).

37 Due to these life cycle requirements and the distance of designated SACs for this species from the proposed EOWDC area (> 7 km), it is considered that the freshwater pearl mussel is unlikely to be subject to direct impacts from the proposed development, however, indirect effects might arise as a result of possible impacts on their host populations (Atlantic salmon and sea trout).

38 Therefore, the characterisation of potential in-combination impacts of the development on migratory salmonids and on the freshwater pearl mussel are addressed separately within the salmon and sea trout assessment for the proposed EOWDC. It is expected that any in-combination impacts on the freshwater pearl mussel will not be significant if the impact on the salmonid population is not significant.

1.2.7 Worst Realistic Case

39 As part of the proposed development project, there is the intention to install a mix of "first run of production" wind turbines on a mix of conventional and novel foundations. The final types of structures (e.g. turbine or foundation) will be unknown at the time of the consent application and will be decided post consent during the detailed engineering design phase.

40 Eleven wind turbines are to be installed in the proposed development area, with the possible deployment of 4 wind turbines in 2013, and of 7 wind turbines in 2014 (although all 11 could potentially be installed in 2013). Each of these wind turbines will be of between 4 and 10 MW generative capacity. Five different foundation types are under consideration (namely concrete/steel monopile, jacket on piles, tripod on piles, gravity base structure, and suction caisson/bucket). The various options may require different levels of scour protection and different installation methods (Scoping Report, 2010; Chapter 3, Description of the Proposed Development).

41 Based on the technical information available to date (see chapter 3, Description of the Proposed Development), and following the 'Rochdale Envelope Approach', the impact assessment has used a 'worst case scenario' in order to assess the worst possible impacts of the proposed development on the marine ecology of the area. This approach provides flexibility to AOWFL in a changing market but also ensures that all possible impacts of the test site have been assessed.

1.3 Impact Assessment

42 Different sources of impact on marine communities (intertidal and subtidal benthos, fish and shellfish) have been identified. The potential impacts, mitigation measures, residual and in-combination impacts, and monitoring related to these different sources are presented separately for the different project phases.

43 The assessment of impacts which are likely to arise during construction of the proposed development took into account the different activities which are likely be carried out during this project phase, such as shipping, transport of components to site, assemblage on site, anchoring, jack-up rigs installation, excavation, foundations and cable installation.

44 With regards to the operational phase, the assessment has accounted for the potential impacts arising from the physical presence of the development structures (wind turbines, foundations, scour, cables) in the area.

45 Decommissioning and removal of the structures, foundations and cables will be necessary within a period of 22 years (i.e. the maximum design life of the proposed EOWDC). Piled foundations will be cut below the seabed and anything above this will be removed. Suction and gravity base type foundations will be fully removed. It is likely that the subsea cables would be left buried and notified as being disused, and therefore no associated impacts are anticipated. Removal of cables is not intended except where surveys before decommissioning identify a risk of them becoming uncovered.

46 It is anticipated that the decommissioning approach would follow industry standards at the relevant time in the future. The expected effects of decommissioning activities are expected to be broadly similar to those associated with the construction phase (OSPAR, 2004).

1.3.1 Water Quality Impairment (Release of Contaminants)

1.3.1.1 Construction & Decommissioning Phase

Potential Impacts

47 Barges, tugs, jack-up rigs and other support vessels will be required to transport components to/from site and assemble/remove them on site (further details in Chapter 3, Description of the Proposed Development).

48 There is potential for contaminants to be accidentally released directly during the construction and decommissioning works, including drilling lubricants, degreasing agents and detergents from vessels, as well as subsequent release of sewage, ballast water, chemicals (oil). If grout and anti-fouling paints are to be used, then grout spills can alter the pH of the local environment temporarily, whereas biocides are, by their nature, toxic to marine species. A consequent impairment of water and sediment chemical quality might arise. Adherence to regulatory operational standards such as MARPOL 73/78, the UK Merchant Shipping (prevention of pollution) Regulations 1983 and the Merchant Shipping (Prevention of Pollution by Garbage) Regulations 1988, UK Offshore Chemical Regulations 2001 will ensure that such a potential release is minimised. Any potential discharges are likely to be very localised and short-term in duration. In addition, the proposed EOWDC development is located in an area of high hydrodynamic energy and a high level of dispersion and dilution of any contaminants is expected. The overall magnitude of this effect is therefore assessed as negligible.

49 The construction and decommissioning works (including cabling) will re-suspend seabed sediment, with the potential for any sediment-bound contaminants to be released into the water column, impairing water quality. Data from sediment analyses (CMACS, 2010) show that no significant sediment contamination has been detected, therefore this issue has been scoped out of the assessment.

50 If an accidental spillage occurs, there may be potential adverse biological effects of contaminant release on subtidal benthos, fish and shellfish receptors.

51 Possible toxic effects on subtidal benthos would be restricted to the immediate area of the construction site (site-specific effect), and the effect would be reversible. The potential impact on benthos has been assessed as of negligible magnitude, the receptor of medium sensitivity (due to the fact that this receptor is sedentary and unable to move away from the effect) and therefore the significance of the impact would be negligible.

52 Contrary to the situation for the most of the benthos, the fish fauna has the ability to escape from the local affected area if conditions become poor, hence its sensitivity to contaminant release is assumed to be lower than for benthos. The potential impact on fish has been assessed of negligible magnitude, the receptor of medium to low sensitivity and therefore the significance of the impact would be negligible.

Mitigation

53 No additional mitigation for this impact is required.

Residual Impacts

54 The residual impacts have been assessed as of negligible significance.

Cumulative Impacts

55 As any impacts would be extremely localised and, given adherence to operational standards, unlikely, cumulative impacts are not expected.

In-Combination Impacts

56 No in-combination impacts are predicted.

Monitoring

57 No specific monitoring is required.

1.3.1.2 Operational Phase

58 This impact is unlikely to occur during the operational phase.

1.3.2 Sediment Resuspension / Redeposition

1.3.2.1 Construction & Decommissioning Phase

Potential Impacts

59 Activities during foundation installation and removal of the above-seabed structures are predicted to generate levels of suspended sediment above those found naturally. In terms of the volume of sediment disturbance, the worst case scenario is based on the installation/removal of the 11 x 10 MW wind turbine array as a single phase, with gravity base foundations used (see Coastal Processes Assessment, Section 8. Further sediment resuspension and deposition will also result from the cable laying activities in the proposed development area.

60 The surface sediments over the majority of the proposed EOWDC site comprise fine sand, and any disturbance to such sediments is likely to result in bed-load transport rather than in suspension. Given the weak tidal currents in the area (responsible for the sediment transport offshore) (ABPmer, 2011), it is likely that, following disturbance by the bed levelling process, sandy material would fall close to the point of disturbance and

then become part of the active baseline sedimentary regime. However, areas with a higher proportion of silt content also occur within the lease boundary of the proposed wind farm site. Disturbance of finer material from this area would result in fine sediments being transported in suspension and dispersing over a wide area. It is likely that the main effects would be restricted to the EOWDC area (and the areas around the cables) given the localised nature of the sediments that might be resuspended and the probability of relatively local dispersion. Consequently, an assessment of the potential effects of the increase in suspended sediments can be limited to those receptors that exist within the proposed EOWDC site.

61 Potential adverse biological effects of sediment resuspension/redeposition in the aquatic system may affect subtidal benthos, fish and shellfish receptors.

62 Raised levels of suspended sediment may impact benthic communities through clogging of respiratory and feeding mechanisms. Sediment displacement may cause smothering of the bed and the benthos in the immediate area of the construction/decommissioning site (Hiscock *et al.*, 2002; Metoc Plc, 2000; OSPAR, 2004). Sediment displacement may also lead to temporary changes in the characteristics of the sediments, such that they no longer provide an optimum habitat for existing communities to function. However, benthic communities in circalittoral sands are generally well adapted to high energy conditions and will tolerate changes such as sediment disturbance, increased turbidity or increased levels of suspended sediments relatively well, with an ability to recover rapidly in the case of strong impacts (Kaiser & Spencer, 1996; Elliot *et al.*, 1998; Connor *et al.*, 2004). This is confirmed by the assessment of the sensitivity of the benthic communities in the proposed development site with respect to the sediment disturbance carried out on the basis of data given in MarLIN (Appendix 1). None of the biotopes present are sensitive to increased suspended sediment loads, are of only low sensitivity to sediment disturbance, and are expected to recover immediately after smothering. Consequently, the potential impact on benthos has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible.

