MORAY EAST
OFFSHORE WINDFARM

UXO Clearance Environmental Report

Moray East Offshore Wind Farm

December 2018

Moray Offshore Windfarm (East) Limited

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List of Abbreviations

AEZ	Archaeological Exclusion Zones
AC	Alternating Current
ADD	Acoustic Deterrent Devices
AIS	Automatic Identification System
BAP	Biodiversity Action Plan
CD	Chart Datum
CI	Confidence Interval
CIA	Cumulative Impact Assessment
CRRU	Cetacean Research and Rescue Unit
CV	Coefficient of Variation
EC	European Commission
EIA	Environmental Impact Assessment
EOD	Explosive Ordnance Disposal
EPS	European Protected Species
ES	Environmental Statement
FCS	Favourable Conservation Status
FLO	Fisheries Liaison Officer
HE	High Explosive
HF	High Frequency
ICES	International Council of the Exploration of the Sea
JCP	Joint Cetacean Protocol
LF	Low Frequency
LSE	Likely Significant Effect
MF	Mid Frequency
ML	Marine Licence
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Mammal Observer
MSL	Mean Sea Level
MS-LOT	Marine Scotland – Licensing Operations Team
MU	Management Unit
NEQ	Net Explosive Quantity
nm	Nautical Miles
NMFS	National Marine Fisheries Service
NNR	National Nature Reserve
NtM	Notice to Mariners

OfTI	Offshore Transmission Infrastructure
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PAM-Op	Passive Acoustic Monitoring Observer
PEXA	Practice and Exercise Areas
PMF	Priority Marine Features
pUXO	Potential Unexploded Ordnance
PTS	Permanent Threshold Shift
PW	Pinnipeds in Water
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCI	Site of Conservation Importance
SEL	Sound Exposure Level
SHETL	Scottish Hydro Electric Transmission Limited
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SPL	Sound Pressure Level
SSC	Suspended Sediment Concentrations
TI	Transmission Infrastructure
TTS	Temporary Threshold Shift
[redacted]	United Kingdom
[redacted]	Unexploded Ordnance
WCS	Worst Case Scenario

Executive Summary

Moray East is currently undertaking surveys for identification of potential unexploded ordnance (pUXO) prior to commencement of construction of the Moray East Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) - referred to collectively as the Development). Selected pUXO identified during the current surveys (that cannot be avoided during the construction and operations and maintenance activities) will be targeted for a detailed inspection by a vehicle (e.g. Remotely Operated Vehicle (ROV)), and potentially divers to confirm whether the targets are an unexploded ordnance (UXO) hazard and therefore a risk to those activities. If identified as a UXO hazard Moray East, in the first instance, will seek to avoid the UXO hazard. If avoidance is not possible, Moray East will undertake physical removal of the UXO using controlled detonation, and UXO debris (fragmentation) will be recovered to the vessel deck according to the terms of the Marine Licence. UXO debris greater than 30 cm in size, or debris which may contain explosive material originating from the UXO target will be recovered by the ROV to the deck of the vessel.

The UXO clearance activities, if required, will also involve the removal of any non-UXO debris. If, after inspection, the target is confirmed as non-UXO debris, and is able to be recovered by the vehicle (or vessel's crane), it can either be re-positioned on the seabed in a pre-determined lay down area with GPS co-ordinates logged or recovered to the deck of the vessel. If the debris cannot be recovered or moved, the debris shall remain in place and be avoided by re-routing.

In order to safely undertake any UXO clearance activities at the Moray East site and OfTI Corridor (i.e. the Development area), a Marine Licence and a European Protected Species (EPS) Licence are required from Marine Scotland Licensing Operations Team (MS-LOT). This Environmental Report is submitted in support of the Marine Licence application submitted by Moray East for the UXO clearance activities. The UXO clearance activities will take place between February and May 2019 (inclusive), with the UXO detonations being carried out over a maximum of 10 non-consecutive days.

An assessment of the potential impacts of the UXO clearance activities has been carried out in relation to key receptors including: physical processes; benthic ecology; fish and shellfish; marine mammals; ornithology; marine archaeology; commercial fisheries; shipping and navigation; and infrastructure and other users. The impact assessment concluded that there will be no significant impacts due to the proposed UXO clearance activities.

A Marine Mammal Mitigation Plan (MMMP) has been produced in support of the Marine Licence application in order to mitigate against potential any potential impacts to marine mammals due to the UXO clearance activities (Appendix A).

Definitions

The following definitions have been used throughout this document with respect to the company, the consented wind farms and how these definitions have changed since submission of the Moray East Environmental Statement (ES) in 2012 and the Moray East Modified Transmission Infrastructure (TI) ES in 2014.

- **Moray Offshore Windfarm (East) Limited (formerly known as Moray Offshore Renewables Limited)** – the legal entity submitting this UXO Clearance Environmental Report;
- **Moray East Offshore Wind Farm** - the wind farm to be developed in the Moray East site (also referred as the Wind Farm);
- **The Moray East site** - the area in which the Moray East Offshore Wind Farm will be located. Section 36 Consents and associated Marine Licences to develop and operate up to three generating stations on the Moray East site were granted in March 2014. At that time the Moray East site was made up of three sites known as the Telford, Stevenson and MacColl offshore wind farm sites. The Section 36 Consents and Marine Licences were subsequently varied in March 2018;
- **Telford, Stevenson and MacColl wind farms** – these names refer to the three consented offshore wind farm sites located within the Moray East site;
- **Transmission Infrastructure (TI)** - includes both offshore and onshore electricity transmission infrastructure for the consented Telford, Stevenson and MacColl wind farms. Includes connection to the national electricity transmission system near New Deer in Aberdeenshire encompassing AC offshore substation platforms (OSPs), AC OSP interconnector cables, AC export cables offshore to landfall point at Inverboyndie continuing onshore to the AC collector station (onshore substation) and the additional regional Transmission Operator substation near New Deer. A Marine Licence for the offshore TI was granted in September 2014 and a further Marine Licence for two additional distributed OSPs was granted in September 2017. The onshore TI was awarded Planning Permission in Principle in September 2014 by Aberdeenshire Council and a Planning Permission in Principle under Section 42 in June 2015;
- **Offshore Transmission Infrastructure (OfTI)** – the offshore elements of the transmission infrastructure, comprising AC OSPs, OSP inter-connector cables and AC export cables offshore to landfall (for the avoidance of doubts some elements of the OfTI will be installed in the Moray East site);
- **Moray East ES 2012** – The ES for the Telford, Stevenson and MacColl wind farms and Associated Transmission Infrastructure, submitted August 2012;
- **Moray East Modified TI ES 2014** – the ES for the TI works in respect to the Telford, Stevenson and MacColl wind farms, submitted June 2014;
- **The Development** – the Moray East Offshore Wind Farm and Offshore Transmission Infrastructure (OfTI);
- **OfTI Corridor** – the export cable route corridor, i.e. the OfTI area as assessed in the Moray East Modified TI ES 2014 excluding the Moray East site;
- **Design Envelope** – the range of design parameters used to inform the assessment of impacts;
- **Development area** - the Moray East site and OfTI Corridor together;

- **Moray East Offshore Wind Farm Consents** – are comprised of the following:

  Section 36 Consents:

  - Section 36 consent for the Telford Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Telford Offshore Wind Farm assigned to Moray East on 19 June 2018.
  - Section 36 consent for the Stevenson Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Stevenson Offshore Wind Farm assigned to Moray East on 19 June 2018.
  - Section 36 consent for the MacColl Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the MacColl Offshore Wind Farm assigned to Moray East on 19 June 2018.

  Marine Licences

  - Marine Licence for the Telford Offshore Wind Farm (as varied) – Licence Number: 04629/18/1 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on the 19 July 2018.
  - Marine Licence for the Stevenson Offshore Wind Farm (as varied) – Licence Number: 04627/18/1 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on the 19 July 2018.
  - Marine Licence for the MacColl Offshore Wind Farm (as varied) – Licence Number: 04628/18/2 - consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on the 19 July 2018.

- **OfTI Licences** – are comprised of the following:
  - Marine Licence for the Offshore Transmission infrastructure – Licence Number 05340/14/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the “OfTI Marine Licence”)
  - Marine Licence for two additional distributed OSPs – Licence Number 06347/17/1 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction, operation and maintenance works and the deposit of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the “OSP Marine Licence”)

1 Introduction

1.1 Project Background

In March 2014, Moray Offshore Windfarm (East) Limited (Moray East) received consent from the Scottish Ministers under Section 36 of the Electricity Act 1989, and the associated Marine Licences the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009 for the construction and operation of the Moray East Offshore Wind Farm. At that time, the Moray East site was made up of three sites known as "Telford", "Stevenson" and "MacColl" offshore wind farm sites. Moray East plans to develop the three consented wind farms (Telford, Stevenson and MacColl) as a single wind farm (Moray East Offshore Wind Farm) (Figure 1-1) below.

A Marine Licence for the Offshore Transmission Infrastructure (OfTI) was granted in September 2014 and a further Marine Licence for two additional distributed offshore substation platforms (OSPs) was granted in September 2017 (together these are referred to as the OfTI Licences).

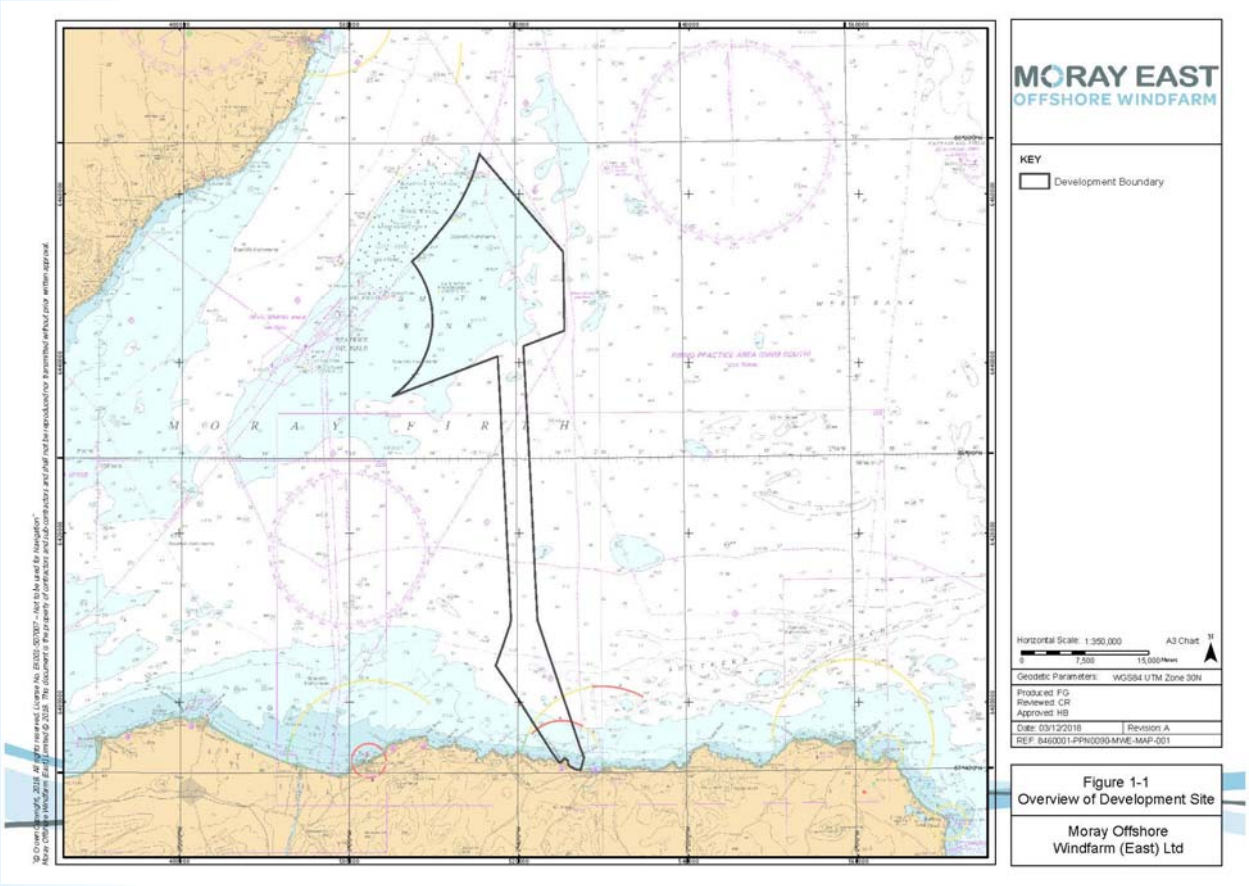

Figure 1-1. Moray East Site and OfTI Corridor

1.2 Purpose of the Environmental Report

In order to safely undertake any UXO clearance at the Moray East site and OfTI Corridor (i.e. the Development area), a Marine Licence and a European Protected Species (EPS) Licence are required from Marine Scotland Licensing Operations Team (MS-LOT). A Marine Licence is required for the UXO clearance activities under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009. The requirement to consider EPS in developments in waters off Scotland derives from the Conservation of Offshore Marine Habitats and Species Regulations 2017 which transpose the requirements of the Habitats

Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora).