63 An increase in sediment loads above background levels caused by the construction and decommissioning activities has the potential to locally affect fish and shellfish receptors in the proposed EOWDC site. It is likely that mobile fish in the vicinity of any excavation and piling work would temporarily move from the area as soon as noise levels increase and would, therefore, not be exposed to the greatest increases in suspended sediment levels that would arise locally. Effects on non-mobile organisms (e.g. many shellfish) are expected to be greater as they are less able to escape from the affected area if conditions become poor. However, no significant populations of sedentary shellfish were recorded within the proposed development site. Given the relatively homogeneity of the benthic habitat in this coastal area, escaping fish are likely to find similar habitats in adjacent, unaffected, areas (e.g. suitable nursery habitats for flatfish). Although there are no direct data to describe this, indications on habitat use and population levels in these surrounding areas would suggest that there is some assimilative capacity here for displaced populations. As such, these adjacent areas may be capable of buffering

the local and temporary impairment of the habitat within the proposed development area. Furthermore, the species recorded in the baseline surveys will to some extent be adapted to regular increases in suspended sediments above background levels due to the natural conditions that exist in the Aberdeen Bay. In fact, suspended sediments in this area are relatively high compared to many other UK coastal areas with significant fluctuations resulting from tidal or weather (storm) events.

64 Increased sediment deposition may also lead to potentially adverse impacts upon fish spawning habitat, with particular regard to demersal spawners (e.g. sandeel and herring). Deposition of sediment (and particularly fine sediment) onto such habitats may reduce water flow to the eggs and subsequently reduce their oxygenation. However, only low levels of deposition are likely to occur within the proposed EOWDC site and outside the site boundaries deposition would be negligible. In addition, no specific spawning grounds were detected in the proposed development area.

65 Based on the fact that (a) the effects will be temporary and localised; (b) no important spawning or nursery grounds are present or are strictly localised within the proposed development area; (c) the majority of fish resources recorded within the site are typical of the wider region, already adapted to natural increases in suspended sediment levels, and mobile, the potential impact on fish has been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

Mitigation

66 Given the negligible to minor significance of the impact, no specific mitigation is required.

Residual Impacts

67 The residual impacts have been assessed as of negligible to minor significance.

Cumulative Impacts

68 The additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development, given the smaller scale of the Ocean Laboratory. Given the negligible to minor impact identified during wind farm development construction, it is unlikely that there would be the potential for significant cumulative impacts particularly as construction periods for the proposed installations are unlikely to overlap. This would also be the case for the decommissioning phase.

In-Combination Impacts

69 None anticipated.

Monitoring

70 The coastal processes studies for the proposed EOWDC identified that even for the worst case development scenario suspended sediments levels are expected to be within naturally occurring ranges, therefore there is not anticipated to be any advantage in monitoring this aspect.

1.3.2.2 Operational Phase

71 This impact is not expected to occur during the operational phase.

1.3.3 Habitat Loss

1.3.3.1 Construction & Decommissioning Phase

Potential Impacts

72 As highlighted in Section 1.3.1, barges, tugs, jack-up rigs and other support vessels will be required to transport material for the foundations/piling, together with the turbine components themselves to the site. The legs of jack-up barges and the anchorage of construction vessels are likely to result in physical disturbance and abrasion and/or displacement of the seabed with a consequent habitat loss occurring. Although the exact method of wind turbine placement has yet to be finalised, it is likely that jack-up rigs would be required with the worst case scenario involving the installation of the 11 x 10 MW wind turbine array. Footprint area will depend on the final vessel set-up, and the worst case scenario has been assumed to be a maximum of 12 (6 legged jack-up and 6 legged barge) footprints per turbine. Taking into account multiple operations, this could entail an area of impact of up to 4200 m^2/turbine. This would lead to a seabed disturbance area corresponding to 0.2% of the total proposed EOWDC area (20 km^2). Coastal process modelling for the proposed EOWDC demonstrates that the impacts upon the seabed from construction and decommissioning are considered to be of negligible significance.

73 Temporary habitat loss will also arise both in the intertidal and subtidal areas following cable lying. Cables running both between the turbines and to the shore are generally placed in trenches and buried in order to prevent damage to the cable and to prevent disturbance to fishing activities. Options for cable laying include trenching prior to cable laying or by ploughing or jetting directly into the sediment (further details in Chapter 3, Description of the Proposed Development). Each of these methods may be employed in the proposed EOWDC site, although ploughing and jetting are most appropriate to the substrate in the area. Furthermore, the movement of heavy construction vehicles on the intertidal area could cause churning and/or compaction of the surface sediment, resulting in further habitat loss (further details in Chapter 3, Description of the Proposed Development) , the worst case impact, in relation to direct substratum loss in the subtidal and intertidal area, would result from ploughing, with a loss of 10.38 m^2 of habitat per meter of cable laid (including the likely footprint of equipment used). This would lead to a total seabed loss of 0.27 km^2 from the export cable laying (max 26 km total length), and a 0.13 km^2 from the inter-array cable laying (max 13 km total length), this latter area corresponding to 0.7% of the proposed lease boundary. The depth of impact is anticipated to be up to 3 m but final working depth would be based on further studies and suited to the seabed conditions. Any loss will be temporary as, once instated, the sediment would either be backfilled or re-deposit naturally over the cables.

74 Construction activities, in particular foundation installation, will lead to further seabed habitat loss directly within the footprint of these structures. This impact is dealt in detail in Section 1.3.3.2.

75 Potential adverse biological effects of temporary habitat loss will affect benthic communities, both in the subtidal and in the intertidal areas.

76 Impacts on the subtidal benthic ecology would include damage or mortality to invertebrate species (Hiscock *et al.*, 2002). Due to the relatively small area affected at any one time, recolonisation may be rapid after the construction/decommissioning activities have ceased. Within the proposed development area one biotope type, SS.SSA.CMuSa.AalbNuc, has been identified. The higher level biotope SS.SSA.CMuSa of which SS.SSA.CMuSa.AalbNuc is a component is designated as a UK BAP priority habitat. However, the Level 4 biotope SS.SSA.CMuSa.AalbNuc is not uncommon in the wider Aberdeen Bay area, and although *Abra alba* is a common food source for *Asterias rubens* and different species of demersal fish (MarLIN, http://www.marlin.ac.uk/habitatimportance.php), it is not considered to have an especially high ecological importance at the local scale. In addition, the biotope is considered to have a high recoverability, and only a small percentage of the total benthic habitat in the proposed development area is expected to be lost (<1%, considering both foundation and cabling activities). Furthermore the impact will be temporary as it is expected that much of the seabed would be returned to a similar physical condition soon after the disturbance ceases. As such the potential impact on subtidal benthos has been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

77 A localised (site-specific) and temporary impact on intertidal benthos would arise from the laying/removal of the export cable route. Although the exact location of the cable route is currently unknown, as this is dependent on the location of the onshore substation, available data show that the coast in this area is characterised by moderately exposed sandy beaches, with the intertidal fauna dominated by haustorid amphipods (*Haustorius arenarius* and *Bathyporeia pelagica*) and in some cases the spionid polychaete *Scolelepis cirratulus* (Hart, 1971). According to the JNCC biotope classification, this habitat matches with the biotope LS.LSa.MoSa.AmSco (Amphipods and *Scolelepis* spp. in littoral medium-fine sand) (Connor *et al.,* 2004), occurring in coarse sandy beaches on exposed and moderately exposed shores, with sediment grain sizes ranging from medium to fine, often with a fraction of coarser sediment. The recoverability of this biotope from substratum damage is considered to be high, as is its recoverability from smothering (MarLIN).

78 Observations of the temporary habitat disturbance and benthic recolonisation following pipe laying operations carried out in the Lavan Sands near Bangor (North Wales) highlighted a continual repopulation of the disturbed area by mobile organisms, such as the gastropod *Hydrobia ulvae*, during the construction works, and a rapid post-disturbance recolonisation (Rees, 1978). Several species, including the polychaetes *Arenicola marina*, *Eteone longa* and *Scoloplos armiger* were recruited preferentially to the disturbed area. Longer lived species (e.g. *Scrobicularia plana*) showed higher depression of their numbers, lower recruitment and took several years to return in significant numbers after

the pipeline operations had been completed (Rees, 1978; Hiscock *et al.*, 2002). However, for the proposed EOWDC, such an effect is likely to be negligible, as larger, longer lived, usually sedentary species are not found with significant abundances in the exposed shores along Aberdeenshire coast. In turn, the recolonisation of the disturbed intertidal areas by opportunistic species along the Aberdeenshire coast, following the completion of the proposed EOWDC development construction and decommissioning activities, is expected to be rapid, hence the effect would also be reversible over the short to medium term. The potential impact on intertidal benthos has then been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

Mitigation

79 Given the negligible to minor impact assessed, no specific mitigation measures are required. However, good construction practices will be discussed with contractors and could include backfilling trenches to just below the adjacent beach surface level to allow natural accretion to fill the upper surface.