An overview of the overall decision-making process associated with UXO activities is provided in Section 2.1 below. The working methods associated with the non-marine licensable and marine licensable activities are detailed in Sections 2.2 and 2.3 below; an EPS Licence is required for harbour porpoise, minke whale and bottlenose, common and white-beaked dolphins only. This Environmental Report is submitted in support of the Marine Licence application submitted by Moray East for the Explosive Ordnance Disposal (EOD) operations and non-UXO debris clearance.

1.3 Consultation

In October 2018, Moray East submitted a document to MS-LOT detailing the proposed approach to assessment of UXO clearance activity. The proposed approach to assessment was subsequently agreed by Marine Scotland on 6 November 2018. The table below details where specific points raised have been addressed. This Environmental Report follows the assessment approach as agreed with MS-LOT.

Table 1-1 Summary of MS-LOT Consultation

Date and Location of Meeting	Point Raised	Moray East Response
1 November 2018, Edinburgh	MS-LOT requested the EPS Risk Assessment to be provided in a separate document to the Environmental Report.	The Cetacean Risk Assessment forms a separate report, submitted in support of the EPS Licence Application.
8 November 2018, Edinburgh	MS-LOT requested further information on the working methods used during EOD operations.	This information is provided in Section 2.

2 Project Description

The following section provides a description of the UXO clearance activities, including the number, size and location of UXO that may be found and the activities that are licensable under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009.

2.1 Potential for UXO

A worst case scenario (WCS) for the total numbers of UXO that may require detonation within the Development area is ten: four within the Moray East site and six within the OfTI Corridor.

A study has been conducted on the indicative sizes of charges for UXO that could be present within the Development area (Ordtek, 2018). These are provided in Table 2-1 and Table 2-2 below, the text in red indicates the size of charges that are most likely to be present and that may require detonation.

Principal UXO items that are likely to be found within the Development area are German WWI mines and training / High Explosive (HE) bombs, with WWII mines, torpedoes and depth charges a lower residual background threat (Table 2-1).

Table 2-1 UK waters deployed mines (most likely highlighted in red) (Ordtek, 2018)

UXO Type	Maximum UXO Net Explosive Quantity (NEQ) in kg	Likelihood During UXO Investigations
German LMB Ground Mine	700	Highly Unlikely
German UMB Moored Buoyant Mine	41	Highly Unlikely
German RMB Ground Mine	460	Highly Unlikely
German EMC Buoyant Mine	300	Highly Unlikely
German EMA Buoyant Mine	160	Possible
British Mk14 Buoyant Mine	227	Unlikely
British Mk16 Buoyant Mine	145	Unlikely
[redacted]20 Buoyant Mine	227	Unlikely

[redacted]

Air-dropped bombs are also a potential hazard across the site, due to the extensive conflict between shipping and aircraft. The air-dropped bombs most likely to be encountered are detailed in Table 2-2 (Ordtek, 2018).

Table 2-2 UK waters deployed HE bombs (most likely highlighted in red) (Ordtek, 2018)

UXO Type	Maximum UXO Net Explosive Quantity (NEQ) in kg	Likelihood During UXO Investigations
Allied 250lb HE Bomb	50	Unlikely
Allied 500lb HE Bomb	126	Possible
Allied 1000lb HE Bomb	260	Possible
German SC-50 HE Bomb	25	Unlikely
German SC-250 HE Bomb	145	Unlikely
German SC-500 HE Bomb	220	Unlikely

2.2 Moray East Approach

A UXO survey campaign is currently being undertaken to identify the potential for UXO within the Moray East site and OfTI Corridor. The results of this campaign are still being analysed to identify potential UXO (pUXO) within the Development area. Should pUXO be identified, the preference is to avoid the pUXO and re-route. Where practicable, taking into account health and safety, any pUXO targets will be avoided by placing an industry standard 15 m radius avoidance zone around the target for the siting of any infrastructure and other "seabed intrusive" activities (e.g. vessel jack-up). The target locations will be noted and relevant authorities notified, where required. Should re-rerouting not be possible at this stage, the pUXO will be targeted for inspection, and the targets will be confirmed as either UXO or non-UXO debris.

Should the target be confirmed as non-UXO debris, the debris will either be recovered to the deck of the vessel for disposal onshore, or the debris will be repositioned on the seabed (see Section 2.3.2 below). Where debris cannot be repositioned or recovered to the deck of the vessel, they will be avoided through re-routing.

Should the target be confirmed as UXO, the preference is to avoid this target where practicable. If avoidance is not possible, the target will be subject to EOD operations (see Section 2.3.1 below). There are three options for UXO disposal which could be used as part of EOD operations:

1) UXO detonation in situ – this is the preferred option for health and safety reasons,
2) relocation of the UXO on the seabed and then detonation – an example of when this would occur are in instances when detonating in situ could potentially compromise the safety of Moray East or third party assets. In the instance where third party assets are situated nearby, Moray East will contact the third party prior to detonation in order to establish a safe distance between the asset and detonation site. Another example of this occurrence is where two UXO are located in close proximity to one another, whereby one UXO is relocated nearer to the other UXO, allowing a single detonation to take place rather than two separate detonations.
3) recovery of the UXO to the deck of the vessel – this would be undertaken for small items of UXO e.g. hand grenades, or as a last resort for larger items should options 1 or 2 not be possible.

After detonation UXO debris greater than 30 cm in size, or debris which may contain explosive material originating from the UXO target will be recovered to the deck of the vessel and placed in safe storage.

2.3 Licensable Activities (UXO Clearance Activities)

2.3.1 EOD Operations

The following describes the sequencing of the EOD operations:

- After all the pUXO targets have been inspected, the confirmed UXO targets will need to be destroyed in a separate EOD campaign. For this campaign, three vessels will be required:
  - an inspection vessel from which the Remotely Operated Vehicle (ROV) will be deployed and where the explosives will be stored;
  - a launch vessel, and
  - a guard vessel to advise other sea users to maintain 1,500 m safe distance, and confirm prior to detonation that the surrounding area is clear.

  The Acoustic Deterrent Device (ADD) and portable Passive Acoustic Monitoring System (PAM) equipment will be deployed from either the launch or the guard vessel, along with the Marine Mammal Observers (MMOs) and PAM Operator (PAM-Op).

- If a target is confirmed as a UXO by the EOD expert after the UXO inspection, a 250 m radius exclusion zone shall be implemented around the target, the position noted and all relevant authorities notified.
- Once all the target inspections are complete, the vessel will return to the confirmed UXO target, and the geodetic position of the item will be correlated and confirmed with the Client Representative, survey team and EOD Superintendent, at which point the EOD system will be deployed by the ROV and placed in the optimum firing position. There are two main methods used to trigger a detonation: either use of bulk explosives or using a shape charge. The shape charge system would require less than 2 kg of HE, whereas to generate a controlled detonation using bulk charge, the minimum quantity of HE would be between 5 kg and 10 kg per UXO, however after consulting with the EOD Superintendent, a greater quantity may be required.
- Whichever EOD system is used by the EOD contractor, the system shall be safe and reliable, and will have undergone a proven safety and performance testing regime. When a "live firing" run is ordered, the charge will be drawn from the on-board explosives magazine (bomb-proof storage location for explosives), fitted to an anchoring system (typically a concrete block) and secured in the manipulator arm of the ROV. Also attached to the anchoring system is a float with the firing line (typically a shock tube). It is common for safety features like Non-Electric (NONEL) Detonators and Hydrostatic Safety Breaks to be fitted to the EOD system immediately prior to the launching of the ROV to ensure there is no accidental firing of the charge.
- The ROV will be deployed and return to the target at the designated position. When the ROV is 1 m away from the intended target, the anchoring system will be deployed and placed 0.5 m away from the target. In this way, the EOD system will be placed in the optimum firing position without making any physical contact with the target at any time.
- Once in position, the float with the firing line will be released from the ROV manipulator and will ascend to the surface paying out the firing line as it ascends. Afterwards, the ROV will be recovered back to the deck.
- The EOD system will subsequently be in the optimum firing position with the float and firing line at the surface ready to be fitted to the firing mechanism. This is achieved by deploying the launch vessel (Fast Rescue Craft (FRC) or EOD Rigid hull inflatable boat (RhiB)), with the [redacted] Technicians onboard, back to the float to connect the firing line to the firing mechanism.
- The launch vessel will move to 200-300 m range from the target. Within a safe distance of the target, the ADD and portable PAM will be deployed, and the MMOs will perform a visual survey from the either the launch vessel or the guard vessel (see Appendix A).
- The launch vessel will return to the shot-line float, recover it and connect the firing shot line to the e-clips fitted to the surface initiation float. On completion the surface initiation float will be released and the inspection vessel will advise that the operation has been successfully completed.
- On completion of the ADD procedure, the ADD and PAMs hydrophone will be recovered to the vessel and return to the vicinity of the inspection vessel located at 1,500 m of the UXO detonation (approximately 100 m away on lee side) remaining available to advise other vessels in the vicinity if required.
- The safety management of vessels and other traffic within the UXO mitigation zone (1,500 m), will be managed and coordinated by the EOD Superintendent and the vessel master who will liaise directly with the authorities for the area in accordance with the embedded mitigation in Section 4.

- A security radio message will be transmitted to state the vessel name, position of firing and planned time 6 hours, 30 minutes and 10 minutes before the UXO detonation.
- At the agreed firing time, the launch vessel will initiate the firing mechanism and fire the EOD main charge.
- On completion of the successful detonation, the launch vessel will return to the target location, recover the surface initiation float. The MMOs will conduct post-detonation MMO routines (see Appendix A).
- Following the successful detonation, the ROV will be deployed and carry out an as-left survey centred on the target location using the ROV sensors. UXO debris greater than 30 cm in size, or debris which may contain explosive material originating from the UXO target will be recovered by the ROV to the deck of the vessel. This will ensure that the area is cleared of any UXO and that no significant metallic objects remain and will also provide multibeam bathymetry results to quantify the size and shape of any resulting detonation crater, to record any significant environmental impacts and to assist with future engineering plans.

For UXO detonations in shallow waters, (less than 12 m LAT), it is possible the target charge may be set by divers or an ROV (as described above). Initiation and firing procedures remain the same.

It is noted that within the 12 nm zone the responsibility for UXO clearance is in principle with the UK authorities such as Coastguard and Royal Navy. Therefore, if a UXO item is found within the 12 nm zone, consultation will be held with the Police, Royal Navy and Coast Guard following completion of the survey and prior to implementation of UXO clearance activities to determine if the Moray East contractor should clear all required UXO including those within 12nm. As with UXO items found outside the 12 nm zone, all UXO identified will be reported to MS-LOT and other marine users, as set out in the embedded mitigation measures provided in Section 4 below.