Residual Impacts

80 Residual impacts of negligible to minor significance are expected which will be reversible.

Cumulative Impacts

81 The additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development. Furthermore, the supply cable from the Ocean Laboratory to shore is likely to be routed via the main wind farm export cable route, potentially installed in the same trench. Given the minor impact identified during wind farm development construction/decommissioning, it is unlikely that there would be the potential for significant cumulative impacts particularly as construction periods for the proposed installations are unlikely to overlap.

In-Combination Impacts

82 None envisaged.

Monitoring

83 No specific monitoring planned.

1.3.3.2 Operational Phase

Potential Impacts

84 The installation of wind turbine foundations will lead to permanent habitat loss directly within the footprint of the turbines, supporting structures and any protection. The extent of such impacts will be highly dependent on the final choice of the structures to be installed (wind turbines, foundations and scour protection). Due to the greater extent of the total footprint and the requirement for seabed preparation/levelling, the installation of 11 × 10 MW wind turbines with gravity base foundations has been considered to have the greatest potential impact on the seabed communities, with the 'worst worst-case' scenario assuming that no scour protection is provided (according to the coastal process assessment for the proposed EOWDC). Each gravity base foundation area (including scouring) would be a

maximum of 1865 m^2, leading to a total loss of 0.03 km^2 seabed area within the lease boundary, corresponding to 0.17% of the lease boundary (including foundation + scour footprint) (see Section 8.2). Not taking in to account potential scouring or scour protection the total habitat loss from each gravity based structure would be 1,257 m^2 with a total loss of 0.0138 km^2 seabed area corresponding to 0.07% of the lease boundary. In areas of mobile sands, such as those present within the proposed development site, the substratum exposed by scour is likely to be of a similar type to that naturally present, although the high current speeds in the development area may cause a reduction in sediment fines in any scour pits. However, as scour develops and reaches equilibrium, instability is unlikely to occur for more than 12 hours at any foundation location (see Section 8.2).

85 Potential adverse biological effects of permanent habitat loss within the footprint of the wind farm structures will affect subtidal benthic communities, fish and shellfish.

86 The permanent loss of seabed will affect the infaunal component of the benthic community. In the case of this development, the soft sediment communities present will include the robust polychaetes and bivalves. The less mobile epifaunal organisms will also be affected, such as the abundant brittle stars in the area. More mobile epifaunal organisms (such as shrimps and crabs) are likely to avoid any direct effects by moving away from the affected area.

87 The direct habitat loss that will occur within the proposed lease boundary will be the SS.SSA.CMuSa.AalbNuc biotope. This will include a direct loss of 0.17% of the biotope within the proposed development area (assuming a worst case of 40 m diameter gravity base foundations and associated scour). The higher level biotope SS.SSA.CMuSa includes SS.SSA.CMuSa.AalbNuc which is designated as a UK BAP priority habitat. However, given the extent of the Level 4 biotope in the wider area, it is not considered to be of particular ecological importance at the local scale, and as such, the overall impact of the direct habitat loss on benthic communities in the development area will be small, although permanent. The potential impact on subtidal benthos has been assessed as of low magnitude, the receptor of medium sensitivity and therefore the significance of the impact would be minor.

88 Direct habitat loss within the footprint of the proposed development structures may potentially impact sensitive habitats such as fish and shellfish spawning and nursery grounds. Broad scale studies place the proposed EOWDC site within spawning and nursery habitats for a number of commercial and non-commercial species (Coull *et al.,* 2008; CEFAS, 2010b). However, baseline studies did not identify the proposed development site as being of particular importance to fish and shellfish communities. No 'hot spots' of biodiversity or important sensitive habitats, such as spawning and nursery grounds, were detected in the proposed development area. Furthermore, with respect to non-commercial species, such as dragonet and gobies, the potential loss of spawning and nursery habitat from the proposed wind farm development would represent a negligible proportion of similar habitat for these species, as these habitats are ubiquitous throughout the Aberdeen Bay strategic area. The same conclusion has been reached for some commercial species, such as

flatfish, which have potential nursery areas extending in the shallow waters along Aberdeenshire coast, and which may buffer any local nursery habitat impairment from the proposed EOWDC.

89 As such, the loss of potential sensitive habitats due to the installation of the main wind farm structures is likely to be a very small proportion of similar habitats in the wider area. Furthermore, no significant spawning grounds, e.g. for sandeel, herring or Norway lobster, have been identified in the proposed development area and in its surroundings, possibly due to these species' preference for coarser (as for sandeel and herring) or muddier (as for *Nephrops*) sediments than those in the survey area. No significant populations of these species were found in the proposed development site during the epibenthic surveys carried out to assess the baseline conditions. The surveys suggest the minor importance of the site as feeding ground for other important predator species, such as Atlantic salmon and sea trout (sandeel and herring being important prey for such fish species). Given the above considerations, the potential impact on fish has been assessed as of low magnitude, the receptor of medium sensitivity and therefore the significance of the impact would be minor.

Mitigation

90 Given the minor impact assessed, no specific mitigation is required.

Residual Impacts

91 Residual impacts of minor significance are expected.

Cumulative Impacts

92 The additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development. Given the minor impact identified during wind farm development construction/decommissioning, cumulative impacts will also be of minor significance.

In-Combination Impacts

93 None envisaged.

Monitoring

94 No specific monitoring planned.

1.3.4 Effects of the Physical Presence of the Submerged Structures

1.3.4.1 Construction & Decommissioning Phase

Potential Impacts

95 This impact is likely to occur during the operational phase.

1.3.4.2 Operational Phase

Potential Impacts

96 The presence of the wind turbine and their foundations is likely to modify the hydrodynamic regime around the development site (Elsam Engineering A/S and ENERGI E2 A/S, 2005; OSPAR, 2006). The resistance from the

foundations can influence the current and wave conditions in the wind farm area, leading to possible alteration to the character of the topography of the seabed in terms of sand wave redistribution, although this latter impact is expected to be local. However, the coastal process (see Section 8.2) modelling work has shown that impacts upon tidal currents and residual flows as a result of the proposed EOWDC will be of negligible significance.

97 The physical presence of foundations, turbines and any scour protection will provide an artificial reef structure for colonisation by aquatic organisms, known as the "reef effect" (Wilson, 2007).

98 Potential biological effects of the physical presence of the wind farm structures may affect subtidal benthos, and fish and shellfish communities.

99 The submerged wind turbine structures are likely to provide a new habitat for colonisation by epifaunal and encrusting species, as well as by fish, thus leading to changes in the benthic and fish communities in the area (Hiscock *et al.*, 2002; Lewis *et al.,* 2002; OSPAR, 2004). Based on the epifaunal communities present in the area, colonisation by bryzoans, sponges, hydroids and the encrusting polychaete *Pomatoceros* spp. is likely, together with several decapod, mollusc and echinoderm species. Infaunal organisms, or those requiring some sediment, may colonise areas of sediment deposition between rocks. Colonisation of the wind turbines by encrusting organisms may provide a new food source for local fish and shellfish and may also create new habitats that could provide refuges for many fish species. Once fully installed and operational, the wind turbine structures would form a hard substratum that did not exist previously in the area and which would be colonised quickly by communities of benthic organisms and other associated species including commercially important species of fish and shellfish. The overall effect of the foundations and scour protection will be to replace small areas of the existing sandy biotopes with typical hard substrate epifaunal communities. This is likely to increase (albeit extremely locally) the overall species diversity and productivity (Wickens & Barker, 1996; Grossman *et al.,* 1997; OSPAR, 2004). Epibenthic colonisation is dependent upon water depth, hydrography and the degree of scour, with the greatest degree of colonisation being associated with areas of more stable substrata. It should be noted that changes to the sediment properties as a result of scour may prevent recovery of the original benthic community, although they may possibly increase local biodiversity and may also provide a food source for fish and crustaceans (Hiscock *et al.*, 2002).

100 Bio/Consult (2004b, 2005b) concluded that the epifauna on the turbine foundations at the Horns Rev Offshore Wind Farm off the Danish coast led to an eight-fold increase in biomass compared with the typical soft sediment fauna of the area (even though the colonisation on the turbines appeared not to be particularly high in this area due to strong scouring effects). Monitoring reports from other offshore wind farm sites describe the invertebrate recolonisation succession, with common mussels, barnacles (Cirripediae) and red macroalgae dominating the fouling community in the wind farm submerged structures in the first year after the structure deployment (Birklund, 2005; Leonhard and Pedersen, 2005). The organisms that develop on submerged wind farm structures may provide a new, direct food source for certain fish and shellfish species. Alternatively, encrusting species may attract small organisms, such as

mantis shrimps, to graze upon the wind turbines, and these species would themselves be a potential food source for larger fish species. For example, the new hard substrate communities may provide a valuable food source for fish species such as North Sea cod and pout (Bouma and Lengkeek, 2009). The use of wind turbine foundations as spawning and nursery grounds has also been suggested following the observation of the presence of abundant juvenile crab species and egg masses of invertebrates on the foundations and scour protection (Leonhard and Pedersen, 2005).

101 Wind turbines may also produce some form of aggregation of local fish stocks, acting as Fish Aggregation Devices (FAD) (CEFAS, 2010a). This effect has been observed, for example, at the Burbo Bank offshore wind farm, in Liverpool Bay at the mouth of the River Mersey (CEFAS, 2010a).

102 Based upon the evidence from monitoring programmes at existing offshore wind farm sites, there is a possibility that the submerged structures in the proposed EOWDC site would provide a new habitat leading to a positive impact on the benthic biodiversity and also attracting certain fish and shellfish species. However, although the overall effect of the hard structures is considered to be positive, it is considered as localised and it is judged unlikely that populations as a whole in the area would increase above existing levels. The potential impact on benthos, epibenthos and fish has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible (although positive).

103 The physical presence of wind turbine structures might also adversely affect the shoaling behaviour of pelagic fish, such as sprat and herring, leading to possible dispersal of shoals. Sprat and herring exhibit shoaling behaviour throughout their life cycle for a number of reasons, including aiding migration to spawning grounds and increasing protection from predators. Consequently, a disruption to shoaling activity or behaviour as a result of the presence of wind turbines may potentially have an adverse effect on the local ecology of these species. However, there is relatively little evidence to prove or disprove the claim that offshore wind turbines may disrupt shoaling behaviour. In reality, if a large shoal of pelagic fish does come across a wind turbine, or multiple wind turbines, it is judged unlikely that the integrity of the shoal would be significantly adversely affected. Such behaviour may occur naturally (e.g. due to the presence of wrecks or other underwater obstructions) and whilst the shoal may become temporarily fragmented it is likely that the strong behavioural instinct to reform the shoal would result in the shoal integrity being restored quickly. Based upon the considerations above in relation to shoaling behaviour and the potential spacing of the wind turbines in the proposed EOWDC site, the potential impact on fish has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible.

Mitigation

104 No mitigation is required for this impact.

Residual Impacts

105 The residual impact is assessed as of negligible significance.

Cumulative Impacts

106 The additional impact arising from the physical presence of the Ocean Laboratory on the proposed EOWDC site is likely to be of lower significance than that one caused by the wind farm development. Given the negligible impact identified for the wind farm development, it is unlikely that there would be the potential for significant cumulative impacts.

In-Combination Impacts

107 The potential direct and indirect impacts of the proposed development on salmonid, and indirect impacts on freshwater pearl mussel, populations of the River Dee and River South Esk SACs have been addressed within the salmon and sea trout assessment for the proposed EOWDC.

Monitoring

108 Monitoring will be agreed with the relevant statutory authorities and requirements incorporated into the Marine Licence.

1.3.5 Noise and Vibration

1.3.5.1 Construction & Decommissioning Phase

Potential Impacts

109 Noise is associated with many activities during wind farm development, e.g. construction works, vessel movements, piling activities, etc. It is in respect of pile-driving that the greatest levels of noise are likely to arise, being predominantly low frequency underwater noise, that can travel large distances and that can lead to acute short term disruption of the marine fauna (Hiscock *et al*., 2002; Nedwell *et al*., 2007, 2011; OSPAR, 2008). Other sources of noise, such as for example rock dumping (for provision of scour protection), cable trenching of inter-array cables, or increased vessel traffic during construction/decommissioning activities are unlikely to contribute significantly to background noise (which might be relatively high, due for example to the large volumes of shipping already occurring in the area) or to provoke significant effects on marine fauna (Nedwell *et al.,* 2003).

110 In the context of the construction/decommissioning of the proposed EOWDC development, the worst case scenario is assumed to be the installation of the largest piles (8.5 m) (Nedwell *et al*., 2011). This has the likely potential to cause disturbance over the greatest distances, although on a reduced number of occasions (Parvin *et al.,* 2006). According to the underwater noise modelling carried out in support of the EOWDC and accounting for the worst case scenario, the expected peak to peak Source Level of this pile driving operation will be around 250 dB re 1 µPa @ 1 µm, with a propagation with lower losses in deeper waters, out to the east of the proposed development site (Nedwell *et al*., 2011).

111 Potential biological effects of the underwater noise produced during construction works could affect subtidal benthos, and fish and shellfish communities.

112 The impacts of noise during wind turbine array construction upon the benthic communities are not well understood (Metoc Plc, 2000; OSPAR, 2009b). There have been no specific investigations on the effects of marine construction and industrial activities on marine invertebrates (OSPAR, 2009b). However a certain amount of physical damage to invertebrate organisms living in close proximity to pile driving activities is expected. The effects of the pressure wave will be higher on sessile invertebrates, as the more mobile benthic organisms would be able to move away from the area. Significant impacts such as mortality of larval fish and crustaceans are likely to be constrained to within a few metres of the piling activity (Dr J Allen, pers. comm.). However, recruitment to areas where damage could have occurred is likely to be rapid due to the presence of other benthic organisms in the vicinity. The potential impact on benthos has been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

113 The approach to the assessment of the resulting effects on fish in the United Kingdom is to concentrate on times when fish can be considered to be at their most vulnerable to noise disturbance (e.g. spawning seasons, migration, etc.) for those species at risk on a case by case basis (OSPAR, 2008). Fish are receptive to noise with hearing and the detection of vibrations being two of their most developed senses. Typically fish hear at very low frequency (typically 10 Hz to 1000 Hz) (Nedwell and Brooker, 2008). Different species of fish have different hearing abilities, the main reason for this being ascribed to adaptive physiology. According to this, fish have been distinguished as hearing "specialists" (having specialisations that enhance hearing, as for example swim bladder or gas filled bullae) and "generalists" (not having such specialisations). Hearing "specialists" tend to detect sound pressure with greater sensitivity and in a wider bandwidth than "generalists". In particular, herring and sprat are considered as highly sensitive species to noise; species like dab, plaice, salmon and sandeel are considered to have low sensitivity to noise and vibrations, whereas intermediate sensitivity is reported for gadoids (cod, haddock, hake), mackerel and eel (Nedwell *et al.,* 2003).

114 The noise associated with the construction of offshore wind farms (particularly piling noise) may affect marine fish through immediate or delayed fatal injuries (often caused by ruptures to swim bladders in fish, or gas sacks of some larval stages), other injuries such as deafness may impact upon survival, and through behavioural effects (including avoidance). In the case of high intensity sound, damage effects on the air-filled body spaces may occur, leading to possible mortality.

115 The negative effects on fish arising from piling noise produced during the construction works are likely to be limited to within a predictable distance from the source of noise. According to the underwater noise modelling carried out in support of the EOWDC, lethal effects are expected out to a range of 3 m from the piling works, whereas the expected distance for physical injuries is 60m (Nedwell et al., 2011). However, it must be considered that fish are able to move away from the disturbed area. A minimum safe standoff distance from piling operations has been estimated as of 1750 m for hearing specialists like herring, and of 20 m for hearing generalists like dab (Nedwell et al., 2011). According to this information, and as dab and plaice are the most common fish species in the area

(Baseline Technical Report 2011), it is likely that the great majority of fish would vacate the area before significant damage is done, and that impacts would generally be of low magnitude. A 'soft start' to piling, whereby the power of the piling activity is increased slowly over time, should allow fish to move away from the site prior to noise levels increasing, reducing the risk of lethality and possible physical impairment.

116 The spatial range within which behavioural disturbance to fish is present has also been calculated by Nedwell *et al.* (2011). The maximum estimated range from piling is of 20-24 km for herring, extending mainly out to the east of the site (given the higher attenuation in shallow waters), whereas it is around 6 km for dab. Disturbance to flatfish populations is likely to be low, given the low sensitivity of these demersal species to noise disturbance. In turn, disturbance of herring during their spawning period (autumn) could potentially have effects upon the overall reproduction for the year. No important spawning grounds of the species are present directly on the proposed development site, but no specific data on their presence in the surroundings are available. However, this sensitive habitat might occur offshore within the area of disturbance from piling noise, given the presence of suitable sediment types (gravelly sands) for herring spawning 15-20 km offshore from the proposed EOWDC area (Seazone Hydrospatial Data, 2011). Therefore, although there is every likelihood that the impactis likely to be negligible to minor, the absence of data to categorically demonstrate an absence of spawning sites within the area of effect means that a precautionary approach is required, and as such there is the possibility that the significance of the impact is moderate on spawning populations of herring along the coast in Aberdeen Bay.