2.3.2 Non-UXO Debris Clearance

In the event a target is identified as non-UXO (debris) by an EOD expert, a decision will be made regarding the threat of the object to construction and operations and maintenance activities and the object will either be left in situ or relocated. This may be through re-location on the seabed at a pre-determined lay down area or through recovery to the vessel deck with subsequent disposal at an onshore disposal facility. The non-UXO debris may be transported to an alternative location hanging from a crane grab or “held” by the ROV in the water column. Otherwise the non-UXO item (debris) will be recovered to the deck of the vessel for transport, depending on the size and weight of the target. Items relocated to the seabed will have their coordinates logged. Waste disposal onshore will be undertaken by a suitably registered and licensed contractor.

3 Existing Environment

3.1 Overview

A detailed description of the baseline environment for each environmental parameter is available from the Moray East ES 2012 (Moray East, 2012) and the Moray East Modified Transmission Infrastructure (TI) ES 2014 (Moray East, 2014). The following sections provide an overview of the key receptors that may be potentially affected by any UXO clearance activities required within the Development area. The receptors included in this section have been discussed and agreed with MS-LOT (see Section 1.3 above).

The information utilised to provide details of the key receptors has been drawn from the Moray East ES 2012, the Modified TI ES 2014, the results of more recent post-consent / pre-construction surveys and other publicly available information.

3.2 Physical Processes

The Moray East site encompasses part of the summit and the eastern flank of Smith Bank, a morphological high point in the Outer Moray Firth measuring approximately 35 km long from south-west to north east, and 20 km wide (295 km^2). Water depths in this area range from approximately 35 to 55 mCD (below Chart Datum), with the greatest depths found along the south-eastern margin of the site. Smith Bank is separated from the Caithness coast to the north by a relatively deep channel (up to approximately 75 mCD).

Water depths along the OfTI Corridor are highly variable, ranging from <10 mCD in the shallow inshore area adjacent to the Banffshire coast to approximately 100 mCD in the Southern Trench, a long deep channel located in the southern part of the outer Moray Firth. The Southern Trench reaches depths of approximately 220 m CD off the Aberdeenshire coast to the east of the OfTI Corridor.

Seabed sediments across the Moray East site generally consist of Holocene gravelly sand and sand (Moray East, 2012). Seabed sediments along the OfTI Corridor are variable, reflecting variability in both the prevailing hydrodynamic conditions and underlying geology. At both the northern end of the OfTI Corridor and in the vicinity of the landfall, seabed sediments generally consist of gravelly sands and sandy gravel (Moray East, 2014). Fine (silt and clay sized) particles are largely absent from the Moray East site and OfTI C[redacted]

T[redacted]dence suggests that (bedload) material is travelling into the Firth from the north, passing along the Caithness coast and towards the Inner Moray Firth (Moray East, 2012). Tidal currents are largely incapable of mobilising anything larger than fine sand-sized material within the Moray East site and OfTI Corridor and as a result, there is only limited net bedload transport of sediment due to tidal currents alone. However, during storm events, it is likely that the commonly present medium-sized sand is regularly mobilised across the Moray East site.

During site characterisation surveys for Moray East ES 2012 and Modified TI ES 2014 levels of sediment contaminants were below guideline levels at all sampling locations within the Development area (Moray East, 2012; Moray East, 2014).

3.3 Benthic Ecology

3.3.1 Offshore Wind Farm

The benthic survey conducted for the Moray East ES 2012 showed that the dominant seabed sediment habitat type within the Moray East site was slightly gravelly sand with patches of shelly gravelly sand, sandy gravel and gravel. The benthic communities associated with these seabed habitat types were found to be rich and diverse and were characterised by polychaete worms (e.g. *S. bombyx*, *Notomastus spp.*,

Lumbrineris gracilis and *Chone sp.*), the burrowing urchin (*Echinocyamus pusillus)* and the bivalve *Cochlodesma praetenue*. Statistical analysis showed that benthic communities were most influenced by depth and sediment types. The most common biotopes identified within and around the Moray East site include:

- *SS.SSa.CFiSa EpusOborApri (Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand)
- *SS.SCS.CCS. MedLumVen (Mediomastus fragilis, Lumbrineris spp.* and venerid bivalves in circalittoral coarse sand or gravel*)*
- SS.SSa.OSa. OfusAfil (*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand) or *SS.SSa.IMuSa. FfabMag* (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand)

No rare or protected species with respect to the EC Habitats Directive 92/43/EEC and/or the Wildlife and Countryside Act 1981 (as amended), were found within the boundaries of the Moray East site. Individual juvenile Icelandic cyprine or Ocean quahog *Arctica islandica* was recorded, which is on the OSPAR List of Threatened and/or Declining Species and Habitats (Region II – Greater North Sea) and the list of Scottish Priority Marine Features (PMF). Other PMF recorded include: the coarse sand biotope, MoeVen (recorded at one reference station outside the boundaries of the Moray East Site) and Sandeels (as sandeel complex *Ammodytes marinus, A. tobianus*), as included within the Scottish PMF list. "Subtidal sands and gravels" habitat was also recorded which is a UK Biodiversity Action Plan (UK BAP) priority habitat as a result of its importance for the conservation of biodiversity. Although the UK BAP has now been succeeded by the post 2010 Biodiversity Framework, "Offshore subtidal sands and gravels" are included in the Scottish PMF list.

3.3.2 OfTI Corridor

Benthic ecology data for the OfTI Corridor were collected in 2014, using digital video and stills cameras (Moray East, 2014). Observations of the borehole samples collected during geotechnical campaigns were used to corroborate the seabed video/photographic data. Four habitats/biotopes were classified along the OfTI corridor, although these often occurred both singly and as twinned mosaics:

- Level 3 main habitat *SS.SSa* (subtidal sands and muddy sand)
- Level 4 biotope complex *SS.SMx.CMx* (circalittoral mixed sediment)
- Level 5 biotope *SS.SMu.CFiMu.SpnMeg* (seapens and burrowing megafauna in circalittoral fine mud)
- Level 6 Sub-biotope *CR.MCR.EcCr.FaAlCr.Pom* (faunal and algal crusts with *Pomatoceros triqueter* and sparse *Alcyonium digitatum* on exposed to moderately exposed circalittoral rock).

Observations of subtidal mixed coarse sediments and muddy sand sediments match historic records of this area, with two broad habitats and two detailed biotopes being classified and mapped by the acoustic and seabed video data. The two detailed biotopes are indicative of valued seabed features including a Scottish Priority Marine Feature (PMF) and an Annex I (EC Habitats Directive) habitat:

- The Level 5 *SS.SMu.CFiMu.SpnMeg* biotope was attributed to the majority of the OfTI Corridor below approximately the 50 m contour based on the widespread occurrence of "sea-pen and burrowing megafauna communities" evident from the video and stills images. The *SS.SMu.CFiMuSpnMeg* biotope is a component of the "burrowed mud" habitat which is a PMF in Scotland and which is one of a number of PMF's identified by the Scottish nature conservation agencies to help focus conservation action within Scotland's seas.
- The *CR.MCR.EcCr.FaAlCr.Pom* biotope is illustrative of the Annex I (EC Habitats Directive 92/43/EEC) geogenic reef and includes areas of cobbles, boulders and rocky outcroppings.

3.4 Fish and Shellfish

3.4.1 Commercial Species

The Moray Firth supports a number of commercially targeted fish and shellfish species. The principal shellfish and cephalopod species landed are Nephrops *(Nephrops norvegicus)*, scallops (*Pecten maximus)* and squid (*Loligo spp)*. With respect to fish, haddock (*Melanogrammus aeglefinus)*, herring (*Clupea harengus)*, whiting (*Merlangius merlangus)*, monkfish / anglerfish (*Lophius spp*.), mackerel (*Scomber scombrus)* and cod (*Gadus morhua)* constitute the majority of landings (Moray East, 2012). Within ICES rectangle 45E7 and 44E7, which represented the OfTI study area within the Modified TI ES 2014, haddock represents a considerably higher proportion of total landings than all other fish species. Landings weights for anglerfish, cod and herring are comparatively low (Moray East, 2014).

3.4.2 Spawning and Nursery Grounds

There are spawning and nursery grounds for a number of species within and in the immediate vicinity of the Moray East site and OfTI Corridor, including cod, herring, lemon sole (*Microstomus kitt)*, Nephrops, plaice (*Pleuronectes platessa)*, sandeel (*Ammodytidae* spp.), and sprat (*Sprattus sprattus*). There are also nursey grounds for the following species: Anglerfish, Blue Whithing (*Micromesistius poutassou)*, haddock, hake (*Merluccius merluccius)*, ling (*Molva molva)*, mackerel, saithe (*Pollachius virens)*, spotted Ray (*Raja montagui)*, spurdog (*Squalus acanthias)* and thornback ray (*Raja clavate)*. The Development area does not overlap with the spawning grounds of either the Orkney / Shetland or the Buchan herring stocks (the two stocks known to have spawning grounds in the vicinity of the Moray Firth) but it is located within high intensity nursery grounds as defined by Ellis *et al.* (2010).

3.4.3 Species of Conservation Importance

A number of species of conservation importance are found in the Moray Firth and may therefore transit through the Development area. These include diadromous migratory species, (those using the marine and freshwater environments during their life cycle) elasmobranchs (sharks and rays) and commercial fish species.

D[redacted]s migratory species potentially present include European eel (*Anguilla Anguilla)*, allis and t[redacted]*sa alosa, Alosa fallax)*, sea and river lamprey (*Lampetra fluviatilis, Petromyzon marinus)*, smelt (*Osmerus osperlangus)*, salmon (*Salmo salar)* and sea trout (*Salmo trutta)*.

A number of other fish species, which are commercially exploited, with conservation status may be present in the development area of the including anglerfish, mackerel, cod, herring and sandeel. Atlantic salmon and sea lamprey are of conservation interest in a number of SAC rivers in the Moray Firth area.

3.5 Marine Mammals

3.5.1 Commonly Sighted Species in the Moray Firth

The Moray Firth is an important area for marine mammals, with at least 14 species of cetacean and two species of seal being recorded in and around the Moray Firth. The bottlenose dolphin (*Tursiops truncates)* and harbour seal (*Phoca vitulina)* populations are both considered to be nationally and internationally important and are primary features of the Moray Firth Special Area of Conservation (SAC) and Dornoch Firth and Morrich More SAC (Moray East, 2012), respectively. Bottlenose dolphin, harbour porpoise (*Phocoena phocoena)*, harbour seal and grey seal (*Halichoerus grypus)* are all listed under Annex II of the Habitats Directive as requiring protection through the designation of SACs (Moray East, 2012). Large

cetacean species, including minke whale (*Balaenoptera acutorostrata)*, humpback whale (*Megaptera novaeangliae)* and less frequently killer whale (*Orcinus orca)* and long-finned pilot whales (*Globicephala melas)* have been recorded within the Moray Firth during the summer months as they migrate.

This section sets out the spatial and temporal sensitivities of the key marine mammal species recorded in Moray Firth.

3.5.1.1 Harbour (Common) Seal

A number of haul-out sites for harbour seals are located within the Moray Firth, primarily in the Beauly, Cromarty and Dornoch Firths (Thompson *et al.,* 1996b; Special Committee on Seals (SCOS), 2010). Since 2010, there has been substantial re-distribution in the area as counts at the Inner Firth have declined, whilst counts at Culbin Sands and Findhorn have increased rapidly (SCOS, 2017). The harbour seal population in the Moray Firth has declined by 40 % compared to numbers recorded in the mid-1990s, however the population have become relatively stable in recent years (SCOS, 2010; SCOS, 2017). Harbour seals occur throughout the year in these areas, with peak numbers at haul-out sites between June and August when they are used as breeding sites (Thompson & Miller, 1990; Thompson *et al*., 1996a). Counts between 2011 and 2016 recorded 940 seals within the Moray Firth haul out sites, the majority of which were recorded within the Inner Firth at Culbin, Loch Fleet and Findhorn (Figure 3-1) (SCOS, 2017). The total population of harbour seals in Scotland was 25,149 in 2011-2016, with 940 within the Moray Firth Management Unit (MU) (SCOS, 2017).