117 Underwater noise generated during construction could have a physiological or lethal effect particularly on young fish (eggs and larvae). A conservative estimate of 230-240 dB re 1 µPa @ 1m has been used as a limit for likely significant levels of damage to young stages of fish (Gausland, 2003). According to the estimates obtained by Nedwell *et al.* (2011) for the proposed EOWDC, 240 dB would be reached within approximately 3 m of an 8.5 m monopile. Hence, as a conservative but also very simplistic estimate, the mortality of all eggs and larvae may be assumed within the 3 m radius of piling. However, considering that the mortality levels characterising fish eggs and larvae are naturally high, such an effect over a wider marine ecological context would be negligible.

118 A potential impact of underwater noise production (mainly by piling activities) might also affect salmonid migration routes in the area. This aspect is assessed in the salmon and sea trout assessment for the proposed EOWDC..

119 Given the above considerations, the potential impact on fish has been assessed of low to possibly medium magnitude, receptor of medium sensitivity and therefore the significance of the impact would be minor to possibly moderate. The latter classification mainly derives from the aforementioned precautionary approach adopted in the assessment of the possible effect on herring spawning grounds, given the lack of specific data on their local distribution within the area of influence of the impact.

Mitigation

120 No additional mitigation is required.

Residual Impacts

121 Residual impacts on benthos will be of negligible to minor significance and are expected to be of a short-duration. Given that the construction effects are likely to be short-term, intermittent and of low to medium magnitude, residual impacts on fish are anticipated to be of minor significance, although a possibly moderate significance is acknowledged, following the aforementioned precautionary approach.

Cumulative Impacts

122 Given that the additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development, and that construction periods for the proposed installations are unlikely to overlap, it is unlikely that there would be the potential for significant cumulative impacts.

In-Combination Impacts

123 The potential direct and indirect impacts of the proposed development on salmonid, and indirect impacts on freshwater pearl mussel, populations of the River Dee and River South Esk SACs have been addressed within the salmon and sea trout assessment for the proposed EOWDC.

Monitoring

124 Monitoring will be agreed with the relevant statutory authorities and requirements incorporated into the Marine Licence. In the case salmon and sea trout, AOWFL will consult with Marine Scotland, Scottish Natural Heritage and the Dee, Don and Ythan Salmon District Fishery Boards in order to identify feasible and relevant monitoring options.

1.3.5.2 Operational Phase

Potential Impacts

125 Current evidence from noise monitoring at operational offshore wind farms suggests that the noise generated is generally at a low frequency, which may be within the best hearing frequency for many fish species, but of a level that is typically lower than sound generated by most vessel activity, even when considering the worst case of 11 x 10 MW operating wind turbines. The noise and vibration produced would increase with increasing wind speeds, with a corresponding increase in background noise levels also expected in these conditions, such that there would be a broadly constant level above background noise (Nedwell and Howell, 2004).

126 Potential biological effects of the underwater noise and vibration produced during the operational phase could affect subtidal benthos, and fish communities.

127 The impacts of noise and vibration during turbine operation, upon the benthic communities are not well understood. A relatively low level of operational noise is expected across all options and it is unlikely that benthic invertebrates would be significantly affected. Certain invertebrate species, including edible crab, have been frequently seen in very high numbers living on the piles of large operating wind turbines. Leonhard and Pedersen (2005) reported a total of 70 invertebrate taxa recorded during

post-construction surveys (in March and September) within the Horns Rev offshore wind farm, including 14 epifaunal species newly recorded within the seabed area. This study also indicated an increase in edible crab and suggested that the wind turbine foundations can function as hatchery and nursery grounds for some species. Several of the species found at Horns Rev are also found across the Aberdeen Bay including the brown shrimp, edible, harbour and hermit crab. The potential impact on benthos has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible.

128 Operating wind turbines would produce near field noise and vibration which may be detected by fish using their lateral line systems. As fish are thought to use particle displacement (i.e. vibrations caused by the back and forth movement of water molecules) for prey (and predator) detection, it is possible that the operating wind turbines would disguise such signals. However, Hoffman *et al*. (2000) state that the regular, low-frequency hydrodynamic fields generated by operating wind turbines are likely to be perceived very differently by fish in comparison to the fields generated by animals.

129 Herring has a fairly broad response to the low frequency components of underwater sound, with a hearing threshold at levels below 80 dB re 1 µPa (Enger 1967), and as such may potentially detect such noise. Other fish species tend to have much poorer hearing and the noise levels generated by the operating wind farm may be below that required in order to stimulate an avoidance response. Gadoid species such as cod have been shown to aggregate around noisy underwater structures such as operational oil and gas rigs (Valdemarsen 1979; Soldal *et al*., 2000). This is because the cod either habituate to the operational wind turbine noise, or tolerate it because of the benefits provided (e.g. shelter from currents or an increase in food source). Post-construction surveys for fish and benthic invertebrates within the Horns Rev wind farm recorded a number of species which included hearing-sensitive species such as the sprat and mackerel, and schools of cod (Elsam Engineering A/S and ENERGI E2 A/S, 2005).

130 The potential impact on fish has been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

131 There is also the possibility that operational underwater noise and vibration might affect salmonid migration routes in the area, but this has been assessed within the salmon and sea trout assessment for the proposed EOWDC.

Mitigation

132 No specific mitigation measure is recommended.

Residual Impacts

133 Residual impacts are assessed as of negligible to minor significance.

Cumulative Impacts

134 No cumulative impacts are anticipated.

In-Combination Impacts

135 None envisaged.

Monitoring

136 No specific monitoring required.

1.3.6 Electromagnetic Fields

1.3.6.1 Construction & Decommissioning Phase

Potential Impacts

137 This impact is likely to occur during the operational phase.

1.3.6.2 Operational Phase

Potential Impacts

138 It was shown by CMACS (2003) that industry standard AC offshore cables (three-core XLPE) do not generate an electric field outside the cable directly. However, a magnetic field is generated in the local environment by the alternating current in the cable, and this generates an induced electric field close to the cable. The potential impacts of electromagnetic fields (EMF) in the marine environment are the subject of ongoing research under the auspices of the Collaborative Offshore Wind Research Into the Environment (COWRIE; Huddleston, 2010).

139 Potential biological effects of the EMF produced during the wind farm operation may affect subtidal benthos and fish communities.

140 The fields produced by the sub-sea power cables used in offshore wind farm developments are within the ranges that could affect the behaviour of electro-sensitive fish species and species sensitive to magnetic fields, although very little information on the importance of any such changes in behaviour is available (OSPAR, 2006, 2008). The main area of concern relates to impacts on electro-sensitive fish species such as elasmobranchs, which may be attracted to the EMF emissions of buried cables or forced to avoid an affected area entirely.

141 The potential for EMF to have similar effects on benthic invertebrates is extremely limited. Although little information is available, it can be assumed that electro- and magnetic-sensitivity is of negligible influence on the behaviour, distribution and orientation of the range of benthic species found within the proposed EOWDC area. This assumption appears to be supported by the results of monitoring studies carried out at Horns Rev (Bio/Consult, 2004a, 2005a) and North Hoyle (NPower Renewables, 2008), which showed no evidence of a change in the benthic community, during operation that could be attributed to the presence of the wind farm. The potential impact on benthos has been assessed as of low magnitude, the receptor of possibly low sensitivity and therefore the significance of the impact would be negligible.

142 Field studies on fish provided the first evidence that operating cables change migration and behaviour of marine animals (Klaustrup, 2006). The potential environmental receptors of EMF impacts include a range of species that are considered to be of up to high level importance (most

elasmobranchs, all migratory and commercial fish species). Gill *et al.* (2009) undertook research on EMF and benthic elasmobranchs and concluded that they can respond to EMF, but that the response is unpredictable and in some instances does not occur, with a degree of species and individual specifics.

143 Magnetic field and field anomalies may be used by fish for orientation especially when migrating (Fricke, 2000). This is the case, for example, for European eel, Atlantic salmon and sea trout juveniles, as reviewed by Gill and Bartlett (2010). Possible effects on salmonids migration are detailed within the salmon and sea trout assessment for the proposed EOWDC and are not considered for the impact assessment in this section.

144 Elasmobranch fish (sharks and rays) are of particular interest to the offshore wind farm industry given their ability to detect very low levels of electromagnetic field. Elasmobranch fish can detect magnetic fields which are weak compared to the earth's magnetic field, these fishes being more than ten-thousand fold as electrosensitive as the most sensitive teleosts (OSPAR, 2009a). In addition it is currently thought that elasmobranch stocks are in decline (Ellis *et al.,* 2005) and whilst the reasons for this are poorly understood (although overfishing is widely perceived to be important) it is possible that the impacts of EMF may contribute to this decline. Hence, these receptors' electro-sensitivity can be considered as high. However, the presence of sharks and rays in the Aberdeen Bay is scarce, as gathered from the Baseline Report 2011, hence the effect is likely to be of low magnitude.

145 Indirect impacts on fish behaviour might arise also from attractive or repulsive electrical fields. An attractive artificial field may induce a food search investigation of seabed by individual animals, hence leading to a waste of energy. A repulsive field, in turn, could have a direct impact by actively repelling animals, thereby interrupting normal behaviour and potentially excluding habitat from use.

146 The orientation of the export cable route in the proposed EOWDC development is considered to be optimal for minimising potential impacts on fish species moving into and out of the Aberdeen Bay from the North Sea, as the corridor runs roughly up the centre and parallel to the coast of the Aberdeen Bay. This would allow access into and out of the Aberdeen Bay from both north and south. The potential impact on fish has been assessed as of low magnitude, the receptor of medium to high sensitivity and therefore the significance of the impact would be minor.

Mitigation

147 No specific mitigation is required. Industry standards and best practice arising out of ongoing research work would be adopted for the EOWDC development where practicable.

Residual Impacts

148 Residual impacts are assessed as of minor significance.

Cumulative Impacts

149 The additional impact arising from the physical presence of the Ocean Laboratory on the proposed EOWDC site is likely to be of lower significance than that one caused by the wind farm development. During the operational phase, the additional impact is likely to be generally minor,

leading to a cumulative impact of minor to moderate significance. In addition, no important fishing grounds are present in the proposed development site, and as such, the possible additional impact on fish and shellfish receptors arising from fishing activities is considered to be low.

In-Combination Impacts

150 The potential direct and indirect impacts of the proposed development on salmonid, and indirect impacts on freshwater pearl mussel, populations of the River Dee and River South Esk SACs have been addressed within the salmon and sea trout assessment for the proposed EOWDC.

Monitoring

151 Monitoring will be agreed with the relevant statutory authorities and requirements incorporated into the Marine Licence.

1.3.7 Heating

1.3.7.1 Construction & Decommissioning Phase

Potential Impacts

152 This impact is likely to occur during the operational phase.

1.3.7.2 Operational Phase

Potential Impacts

153 There is potential for heating effects of cables on the surrounding habitats in the intertidal area (from the export cable) and in the subtidal area (from export and inter array cables). Depending upon the properties of the cables, the electrical current running through them and the thermal resistance of the surrounding sediments, there is potential for temperature increase in the sediments around the cables. Studies in Long island and Connecticut showed that a pair of 4.1 inch diameter sublittoral cables (40 km long; 330 MW; 140 kV direct current) buried to 1.8 m caused an estimated increase in seabed surface temperature of 0.1 ^{o}C and an estimated increase in overlying water temperature of 0.000003 ^{o}C (London Array Ltd, 2005). These cables and conditions are comparable to those at the proposed EOWDC development.

154 Potential biological effects of sediment heating around the cables might impact on the intertidal and subtidal benthos, by affecting the physiology and survival of certain species, or altering the benthic community by leading to emigration or immigration in the impacted area.

155 However, given that the cables will be buried to at least 0.6 m, the overall effect of sediment heating on the intertidal fauna is expected to be low (if detectable) in magnitude and very localised, as the majority of animals in intertidal areas inhabit the top 15 cm (Eleftheriou and McIntyre, 2005). The potential impact on intertidal benthos has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible. Such an impact would be expected to be largely reversible once operation ceases.

156 It is also likely that the heating effects on the sublittoral conditions associated with both the array and shore transmission cables will be both extremely small, and extremely localised. Such effects may well be below limits of detection, particularly when considered in the context of natural fluctuations in temperatures (London Array Ltd, 2005). The potential impact on subtidal benthos has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible.

Mitigation

157 No mitigation measures are required.

Residual Impacts

158 The residual impact on intertidal and subtidal benthic communities arising from sediment heating is expected to be negligible and reversible.

Cumulative Impacts

159 The additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development. Furthermore, the supply cable from the Ocean Laboratory to shore is likely to be routed via the main wind farm export cable route, potentially installed in the same trench. Given the minor impact identified during wind farm development operation, it is unlikely that there would be the potential for significant cumulative impacts.

In-Combination Impacts

160 No in-combination impacts are anticipated.

Monitoring

161 Monitoring will be agreed with the relevant statutory authorities and requirements incorporated into the Marine Licence.

1.3.8 EOWDC Future Research and Monitoring Opportunities

162 The presence of a Ocean Laboratory in association with the proposed wind farm development would provide a good opportunity to allow research organisations to undertake long-term environmental studies on several aspects of the marine ecology in the area, as well as monitoring of the actual impacts and of the efficacy of possible mitigation measures applied.

163 Research information on the impacts of noise and vibration on fish, could be initiated in the area for the different project phases.

164 Research into the relative benefits of reef and FAD effects from the newly introduced artificial structures could also be carried out, taking into account their impact on commercial fisheries.

165 On a local scale, these effects can enhance fishing success, or increase fish populations by also supporting fish breeding and recruitment. Hence, research on the role of these newly created habitats and the monitoring of the structure and functioning of associated communities (species richness, biodiversity, functional guilds, population status) over time is suggested.

166 Additional research could also be carried out to determine (and audit) actual operational increases in temperature in the sediments around the cables and its effect on intertidal benthic communities (structure and functioning of the community, behavioural responses).

1.3.9 Summary of Impact Assessment

167 The potential impacts arising from the proposed wind farm development and related to the worst case scenario, as explained before, are summarised in table 2.

Table 2. Impact Assessment Summary

Impact source	Project phase	Receptor	Magnitude of Effect	Sensitivity of Receptor	Significance	Possible Mitigation	Significance after Mitigation	Monitoring	Cumulative / In-combination impacts
Water quality impairment (release of contaminants)	Constr. / Decomm.	Subtidal benthos and epibenthos	Negligible (built-in mitigation measures will be undertaken)	Medium	Negligible	--	Negligible	--	Negligible
		Fish and shellfish	Negligible (built-in mitigation measures will be undertaken)	Low to Medium	Negligible	--	Negligible	--	Negligible
Sediment Resuspension / Redeposition	Constr. / Decomm.	Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible
		Fish and shellfish	Low	Low to Medium	Negligible to Minor	--	Negligible to Minor	--	Negligible to Minor
Habitat Loss	Constr. / Decomm.	Intertidal benthos	Low	Low to Medium	Minor	--	Minor	--	Minor
		Subtidal benthos and epibenthos	Low	Medium	Minor	--	Minor	--	Minor
Habitat Loss	Operation	Subtidal benthos and epibenthos	Low	Medium	Minor	--	Minor	--	Minor

Impact source	Project phase	Receptor	Magnitude of Effect	Sensitivity of Receptor	Significance	Possible Mitigation	Significance after Mitigation	Monitoring	Cumulative / In-combination impacts
		Fish and shellfish	Low	Medium	Minor	--	Minor	--	Minor
Physical Presence of the Submerged Structures	Operation	Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible
		Fish and shellfish	Low	Low	Negligible	--	Negligible	--	Negligible
Underwater noise and vibration	Constr. / Decomm.	Subtidal benthos and epibenthos	Low	Low to Medium	Negligible to Minor	--	Negligible to Minor	--	Negligible to Minor
		Fish and shellfish	Low to Medium	Medium	Minor to possibly Moderate	Noise mitigation at source (e.g. soft-start procedure)	Minor to possibly Moderate	Monitoring will be agreed with the relevant statutory authorities	Minor to possibly Moderate
	Operation	Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible
		Fish and shellfish	Low	Low to Medium	Negligible to Minor	--	Negligible to Minor	--	Negligible to Minor
Electromagnetic fields	Operation	Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible

Impact source	Project phase	Receptor	Magnitude of Effect	Sensitivity of Receptor	Significance	Possible Mitigation	Significance after Mitigation	Monitoring	Cumulative / In-combination impacts
		Fish and shellfish	Low	Medium to high	Minor	--	Minor	--	Minor
Heating	Operation	Intertidal benthos	Low	Low	Negligible	--	Negligible	--	Negligible
		Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible

1.4 Summary

168 This report assesses the possible impacts of the proposed European Offshore Wind Deployment Centre ("EOWDC") off the coast of Aberdeen on the marine ecology present within the development site and within the wider Aberdeen Bay area. The status of different receptors (namely intertidal benthos, subtidal benthos, epibenthos, shellfish and fish) has been assessed against the possible effects arising from the construction, operation and decommissioning activities in the proposed development site.