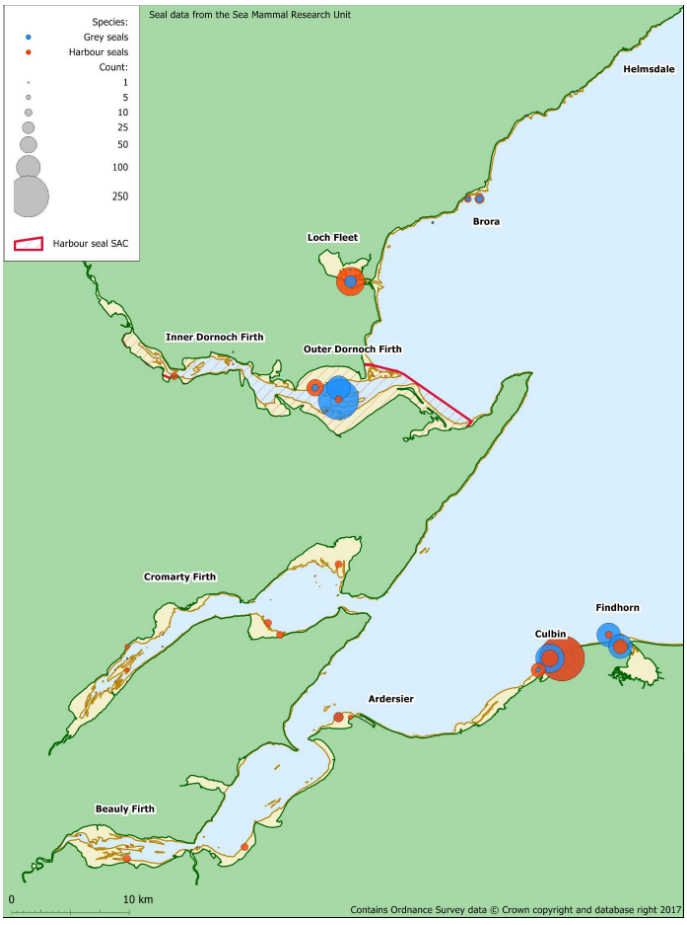

Figure 3-1 Harbour and grey seal haul out sites in the inner Moray Firth from SMMRU surveys in 2016 (SCOS, 2017).

Seals within the Moray Firth are found to forage in waters of 10 to 50 m depth over areas with predominantly sandy seabeds. Tagging studies within the Firth have found that harbour seals generally travel no more than 60 km from their haul-out sites (Thompson *et al.,* 1996b), with a tendency to forage slightly further afield in the winter (Thompson *et al.,* 1996a). The closest haul out site to the Development

area is Brora, which is 55 km to the west of the southern Moray East site. Findhorn is 58.2 km to the south west of the OfTI Corridor, followed by Culbin which is 64 km to the south west of the OfTI Corridor.

Boat-based marine mammal surveys were conducted in the Moray Firth between April 2010 and March 2012, commissioned by Moray East as part of the Environmental Impact Assessment (EIA), in order to provide site specific marine mammal distribution data at an appropriate scale. During the boat-based survey of the Moray East site plus 4 km buffer, six animals were confirmed as harbour seal. A number of seals observed during the surveys were not identified to species level, some of which may have been harbour seals. The harbour seal density across the site is 0.014 individuals per km^2, as calculated from the Russell *et al.* (2017) seals at sea density maps, summarizing the mean at sea densities from all 5x5 km grid cells overlapping with the Development area (i.e. the Moray East site and OfTI Corridor).

Dornoch Firth and Morrich More SAC

The Dornoch Firth and Morrich More SAC is located 76 km from the Development area, and lists harbour seal as a primary reason for site designation. The site supports a significant proportion of the inner Moray Firth population of harbour seals (JNCC, 2018). In the 2016 aerial surveys conducted by the Sea Mammal Research Unit (SMRU), 145 harbour seals were sighted in Dornoch Firth (SCOS, 2017).

The Conservation Objectives for the site are:

- To ensure for the qualifying species that the following are established then maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within the site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.
- The Moray Firth Seal Management Plan sets out further conservation objectives for interactions between seals and salmon within the Donorch Firth and Morrich More SAC. The aims of the plan are to:
    - Manage seal and salmon fishery conflicts within the Moray Firth to have minimal impact on wildlife and tourism;
    - Restore and “favourable conservation status” of harbour seals and salmon in their SACs;
    - Reduce the impact of shooting on the harbour seal population, through licensing and targeting key areas where they may be conflicts;
    - Reduce the impact of seal predation, especially on spring salmon stocks;
    - Develop non-lethal methods, such as seal scarers, to reduce the number of seal-salmon interactions particularly within rivers; and
    - Monitor and research the status of seal populations, salmon stocks and interactions between them.

Loch Fleet National Nature Reserve

The Loch Fleet National Nature Reserve (NNR) is located 78 km from the Development area, and lists marine mammals as an interest feature, particularly harbour seal which haul-out at the site year-round. Surveys carried out by the SMRU in August 2016 recorded approximately 100 harbour seals in Loch Fleet NNR (SCOS, 2017).

There are no specific conservation objectives for the site; however, the overall objective is to allow natural change to occur through the site with minimal disturbance to habitats and species.

3.5.1.2 Grey Seal

Grey seals within the Moray Firth are predominantly observed during the summer period, although smaller numbers are present throughout the year. Non-breeding grey seals have been observed at intertidal sites within the Moray Firth, also used by harbour seals. In August 2016, surveys carried out by SMRU recorded a MU population of 1,252 grey seals within the Moray Firth, approximately 350 of which were at Outer Dornoch Firth (SCOS, 2017).

Breeding grey seals are mostly found at the rocky beaches and caves to the north (Thompson *et al.,* 1996b). It is thought that grey seals travel into the Moray Firth from different breeding sites (such as Orkney, Firth of Forth and Farne Islands) and use the area for food and non-breeding haul-out (Thompson *et al.,* 1996b). The closest breeding site to the Project is Orkney, approximately 42 km to the north of the Development area. The closest haul out site is Helmsdale, which is approximately 42 km from the Development area.

Tagging studies within the Moray Firth have identified grey seals foraged over a much wider area than the harbour seal, with great variation between individuals (Thompson *et al.,* 1996b). Grey seals are thought to forage on two geographical scales: on short repeated trips to discrete foraging areas and on long distant trips from one haul-out site to another which can be up to 2,100 km (McConnell *et al.,* 1999). The majority of trips recorded by McConnell *et al.,* (1999) from grey seals tagged at Abertay and the Farne Islands were short and for foraging, around 40 km. High-usage corridors can connect haul out sites to foraging areas, which can be up to 100 km offshore (Jones *et al.,* 2015). Although it is thought that most seals breed in the same region as they forage, Russel *et al.* (2013) found between 21 % and 58 % of females foraged in a different region from where they bred around the UK.

The grey seal density across the site is 0.23 individuals per km^2, as calculated from the Russell *et al.* (2017) seals at sea density maps, summarizing the mean at sea densities from all 5x5 km grid cells overlapping with the Development area (i.e. the Moray East site and OfTI Corridor).

3.5.1.3 Harbour Porpoise

Harbour porpoise are distributed throughout the Moray Firth (Hastie *et al.,* 2003b; Thompson *et al.,* 2010a; Robinson *et al.,* 2007). During the warmer months (May to July) there is a seasonal increase of harbour porpoise along the coast due to lactating females and their calves moving inshore, who are then followed by males (Robinson *et al.,* 2007). As bottlenose dolphins are known to attack harbour porpoise where they are present in the same area, the densities of harbour porpoise tend to be lower in areas where bottlenose dolphins are prevalent (Spitz *et al.,* 2006; Evans *et al.,* 2015).

The Joint Cetacean Protocol (JCP) Phase III report (Paxton *et al*., 2016) demonstrated that the Outer Moray Firth has high persistent densities of harbour porpoise during the summer period, with an estimated abundance of 9,000 (Lower Confidence Interval (CI) = 5,800, Upper CI = 13,500), which represents 1.3 % of the North Sea MU population (Paxton *et al*., 2016). The Phase III JCP report outlines the densities of harbour porpoise within specific "*areas of interest for offshore development*" around the UK, including the Moray Firth, both inner and outer, which includes the Development area. The harbour porpoise density in this "*Moray Firth offshore development area*" (an area defined within the JCP Phase III Report and covering the Moray Firth) is estimated at 13,500 in the winter period (97.5 % CI 7,400 – 27,100) and at 5,300 in the autumn (97.5 % CI 3,200 – 9,500), with the estimates for the spring and summer period falling between the estimates for the winter and autumn (Paxton *et al*., 2016). This gives a worst-case density estimate of 1.7 individuals per km^2 based on the winter abundance estimate and the total area of the "*Moray Firth offshore development area*" of 7,899 km^2.

The second SCANS (Small Cetaceans in the European Atlantic and North Sea) survey (Hammond *et al*., 2013) estimated harbour porpoise densities of 0.274 individuals per km^2 (Coefficient of Variation (CV) = 0.36) in the relevant block for the Development (Block J), with an estimated abundance of 10,254 (CV =

0.36). Preliminary results from the more recent aerial SCANS III surveys showed a slightly lower density estimate of 0.152 individuals per km^2 (CV = 0.28) within the relevant survey block for the Moray Firth (Block S), with an estimated abundance of 6,147 (95 % CI 3,401 – 10,065) (Hammond *et al*., 2017). The estimated MU population for harbour porpoise in the North Sea is 345,373 (95 % CI 246,526 – 495,752) based on the SCANS-III survey results (Hammond *et al*., 2017).

Relative density estimates from boat-based surveys at the Moray East site (2010-2012) were 0.16 animals per km^2; slightly lower than those predicted for the Moray Firth by SCANS II. For the Moray East site plus 4 km buffer (including the three sites of Telford, MacColl and Stevenson) (Moray East ES 2012, Chapter 4 Biological Environment), habitat modelling was undertaken for harbour porpoise and bottlenose dolphin to determine the potential harbour porpoise presence in the Moray Firth. This modelling included a number of different surveys and environmental data such as water depth, slope, distance to shore and the sediment type. The results of these models were used to determine the relative density estimates in the Moray Firth on a 4x4 km grid. The result of this shows a high abundance of harbour porpoise along the shorelines, with more individuals in water depths of 40-50 m. Within the Moray East site, there are more harbour porpoise present within the north and western parts of the site, with relatively few in the south and east. The identified densities range from 0.2 to 1.05 individuals per km^2. See Figure 3-2 below for the predicted harbour porpoise density in the Moray Firth.