169 As the details of the main physical structures of the development (e.g. turbine foundations, scour protection, cable array) and installation methods have not yet been decided, the impact assessment has been based on an identified worst case scenario. This has generally been assumed as the installation of 11 turbines and foundations rated at a generative capacity of 10 MW, and with the installation of these occurring over a single phase. Further installation details where applicable have also selected a worst case in terms of the likely highest impact option to individual receptors.

Intertidal Benthos

170 Impacts on intertidal benthos are considered to be restricted to laying/removal (during construction and decommissioning phases) and to the presence (during operational phase) of the export cable connecting the offshore wind farm development to the onshore substation. Cable laying or removal would cause a localised and temporary disruption to the status of the soft sediment intertidal communities along the cable route through direct habitat loss (trenching) and indirect loss (smothering by spoil). However, following instatement, it would be expected that a rapid recolonisation would occur, initially by opportunistic species and then by a more characteristic infauna. Greater impacts are expected on longer-lived sedentary species, due to their lower recoverability rate, but these species are of minor importance in the intertidal benthic assemblage of the moderately exposed shores typical of the Aberdeenshire area. As such, the overall impact is assessed as of minor to negligible significance.

171 Data indicate that an increase in temperature can be also detected in sediments around export cables, and that this might possibly affect the physiology and mortality of benthic species, with subsequent alteration of intertidal benthic communities. Although little information on the effect of small temperature changes on benthic communities is available, any effect is likely to be highly localised and of very low magnitude. As cables will be buried to a depth of around 60 cm or more, i.e. below the depth that most animals occur, impacts are predicted to be negligible.

Subtidal Benthos & Epibenthos

172 Potential impacts on subtidal benthic and epibenthic fauna are expected to arise during the construction phase, due to habitat disturbance and permanent habitat loss, accidental release of contaminants from construction works and underwater noise.

173 Based on a worst case design and installation option for the proposed development and knowledge of the prevailing baseline sediment conditions

in the area (e.g. low sediment contamination levels), impacts from habitat damage and loss are considered likely to be localised and of low magnitude. The benthic biotope present in the potentially affected area has a generally low sensitivity to temporary habitat disturbance, has no particularly high conservation value and is not uncommon in the wider area. Overall subtidal habitat loss impacts during the construction phase have therefore been assessed as of minor significance.

174 Minor issues have been raised with regard to the effects of increased turbidity and sediment re-suspension on benthic and epibenthic subtidal communities during construction. However, given that the infaunal communities in the area are likely to be adapted to naturally high levels of such conditions, impacts are predicted to be of negligible significance. Similar types of impact can be identified for the decommissioning phase, although a lower significance is assessed in this case, due to the absence of a permanent habitat loss (linked to the footprints of installed structure which are expected to be readily recolonised after removal).

175 The operational phase will involve an ongoing 'habitat loss', the effects of which are considered of low magnitude. Given the medium sensitivity of the receptor the impact has been assessed as of minor significance. Possible additional issues identified for the operational phase include the effects of underwater noise, electromagnetic fields (EMF) and heat. The potential sensitivity of the receptors has been identified as low and effects during the operational phase have been assessed as of low magnitude. Impact significance is therefore negligible.

Shellfish & Fish

176 Noise and vibration generated during wind farm construction work (mainly from piling) are likely to have the greatest impacts on the fish fauna of an area, potentially leading to injuries, mortalities and behavioural effects. For the EOWDC development, these effects are likely to be short-term and intermittent, and their magnitude is expected to decrease with distance from the noise source. Most fish are able to exhibit avoidance behaviour that can naturally reduce impact levels when conditions become unsuitable. Soft start procedures will allow fish to move away from the noise source before maximum noise levels are reached. Furthermore, the most abundant species in the proposed development area (e.g. flatfish) are believed to have low sensitivity to noise and vibrations, and no significant sensitive fish habitats (spawning or nursery grounds) occur in the proposed development site. Such sound pressure has the potential to propagate outside the proposed development site, and could potentially affect hearing sensitive habitats further offshore (e.g. herrings spawning grounds), although there are no data available on the local distribution of these habitats in the possible range of disturbance of piling noise. Due to this lack of information, it has been necessary to adopt a precautionary approach and an overall assessment of construction noise impacts on fish (using the worst case development scenario) is considered to be of minor to possibly moderate significance.

177 Other potential impacts on fish and shellfish during construction may arise from sediment re-suspension and contaminants release, but these have been assessed as of negligible to minor significance due to their effect being highly localised and temporary. Similar types of impact to those

described above can be identified for the decommissioning phase, although a further lower significance is assessed in this case.

178 Potential impacts on fish during the operational phase mainly arise from electromagnetic emissions associated with cabling, these considered to be being of minor significance. EMFs from subsea cables might interfere with electro-sensitive fish, such as medium sensitive salmonids (medium sensitivity) and elasmobranchs (high sensitivity). However, the presence of sharks and rays in Aberdeen Bay is infrequent hence the effect has been assessed of low magnitude and the impact of minor significance. Impact on migrating salmonids is assessed in detail within the salmon and sea trout assessment for the proposed EOWDC.. Cable burial can provide a possible mitigation to such an impact, and, given the current general paucity of information, it is considered that industry standard mitigation measures should be implemented at the time of construction/operation. Residual impacts are therefore considered to be of minor significance.

179 Other potential impacts to fish and shellfish may arise from underwater noise generated during operational activities, whilst the presence of seabed/water column structures could affect shoaling behaviour of pelagic fishes. However these impacts are considered to be of low magnitude, due to the generally low disturbance intensity (for noise) and temporary effect (for shoaling disruption). A further impact could arise from the "reef effect" and "FAD effect" associated with the presence of the artificial hard substratum structures. However this impact is assessed as being positive (providing new habitat which would be of value for many fish and shellfish), although given the extent of such features within the wider development site, any positive effects would be negligible.

Cumulative impacts

180 Potential cumulative impacts arising from the possible presence of other activities and installations in the proposed development area have been assessed. However, no other such plans or projects were identified near the proposed development site, except for the proposed Ocean Laboratory, which should be installed on the wind farm site itself. Additional impacts arising from the construction, operation and decommissioning of this structure are likely to be broadly similar (in type) to those assessed for the wind farm development. However, these impacts are likely to be of lower significance compared to those caused by the wind farm development, given also the smaller scale of the Ocean Laboratory. Hence cumulative impacts have been assessed as of the same significance levels of those arisen from the proposed development.

181 The potential direct and indirect impacts of the proposed development on salmonid, and indirect impacts on freshwater pearl mussel, populations of the River Dee and River South Esk SACs have been addressed within the salmon and sea trout assessment for the proposed EOWDC.

Water Framework Directive and Good Ecological Status

182 The EU Water Framework Directive (WFD) requires Member States to produce a series of River Basin Management Plans (RBMPs) which are designed to ensure that water bodies achieve Good Ecological (and chemical) Status (GES).

183 The proposed development site is located within the area of the River Basin Management Plan for water body Cruden Bay to the Don Estuary (Identifier Code 200117). This water body has been classified as having an overall High with High Confidence Status with an overall Ecological Status of High and Chemical Status of Pass. As such, within the context of the WFD, the water body currently meets the objective of Good Ecological Status. Within the requirements of the WFD, water bodies have to be maintained in GES.

184 In order for the Cruden Bay to the Don Estuary water body to be maintained in GES, there are a series of measured parameters included in the classification, which contribute to the status values outlined above. These parameters synthesise attributes for chemical and biological determinands, including water quality metrics such as Dissolved Oxygen and pollutant levels; biological metrics such as benthic invertebrates (infaunal quality index), alien species and phytoplankton; and hydro-morphologic attributes.

185 As part of the baseline ecology review and subsequent impact assessment phase, details of such metrics have been characterised and assessed.

186 Based on the findings of this assessment process, it is considered that the construction, operation and decommissioning of the proposed development will have a generally negligible impact on the immediate ecology of the surrounding waters and seabed, and no significant medium or far field impacts. It is considered that the development would have no measurable effect on the attributes used to classify the water body as being in Good Ecological Status, and will not lead to the deterioration of Good Ecological Status at the site.

187 The conclusion of the assessment process is therefore that the development will not affect the Good Ecological Status of the Cruden Bay to the Don Estuary water body.