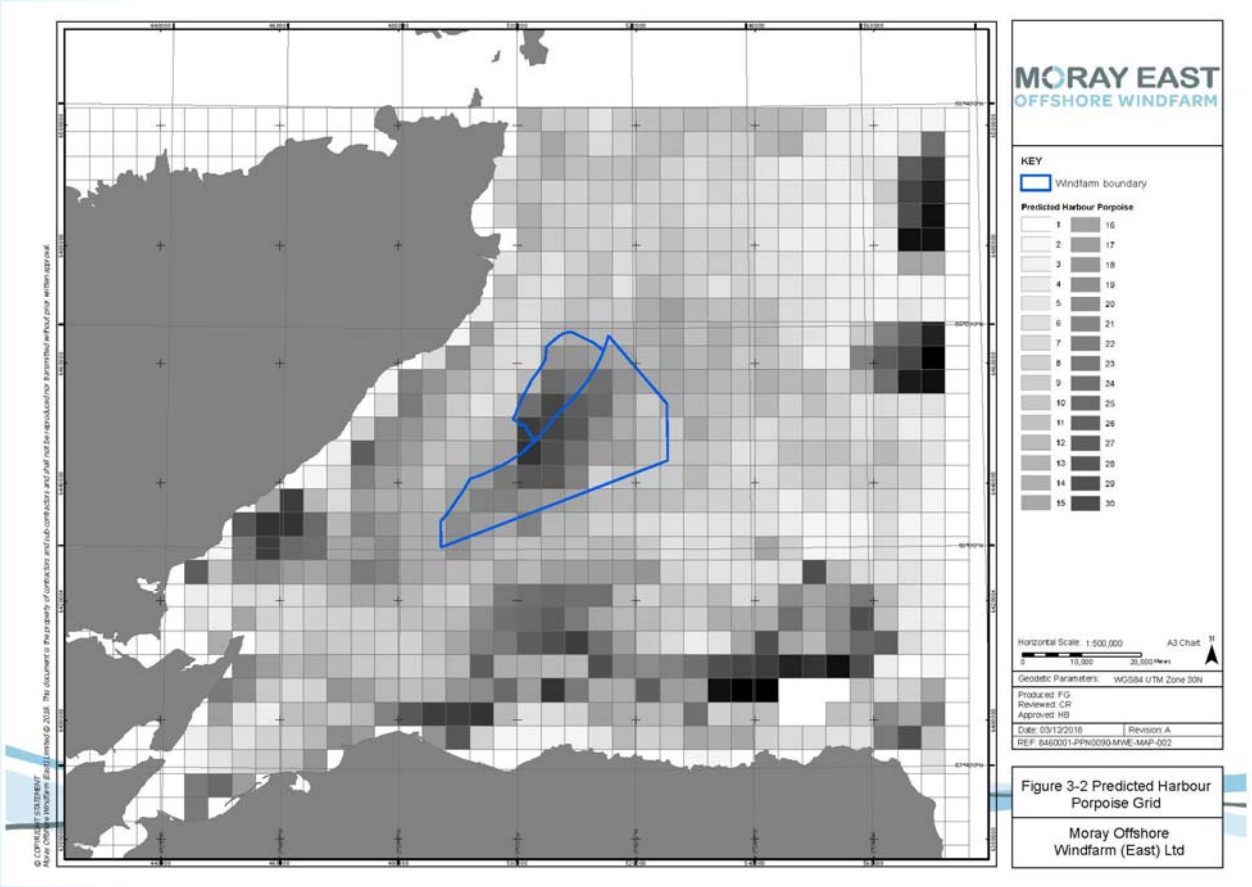

Figure 3-2 Harbour porpoise predicted densities within the Moray Firth (Moray East, 2012)

Data collected from the outer Moray Firth to assess the impact of seismic surveys on marine mammals (DECC funded project), supports the relatively high occurrence of harbour porpoises throughout the Moray Firth with high detection rates of harbour porpoises using autonomous passive acoustic detectors (CPODs) (Bailey *et al.,* 2010; Thompson *et al.,* 2010a).

3.5.1.4 Bottlenose Dolphin

A resident population of bottlenose dolphins can be found within the Inner Firth, for which the Moray Firth SAC has been designated. Although the majority of the population (71 to 111 individuals) appear to

regularly utilise the Moray Firth SAC (95 % CI: 66 to 161), it is clear that a relatively high number of individuals also frequently utilise areas outside the SAC (Thompson *et al.,* 2006; 2009).

The distribution of bottlenose dolphin sightings within the Moray Firth appear to be coastal, with the majority occurring in the Inner Firth and along the southern coast, generally in waters of less than 25 m deep (Hastie *et al.,* 2003a; Robinson *et al.,* 2007). Some individuals of the resident population exhibit movement patterns between the Moray Firth and other areas, for example, bottlenose dolphins from the Moray Firth SAC are regularly sighted in the Tay (Thompson *et al.,* 2011). A study conducted by Thompson *et al.,* (2015) used visual data to investigate the abundance and distribution of dolphin species throughout the Moray Firth. A total of 7,870 dolphins were noted during the visual surveys, 7,465 of which were identified as bottlenose dolphin (95%) (Thompson *et al*, 2015). These were predominantly recorded along the coastal areas particularly at the entrance to the inner Moray Firth, with very few recorded in the outer Moray Firth or offshore areas.

Within the Moray East marine mammal baseline surveys, as reported within the EIA, there were relatively few sightings of bottlenose dolphin made within the Moray East site compared to the coastal area, where dolphin species were predominantly bottlenose dolphins (Moray East, 2012). The predictions of bottlenose dolphin abundance were modelled in the same way as outlined for harbour porpoise above, over a 4x4 km grid taking into account survey data and environmental variables. Within the Moray East Site, 0 – 0.1 bottlenose dolphins were predicted to be present within a 4x4 km grid, however the coastline was predicted to have much higher densities, with up to 0.8 individuals present. The estimated density across the Moray East Site is 0.0005 individuals per km^2, much lower than the estimated densities from the JCP Phase III report and from SCANS-III. See Figure 3-3 below.

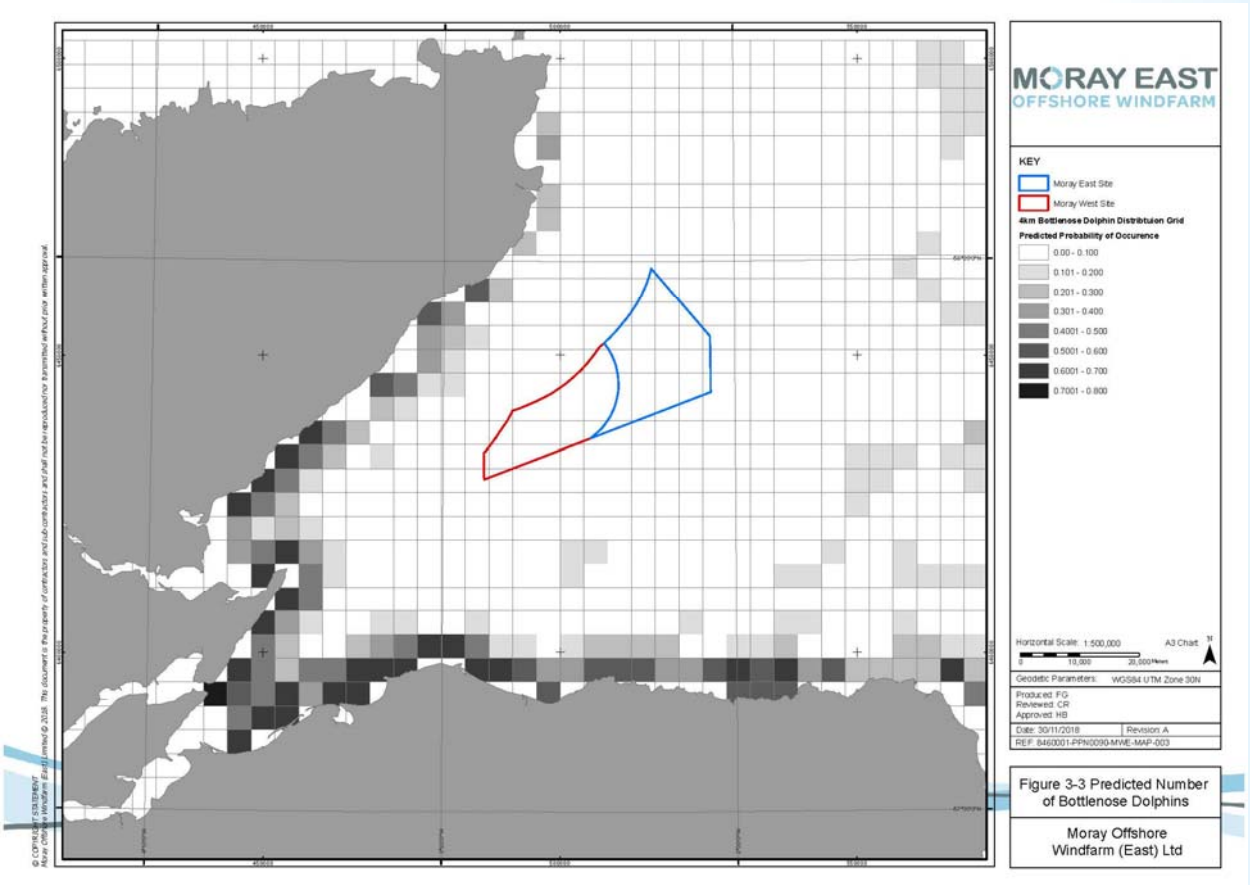

Figure 3-3 Bottlenose dolphin predicted densities within the Moray Firth (Moray East, 2012)

The Development area lies within two different bottlenose dolphin MUs; Coastal East Scotland and the Greater North Sea. The Coastal East Scotland MU has an abundance estimate of 195 (95 % CI 162 – 253) and the Greater North Sea is estimated at 0 (Inter-Agency Marine Mammal Working Group (IAMMWG),

2015). Within the JCP Phase III report, the bottlenose dolphin density for the *Moray Firth offshore development area* was estimated to be between 250 individuals in the summer (97.5 % CI 60-780) and 110 in the autumn (97.5 % CI 40-190) (Paxton *et al*., 2016). This gives an estimated density of 0.3 individuals per km^2. The SCANS-III density estimate for bottlenose dolphin in Block S is 0.004 individuals per km^2 (95 % CI 0 – 527), with an estimated abundance of 151 (CV = 1.01) (Hammond *et al*., 2017).

Moray Firth SAC

The Moray Firth SAC is located 38 km from the Moray East Site and lists bottlenose dolphin as a primary reason for site designation.

The Conservation Objectives for the site are;

- To ensure for the qualifying species that the following are established then maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within the site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

The Natura 2000 data form for the Moray Firth SAC (updated in December 2015) records the conservation status of the population of bottlenose dolphins within Moray Firth SAC as "Good" (JNCC, 2016). The bottlenose dolphins that use the Moray Firth are referred to as the Scottish East Coast population and have been recorded between the Firths of Forth and Tay and the Tyne Estuary (Wilson *et al.*, 2004; Thompson *et al.,* 2011). The two most recent assessments of found this population to be "Stable (increasing)" with approximately 200 animals (Cheney *et al*., 2012; 2014; Quick *et al*., 2014).

3.5.1.5 Minke Whale

Minke whale are present within Moray Firth, and appear to move south into the North Sea and Western Scotland at the beginning of May and remaining present until October, with occasional sightings outside of this period (Evans, 2008; DECC, 2016). Minke whale are the most abundant whale species within the Moray Firth, with sightings being reported throughout the area (Reid *et al*., 2003; Robinson *et al*., 2007; T[redacted]*et al.,* 2010a). Much of the research has concentrated on the southern coast and deeper trench w[redacted]ervations most commonly occurring in deeper waters further from the shore (Robinson *et al*., 2007; Eisfeld *et al*., 2009). Data indicates that minke whales visit the Moray Firth in late summer to forage with the majority of sightings between May and September (Bailey & Thompson, 2009).

Preliminary results of the SCANS III aerial surveys (Hammond *et al.*, 2017) gave a minke whale abundance of 383 (95% CI = 0 to 1,364) and a density of 0.010 animals per km^2 (CV = 0.75) within Block S. The Phase III JCP (Paxton *et al*., 2016) project estimated that within the *Moray Firth offshore development area*, there is an abundance of 210 minke whale in the summer (97.5 % CI 80 - 540) during the summer, which drops to 20 (97.5 % CI 0 - 60) in the autumn, however, in the winter and spring months (when the UXO clearance activities will be taking place) the abundances of minke whale are much lower. In winter and spring, minke whale abundance estimates within the *Moray Firth offshore development* area are 20 (97.5 % CI 0 – 130) and 30 (97.5 % CI 0 – 260) respectively. This equates to a worst-case density of 0.03 individuals per km^2 when using the summer abundance estimate. This is higher than the 0.01 animals per km^2 calculated from the boat-based surveys for the Moray East site (Moray East, 2012), although the small sample size needs to be taken into account when interpreting these results. Additionally, the boat based survey showed minke whales have a preference for sandbanks. For minke whale, there is only one identified MU for the whole of 23,528 (95 % CI 13,989 – 39,572) (IAMMWG), 2015).

Southern Trench proposed Marine Protected Area

Habitat modelling was undertaken to determine if and where there are areas of persistent high densities of minke whale in Scottish waters (Scottish National Heritage (SNH), 2014). The aim of the work was to identify areas that may require further protection through designated sites. Two areas were identified by SNH as having persistent above mean densities of minke whales between 2001 and 2012, these areas were the Sea of the Hebrides and the southern outer Moray Firth (Figure 3-4 below; SNH, 2014). The coastline of the southern Moray Firth has been estimated to have an average of four individuals per km^2 (Paxton *et al.,* 2014).

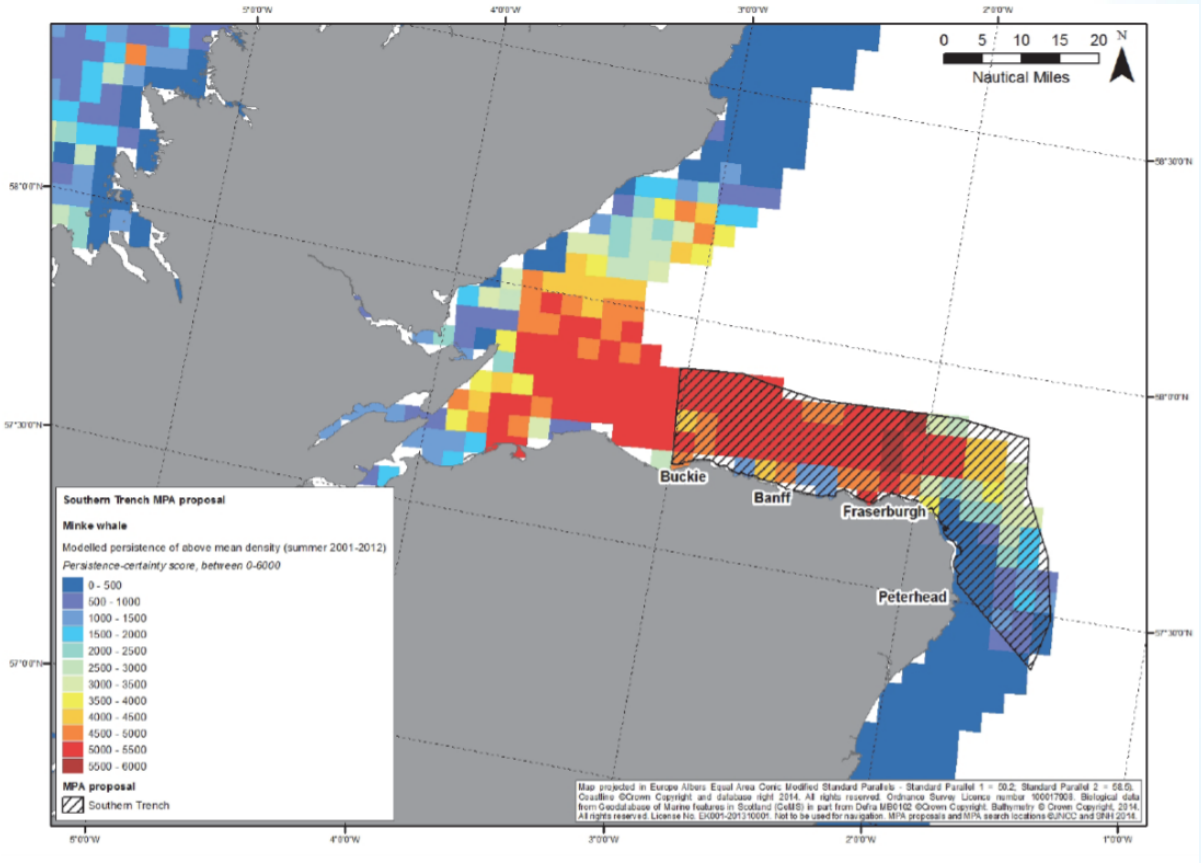

Figure 3-4 Areas with persistently above average density of minke whales in the Southern Trench Moray Firth proposed MPA (SNH, 2014).

Scottish Natural Heritage recommend that Nature Conservation MPAs for minke whale should be used to provide protection to the habitats used by these species (SNH, 2014).

3.5.1.6 White-beaked Dolphin

White-beaked dolphins (*Lagenorhynchus albirostris*) are present all year round in Scotland and the east coast of England, however sightings increase in the summer months as animals move towards the shore (Evans, 1992; Northridge *et al.,* 1995; Reid *et al.,* 2003). Sightings within the Moray Firth are low compared to other areas of the northern North Sea.

During surveys carried out in 2011 for the Beatrice Offshore Wind Farm (OWF), most sightings were in offshore areas, with only occasional sightings within the inner Moray Firth (BOWL, 2012). Site specific seasonal variation was not calculated due to the lack of sightings. In surveys of the Moray East site between 2010 and 2012, a total of three of white-beaked dolphins were sighted (Moray East, 2012). The visual surveys conducted between 1980 and 2010 by Thompson *et* al (2015) recorded a total of 7,870 dolphin individuals; 168 of which were identified as white-beaked dolphin (2% of all sightings). These were concentrated in the offshore areas of the Moray Firth, with very few sightings in coastal areas (Figure 3-5 below).

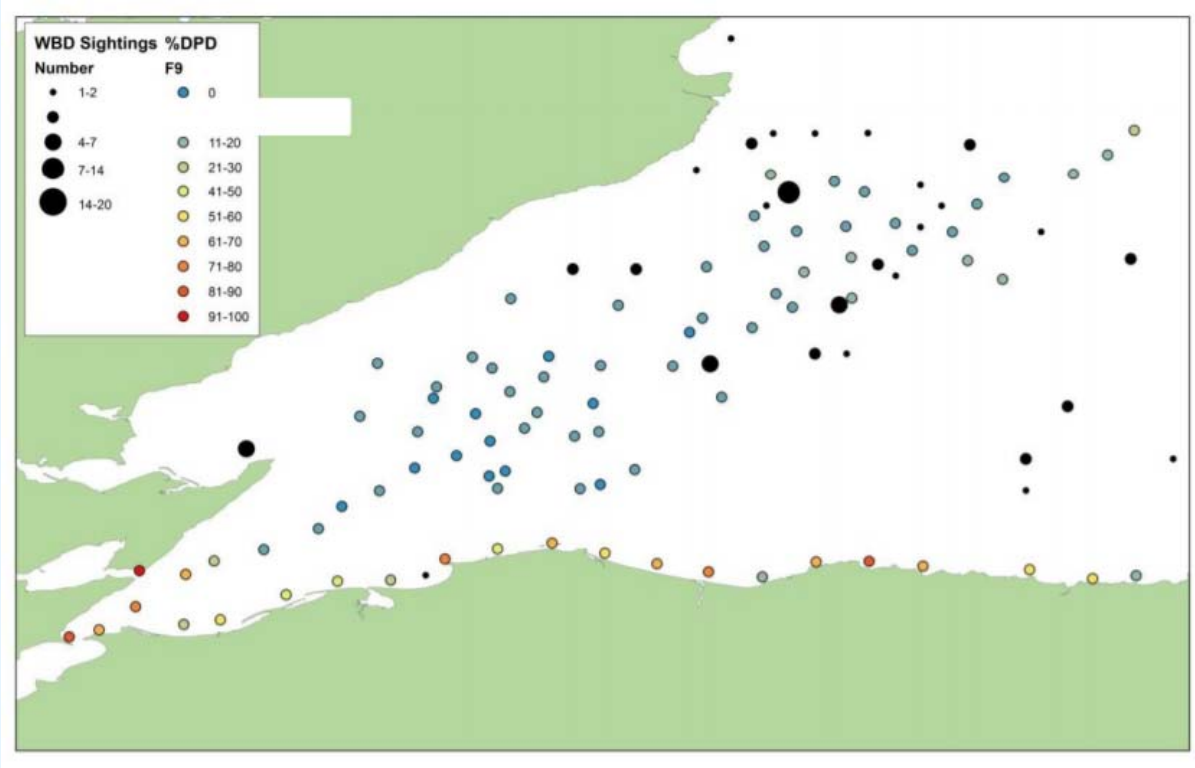

Figure 3-5 White-beaked Dolphin sightings across the Moray Firth recorded between 1980 and 2010 (indicated by the black circles) (Thompson et al., 2015).

The Phase III JCP report suggests that numbers within the "*Moray Firth offshore development area"* are highest during the spring, with an estimated abundance of 180 individuals (97.5 % CI 80 – 400), with the lowest numbers in winter (40 individuals; 97.5 % CI 20 – 110) giving a density estimate of 0.02 individuals per km^2 (Paxton *et al.,* 2016). The reference population for white-beaked dolphin in the Celtic and Greater North Seas MU is 15,895 individuals (95 % CI 9,107 – 27,743) (IAMMWG, 2015). Within the SCANS III Block S, the white-beaked dolphin abundance was estimated to be 868 (95 % CI = 0 to 2,258) and a density of 0.021 animals per km^2 (Hammond *et al.,* 2017).

3.5.1.7 Common Dolphin

Ir[redacted]on dolphins (*Delphinus delphinus)* are rarely sighted in the North Sea, and are much more likely to be found in the waters off the west coast (Reid *et al.,* 2003). Site specific surveys carried out for the Beatrice OWF sighted 15 common dolphins in total, the majority of which were along the north coast with seasonal peaks in June and July during the calving period (BOWL, 2012). During the Moray East surveys carried out between 2010 and 2012 three common dolphins were sighted in total (Moray East, 2012). The Cetacean Research and Rescue Unit (CRRU) also reported sightings along the south coast of the Moray Firth between May and August 2006-2009 (Robinson *et al.,* 2010).

Within the JCP Phase III report, the abundance of common dolphin within the "*Moray Firth offshore development area"* was estimated to be the highest in autumn, with an estimate of 200 individuals (97.5 % CI 80 – 570), and the lowest in winter with 10 (97.5 % CI 0 – 50). This would give a density estimate of 0.025 individuals per km^2. No common dolphin were recorded in Block S of the SCANS-III survey (Hammond *et al*., 2017). The reference population for common dolphin in the Celtic and Greater North Seas MU is 56,556 individuals (95 % CI 33,014 – 96,920) (IAMMWG, 2015).

3.5.1.8 Other Cetacean Species

Risso's dolphins (*Grampeus griseus)* were also recorded in very low numbers in offshore waters off the Moray Firth during site specific surveys for Beatrice OWF with a total of two sightings (BOWL, 2012). The Moray East site specific surveys recorded a total of one Risso's dolphin (Moray East, 2012). During the CRRU surveys, five individuals were sighted in total along the southern coastline of Moray Firth between

2001 and 2005, all between 20 to 50 m isobaths (Robinson *et al.,* 2007). The JCP Phase III report shows an estimated abundance of 0 in all seasons within the "*Moray Firth offshore development area"* (Paxton *et al.,* 2016), and the preliminary results of the SCANS III aerial surveys (Hammond *et al*., 2017) did not record Risso's dolphins within survey Block S.

Occasional sightings of killer whale, long-finned pilot whale, fin whale (*Balaenoptera physalus),* humpback whale and sperm whale (*Physeter macrocephalus)* have also been reported in the outer Moray Firth (DECC, 2016). Killer whale sightings are greatest between April and September, whereas long-finned pilot whales have been sighted in waters off Scotland all year round (DECC, 2016). Due to the rarity of the sightings of these species in Moray Firth, no density estimates are available.

3.5.2 Summary of Species included in the Assessment

As noted in the above section, there are a number of species that are considered to be rare within the Moray Firth area, including Risso's dolphin, killer whale, long-finned pilot whale, fin whale, humpback whale and sperm whale. As such, these species are not considered further for assessment.

A number of seal and cetacean species are found to be present in relatively high numbers, including both grey and harbour seal, harbour porpoise, bottlenose dolphin, minke whale, white-beaked dolphin and common dolphin. Table 3-1 outlines the species included in the assessment, whether they have also been included in the accompanying EPS assessment (produced to support the EPS licence application and provided as the Cetacean Risk Assessment), and the relevant density estimates and reference populations that each species will be assessed against.