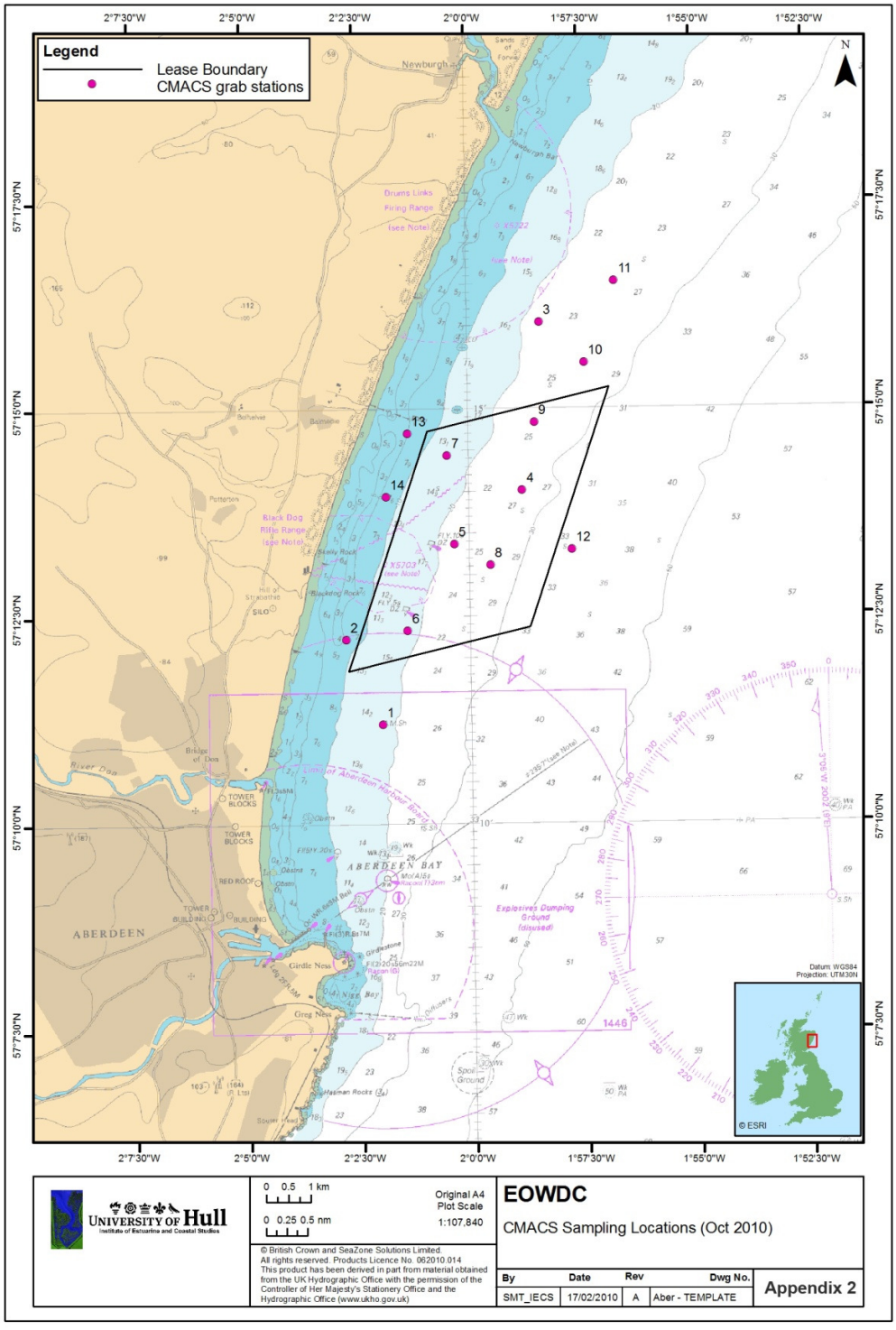
1.5 Appendices

1.5.1 Appendix 1. Sensitivity of benthic biotopes present in the proposed EOWDC area (based on data given in MarLIN)

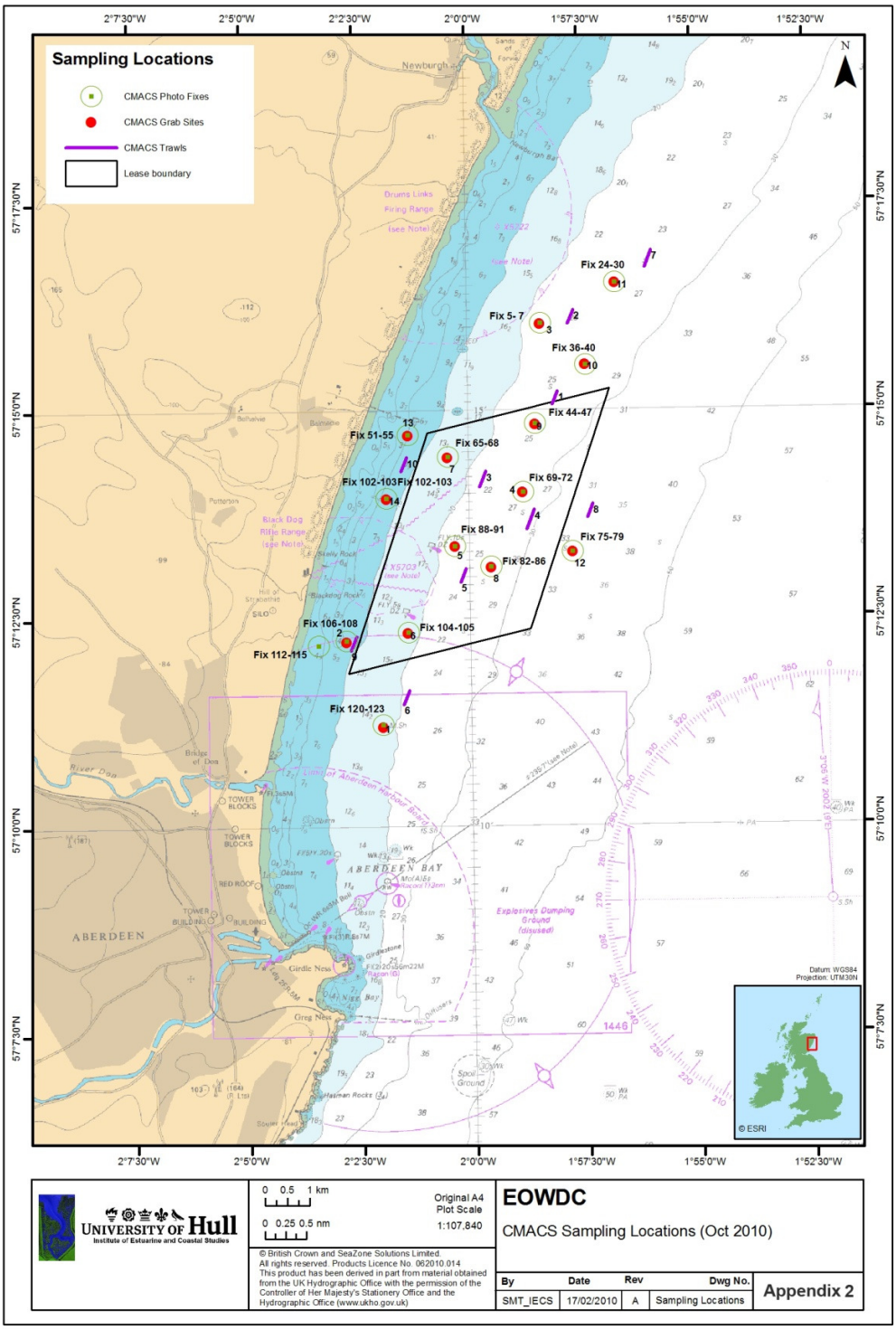
Biotope	**SS.SSA.IFiSa.NcirBat**	**SS.SSA.CMuSa.AalbNuc**
Dominant species	*Nephtys cirrosa, Pontocrates altamarinus*, *Bathyporeia* sp.	*Notomastus latericeus, Nucula nitidosa, Tellina fabula,* Ophiuridae*, Pholoe baltica, Abra alba*
Stations (CMACS survey 2010)	2, 13, 14	1, 3, 4*, 5*, 6*, 7*, 8*, 9*, 10, 11, 12
Sensitivity to increased suspended sediments	Not sensitive	Very low
Sensitivity to abrasion and physical disturbance	Very low	Low
Smothering recoverability	Immediate	Immediate
Substratum loss recoverability	Very high	High

* stations within the proposed development lease boundary (see Appendix 2)

1.5.2 Appendix 2. CMACS Benthic Survey 2010 - Grab Survey Locations



CMACS Benthic Survey 2010 - Survey Locations



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