Table 3-1 Summary of species taken forward for assessment, and their density estimates and reference populations

Species	Density estimate	Reference population	Taken forward for EPS Assessment?
Harbour seal	0.014/km^2 (Russell *et al*., 2017)	940 (Moray Firth MU; SCOS, 2017)	No
Grey seal	0.23/km^2 (Russell *et al*., 2017)	1,252 (Moray Firth MU; SCOS, 2017)	No
Harbour porpoise	1.7/km^2 (*Moray Firth offshore development area*; Paxton *et al*., 2016)	345,373 (North Sea MU; Hammond *et al*., 2017)	**Yes**
Bottlenose dolphin	0.3/km^2 (*Moray Firth offshore development area*; Paxton *et al*., 2016)	195 (Coastal East Scotland MU; Hammond *et al*., 2017)	**Yes**
Minke whale	0.03/km^2 (*Moray Firth offshore development area*; Paxton *et al*., 2016)	23,528 (Celtic and Greater North Sea MU; Hammond *et al*., 2017)	**Yes**
White-beaked dolphin	0.021/km^2 (Survey Block S; Hammond *et al*., 2017)	15,895 (Celtic and Greater North Sea MU; Hammond *et al*., 2017)	**Yes**
Common dolphin	0.025/km^2	56,556 (Celtic and Greater North Sea MU; Hammond *et al*., 2017)	**Yes**

3.5.3 Favorable Conservation Status

Under the Habitat Regulations 1994, regulation 44(3)(b) requires that Scottish Ministers are satisfied that the proposed project or activity must not be harmful to the maintenance of each of the species populations included within the assessment. The overarching objective is to ensure that the species reach "Favourable Conservation Status" (FCS) and that the viability of the population is secured for long-term survival. Article 1(i) of the Habitats Directive defines the conservation status of a species as:

> "*the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within its natural range*."

The conservation status is considered to be "favourable" when:

- *"population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and*
- *the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
- *there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."*

Table 3-2 below provides a summary of the conservation status of the EPS considered in this assessment. The data provided in this table is based on the most recent condition assessment (2007 to 2012) (JNCC, 2012).

Table 3-2 Conservation status of key cetacean species

Species	UK Conservation Status Assessment
Harbour porpoise	Favourable
Bottlenose dolphin	Favourable
Minke whale	Favourable
White-beaked dolphin	Favourable
Common dolphin	Favourable

3.6 Ornithology

The Moray Firth's coastal and offshore waters are internationally important for populations of seabird, seaduck, wader and wildfowl. Because of this, a number of areas bordering the Moray Firth have been designated as Special Protection Areas (SPAs) under EU Directive 79/409/EEC (the Birds Directive). In addition to resident birds, the area is used for breeding, over-wintering or as a temporary feeding ground during the spring and autumn migrations of species breeding in Scandinavia and the Arctic.

The Moray East ES 2012 described the ornithological environmental baseline, which identified the key ornithological species recorded during boat-based surveys undertaken between April 2010 and March 2012, vantage point surveys undertaken from four coastal locations between 2010 and 2011, and aerial surveys and seabird tracking undertaken in summer 2011. In total, ten species were put forward for consideration of impact assessment for the three Telford, Stevenson and MacColl wind farms (now the Moray East site). Additionally, coastal bird surveys were undertaken between May and July 2014 for the Modified TI ES (Moray East, 2014). Based on the results of the survey, 17 species were considered in the impact assessment for the OfTI. Further details are provided below.

3.6.1 Key Species Commonly Sighted Species in the Moray Firth

Five species (fulmar, kittiwake, guillemot, razorbill and puffin) were recorded frequently during boat–based surveys and are designated features of more than one of the three local SPAs (East Caithness Cliffs SPA, North Caithness Cliffs SPA, and Troup, Pennan and Lion's Heads SPA).

Population density and abundance estimates for those five species have been provided in Table 3-3 below, obtained from boat based surveys conducted from 2010 to 2012 to inform the ornithology baseline for the Moray East ES 2012. The estimates show guillemot has the highest density and abundance estimate and fulmar has the lowest.

Table 3-3 Density (Birds / km^2) and Abundance Estimates (Birds Using the Sea) using density surface models, taken from 2010 to 2012 boat-based survey data (Moray East, 2012)

Species	Breeding Season				Non-Breeding Season			
	Density		Abundance		Density		Abundance	
	Site	Buffer	Site	Buffer	Site	Buffer	Site	Buffer
Fulmar	2.77	1.91	782	750	0.25	0.20	197	189
Kittiwake	7.90	4.69	1,963	1,532	0.79	0.29	261	204
Guillemot	25.57	18.60	6,732	6,943	2.84	3.47	990	1,021
Razorbill	6.03	3.53	1,661	1,674	2.64	3.04	892	899
Puffin	6.55	5.55	1,916	1,971	0.75	1.05	450	463

3.6.2 Sites Designated for Ornithological Receptors

A number of sites designated for ornithological receptors were considered in the Moray East ES 2012 and the Moray East Modified TI ES 2014. A summary of local SPAs considered in the ESs are provided in Section 3.11 below and further relevant sites designated since submission of the ESs. Sites include East Caithness Cliffs SPA, North Caithness Cliffs SPA, Troup, Pennan and Lion's Heads SPA and Moray Firth pSPA.

3.7 Marine Archaeology

The following section outlines the baseline conditions relevant to archaeological and cultural heritage within the Moray East site, as presented in the Moray East ES 2012 and relevant results from archaeological analysis of the OfTI corridor, referred to as the "OfTI 2018 Archaeology Study Area" (Moray East, 2018).

For the Moray East ES 2012 archaeological baseline, a study area was defined as the Inner Study Area which was the three proposed wind farm sites (i.e. the Moray East site) and an Outer Study Area which was a 1 km buffer zone around the Inner Study Area. There are no designated archaeological or cultural heritage assets or targets within the Inner or Outer Study Areas. The following archaeological / cultural heritage assets and targets were identified within the Inner and Outer Study Areas (Moray East ES 2012): six recorded wreck sites; two recorded obstructions; 20 geophysical anomalies of archaeological potential, comprising three anomalies of high archaeological potential and 17 anomalies of medium archaeological potential.

The following additional targets of archaeology potential were also identified as being within the Development area during the recent 2018 archaeology assessment of geophysical and geotechnical survey data[1]: ten geophysical anomalies classified as A2 (uncertain origin of potential archaeological potential); and three simple cut and fill P2 classified paleolandscape features (Moray East, 2018).

The Moray East Modified TI ES 2014 determined there are no designated archaeological or cultural heritage assets or targets within the OfTI Corridor. The following archaeological / cultural heritage assets and targets were identified within the Modified TI corridor: 96 anomalies of uncertain origin of possible archaeological interest (classified as A2 anomalies by Wessex Archaeology - uncertain origin of possible archaeological interest); and 19 palaeogeographic features.

[1] The geophysical survey data assessed for this report comprises 2014 data collected across the OfTI and part of the Moray East Offshore Wind Farm, and 2017 geophysical data collected over a small inshore area of the OfTI at Inverboyndie Bay.

3.8 Commercial Fisheries

The Moray East ES 2012 indicated that ICES rectangle 45E7, within which the Moray East site is located, records landings values (average 2001 to 2010) that are of moderate importance on a national and regional scale (Figure 5.1-3 and Figure 5.1-4, Volume 6 b). The principal species targeted are: king scallops (55.4 %); Nephrops (14.1 %); whitefish, including haddock, monks and cod (19.7 %); and squid (7.6 %). The following methods are principally used: boat dredges to target scallops, otter trawls to target Nephrops, seine nets and otter trawls to target whitefish, and demersal trawls to target squid (Moray East, 2012).

The latest ICES data from 2017 shows that the principal species targeted are the following (percentage values per species provided in brackets scallops: (28%), squid (9%), haddock (6%), Nephrops (2%), monk or anglerfish (2%). The recent data shows the landings have largely remained the same from the Moray East ES 2012 baseline (ICES, 2017).

Landings values for all species from rectangle 45E7 are broadly highest between May and September, although there are also moderate landings recorded in April and October. The majority of landings from rectangle 45E7 are into ports in the Moray Firth area. Fraserburgh is the principal port, with 44.8 % of landings (values) from 45E7 (Moray East, 2012).

The principal commercial species targeted by gear type in the area of the OfTI are: Nephrops by demersal trawlers, king scallops by boat dredgers, squid by demersal trawlers, whitefish by demersal trawlers and crab and lobster by creelers. There is also some mackerel hand-lining activity in the area (Moray East, 2014).

3.9 Shipping and Navigation

The Moray East site is located within the vicinity of the Jacky Oil Field and the Beatrice Oil Field. The closest platform is located at the Jacky Field, approximately 3.7 nm west of the Stevenson site. The study area boundary is also approximately 5.4 nm east of the Beatrice Demonstrator wind turbine generators (WTGs) (Moray East, 2012). The study area was selected on the basis that it captures navigational features and traffic which could be affected by nearby development (shown in Moray East ES 2012, Figure 5.2-1, Volume 6b).

Vessel based surveys conducted in April to July 2010 and November 2010 to January 2011 showed in total, [redacted] there was an average of 14 vessels per day passing within 10 nm of the Moray East site during the winter s[redacted]ssels per day recorded during July 2010. It is noted that the increased traffic recorded in the summer survey can be partly attributed to fishing and recreational vessels passing through the area in more favourable weather and sea conditions.

A shipping analysis was performed using 56 days of Automatic Identification System (AIS) data from July and December 2013 to account for seasonal variations for the Moray East Modified TI ES 2014. An average of 18 unique vessels per day passed through the study area during summer and an average of 16 unique vessels per day passed through the study area during winter. The landfall end of the OfTI Corridor was intersected by a coastal shipping route between the inner Moray Firth ports and other ports in the UK and mainland Europe. Smaller recreational vessels were also seen to pass closer to the coast. Fishing activity was noted over the central part of the OfTI Corridor.

A Navigational Risk Assessment (NRA) was submitted in 2010 which presented survey data collected via AIS and Radar over a 90 day period between 1 May and 31 July 2010. Further AIS data was recorded between 4 and 31 March 2018 which has been compared to the 2010 AIS data in order to determine the validity of the data. The analysis showed an average of approximately 11 unique vessels per day was recorded in both survey periods. Overall, the difference in the volume of traffic recorded within the study area during the 2010 and 2018 surveys was insignificant. The majority of vessels recorded were cargo and fishing vessels in both 2010 and 2018 (Moray East, 2018)

3.10 Infrastructure and Other Users

The Development is located adjacent to Beatrice OWF, and approximately 11 km to the northeast of the two-turbine Beatrice Demonstrator WTGs. The Beatrice Demonstrator WTGs are located adjacent to the Beatrice oil field, immediately to the west of the Moray Firth Round 3 Zone. It is comprised of two 5 MW WTGs and has a proposed lifespan of five years and all electricity generated is fed to a nearby oil platform.

There are two operational oil fields to the west of the Moray East site, the Beatrice oil field (Block 11 / 30a) and the Jacky oil field (Block 12 / 21c). These fields and their associated infrastructure do not overlap with the boundary of the Moray East site (Moray East, 2012). There are five plugged and abandoned wells within the OfTI Corridor. Correspondence with the HSE has confirmed that there are no mandatory safety zones associated with the wellheads (Moray East, 2014).

There are no existing subsea cables within the Moray East site. There is one existing subsea cable in proximity to the modified OfTI corridor the SHEFA-2 fibre-optic telecommunications cable.

Practice and Exercise Areas (PEXA) are used for various military practice activities. Portions of the OfTI lie within offshore Danger Area D809 (South), offshore Danger Area D807, and large Air Force Department Area D712D. The closest coastal Danger Area to the landfall is located approximately 35 km to the west at the Binn Hill Firing Range between Buckie and Lossiemouth (Moray East, 2014).

Dredging and disposal activity within the Moray Firth is sporadic and associated with port and harbour maintenance and development and coastal marine disposal sites. Where the proposed OfTI makes landfall, it will travel within several kilometres of the existing ”MacDuff” marine disposal site, which historically has received small volumes of dredge arisings, though at no point will overlap with it (Moray East, 2014).

3.11 Designated Sites

There are a number of nature conservation designations within the Moray Firth and in the vicinity of the Development. Designated sites have been screened into the assessment where there is spatial overlap and/or there are mobile features which may occur within the project area. A summary of the designated sites that were screened into this assessment as having the potential to interact with the UXO clearance activities is provided in Table 3-4.

Table 3-4 Designated sites with the potential to interact with UXO activities

Site name	Screened in qualifying features
Moray Firth SAC	Bottlenose dolphin
Dornoch Firth and Morrich More SAC	Harbour Seal
Berridale and Longwell waters SAC	Atlantic Salmon
River Spey SAC	Atlantic Salmon and Sea Lamprey
River Thurso SAC	Atlantic Salmon
East Caithness Cliff SPA	Annex I species: peregrine Migratory species during breeding season: guillemot, herring gull, kittiwake, razorbill and shag Birds present during breeding season: puffin, great black-backed gull, cormorant, fulmar, razorbill, guillemot, kittiwake, herring gull and shag.

Site name	Screened in qualifying features
North Caithness Cliffs SPA	Annex I species: peregrine Migratory species during breeding season: guillemot Species present during breeding season: puffin, razorbill, kittiwake, fulmar and guillemot
Troup, Pennan and Lion's Head SPA	Migratory species during breeding season: guillemot Species present during the breeding season: razorbill, kittiwake, herring gull, fulmar and guillemot.
Moray Firth pSPA	The European Shag is proposed as a breeding and non-breeding species. The following non-breeding species have also been proposed: Common eider; Common goldeneye; Common scoter; Great northern diver; Greater scaup; Long-tailed duck; Red-breasted merganser; Red-throated diver; Slavonian grebe and Velvet scoter.

[redacted]

4 Embedded Mitigation Measures

There are a number of embedded mitigation measures that will be implemented for the UXO clearance activities, which will reduce the potential for certain impacts. These measures are listed in Table 4-1 below and are referred to in the individual assessments where relevant.

Table 4-1 Embedded Mitigation Measures

Measure	Description
Other Sea Users	
Notification of UXO locations to MS-LOT and Coastguard	Before detonation of UXO begins, all positively identified UXO Items will be documented and reported according to OSPAR requirements, with notification sent to HM Coastguard and the Royal Navy. Notification of the location and size of any UXO to be detonated will also be made to MS-LOT. Following completion of the surveys to identify potential UXO, further inspection of suspected UXO locations and confirmation of which UXO require detonation, a log of the location, type and size of each UXO will be compiled and sent to HM Coastguard, the Royal Navy and MS-LOT as soon as possible prior to the first detonation. Once confirmation that the information has been received and the planned detonation can take place has been given by these organisations, the detonation process can begin.
Notices to Mariners	A Notice to Mariners (NtM) will be issued in advance of any UXO clearance activities to alert vessels and other interests of the timing and location of UXO clearance activity.
Consultation with infrastructure owners and other sea users	Moray East will liaise closely with the following prior to UXO clearance activities and to ensure safe continuation of existing activities as far as reasonably practicable: • Beatrice and Jacky platform owners (Talisman and Ithaca) • Beatrice OWF • Local Fishing Community (through a Fisheries Liaison Officer (FLO))
Safety	
Relocation	UXO will be relocated to the nearest suitable location if it is deemed unsafe to detonate the UXO safely in situ.
Guard vessel	A guard vessel will be present at 100 m from the target location to prevent other vessels (including other vessels involved in the UXO activity) from entering the 500 m detonation safety zone and to ensure the 1,500 m safety distance is adhered to. Once it is determined all vessels are outside of the 1,500m safety distance, the guard vessel will move outside of the detonation safety zone before detonation commences.
Safety distances	A safety distance of 1,500 m will be implemented during EOD operations, to ensure the safety of vessels and other interests operating in the vicinity. Detonation activities will be stopped when any vessel (with the exception of vessels conducting detonation operations) enters or appears to approach within a safety distance of 1,500 m around the blast site. The area (i.e. the 1,500 m safety distance) will also be closed down for normal marine vessel traffic in agreement with the HM Coastguard National Maritime Operations Centre and the Royal Navy and via a Notice to Mariners. Only once confirmation that the blast site is clear from other marine traffic and the all clear is given by a guard vessel can preparation for detonation begin.
Post-Clearance survey	A post-clearance survey will be undertaken at the blast site once the UXO has been detonated to verify the detonation is fully complete. Once it is confirmed the UXO has been detonated the detonation safety zone will be stopped. The detonation and navigation safety distances will continue to remain closed to marine traffic until the operation has been completed successfully.

Measure	Description
Environment	
Pollution Prevention	Pollution prevention measures will be in place on board vessels involved in undertaking the UXO clearance activity, including: • No refuelling of vessels will take place at sea. • Storage facilities on board vessels will be suitable to contain and prevent the accidental release of fuel, oils and chemicals associated with any of the tools used on board the vessel. • Secondary containment (e.g. bunds) will be used with a capacity of not less than 110 % of the containers storage capacity so that in the case of a spill, 100 % of liquid will be retained.
Archaeological mitigation	The vessel master and UXO contractor will be briefed on the exact locations of Archaeological Exclusion Zones (AEZ) and a chart of these locations provided to ensure limited interference with AEZs. UXO clearance works will avoid AEZs unless otherwise agreed with MS-LOT in consultation with Historic Environment Scotland. Any object that is identified as potential archaeology will be reported to the project Archaeologist. If a stray archaeological target is deemed to be of potentially high importance during any of the UXO clearance activities then the Archaeologist will be consulted.

[redacted]

5 Assessment of Effects

5.1 Approach to Assessment

The following sections provide an assessment of the potential environmental impacts of the UXO clearance activities in relation to the following environmental topics: physical processes; benthic ecology; fish and shellfish; marine mammals; ornithology; marine archaeology; commercial fisheries; shipping and navigation; and infrastructure and other users as agreed with MS-LOT (Section 1.3 above).

The impact assessment process followed the Institute of Ecology and Environmental Management (IEEM)[2] (2010) Guidelines for Ecological Impact Assessment in Britain and Ireland – Marine and Coastal. The impact significance criteria used are provided in Table 5-1 below.

Table 5-1 Impact Significance Definitions

Impact Significance*	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in an exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No impact	No change in receptor condition, therefore no impact.

*A significant impact is any impact significance greater than a minor impact.

5.2 Physical Processes

There is potential for an increase in suspended sediment concentrations (SSC) following UXO detonation activities through seabed disturbance from the blast. Once the sediments have been mobilised into the water column following the detonation they will immediately begin to resettle through natural hydrodynamic processes. The seabed disturbance will be limited to the blast site meaning the increase in SSC will be localised to each individual UXO detonation. Although there will be an increase in SSC above background concentrations this is not expected to be of the same magnitude experienced during storm events.

There is also potential for craters to form at each UXO detonation caused by seabed disturbance from the blast. However, any craters will be infilled through the natural sediment transport regimes in the area.

Due to the short-term duration and localised nature of the impact and the low number of UXO expected to require detonation, the effects of increased SSC and deposition on the seabed is considered to be **minor** and no mitigation is considered necessary.

[2] Now the Chartered Institute of Ecology and Environmental Management (CIEEM).

5.3 Benthic Ecology

5.3.1 Temporary Habitat Loss and/or Disturbance

The clearance of UXO within the Development area has the potential to result in the loss of benthic habitat and associated fauna within the vicinity of the blast site. Communities present across the Development area are common and widely distributed throughout Moray Firth. Therefore, recovery at the affected areas will be rapid due to colonization from surrounding unaffected areas.

Due to the localised nature of the impact, coupled with the high recoverability of the communities present, the impact of temporary habitat loss and/or disturbance on benthic ecology is considered to be **minor** and no mitigation is considered necessary.

5.3.2 Increases in SSC and Deposition on the Seabed

The sensitivity of benthic communities within the Development area was assessed in relation to seabed disturbances and increases in SSC in the Moray East ES 2012 and the Modified TI ES 2014. Local receiving habitats are predominately sedimentary in nature and are characterised by sediment burrowing animals and are thus expected to be tolerant to temporary light sediment deposition. Additionally, as stated in Section 5.3.1 above the receiving environment to sediment deposition is widely distributed throughout Moray Firth therefore, recovering from surrounding unaffected areas is likely to be rapid.

Due to the low sensitivity of the benthic communities present and the localised nature of the impact, the impacts of increased SSC and sediment deposition on benthic ecology are considered to be **negligible**.

5.3.3 Release of Sediment Contaminants

During the site characterisation surveys for Moray East ES 2012 and Modified TI ES 2014 levels of sediment contaminants were below guideline levels at all sampling locations (Moray East, 2012; Moray East, 2014). As a result of this, it is not expected that elevated SSC would result in a release of contaminated sediments.

Given the dispersive and dilutive nature of the environment, any minor elevated levels of contaminants in the water column that may arise in association with the elevated SSC following UXO clearance activities are unlikely to result in adverse effects on benthic ecology.

Due to there being no exceedances of guideline levels of contaminants in sediments across the D[redacted]ent area the effect of resuspension of sediment contaminants on benthic ecology is considered t[redacted]

5.4 Fish and Shellfish

5.4.1 Behavioural Disturbance

The detonation of UXO within the Development area has the potential to cause disturbance or injury to fish species in the vicinity of the detonation. The extent of the impact relates to the proximity of the receptor to the detonation, with physical injury occurring only in close proximity to the detonation with behavioural effects occurring further from the source.

Herring spawning activity occurs further to the north around the Orkney and Shetland islands between August and September (Coull *et al.,* 1998) meaning spawning activity for herring will not be affected by the clearance activity taking place in spring.

Cod spawning is located in the Moray Firth and low intensity cod spawning occurs within the OfTI Corridor. Cod spawning occurs between January and April, (Coull *et al*., 1998; ICES, 2005a), therefore, there is potential for the UXO clearance activities to overlap with part of the cod spawning period.

Salmon are considered to be sensitive to noise emissions during their migration route through the Moray Firth either as adults returning to rivers to spawn or as smolts on their way out of rivers into the Firth. Smolt migration typically takes place between March and June, with rivers surrounding the Moray Firth generally exhibiting smolt runs later in the year from April to Early June (Moray East, 2014). Adult salmon migration into the rivers generally occurs from early summer to autumn. However, a small portion of the salmon stock passing through the Moray Firth undergo an early ascent through the river, starting as early as the autumn of the year before spawning, referred to as "spring" run fish (Moray East, 2014). Therefore, UXO clearance activities will only overlap with part of the salmon migration period through Moray Firth.

Given the short duration of the activity (only a maximum WCS of ten UXOs to detonate, over approximately 10 days excluding weather downtime and de/moblisation), the intermittent nature of the noise produced (i.e. UXO would be detonated one at time (unless nearby UXO are grouped together for a single detonation), anticipated two UXO detonation per day) and variation in the location of the noise (i.e. some UXO may be present along the OfTI Corridor and some in the Moray East site), no population level effects are predicted to occur for any fish species present in Moray Firth.

Due to the short duration and localised nature of the impact and the activity occurring outside the peak spawning and migration periods for most key species the effects of physical injury and behavioural disturbance are considered to be **minor**.

While there are no specific measures that can be applied to mitigate potential effects on fish populations, the mitigation measures employed for marine mammals (Appendix A) should encourage fish species to move away from the area prior to the detonation of any UXO. Following the implementation of mitigation measures impacts are considered to be **negligible**.

5.4.2 Temporary Habitat Loss and Disturbance

The clearance of UXO within the Development area has the potential to result in the loss of benthic habitat within the vicinity of the blast site which is of importance to fish species. This impact is, however, predicted to be highly localised and therefore will not result in significant areas of seabed being disturbed.

Following seabed disturbance from UXO detonation there will be an increase in SSC which has the potential to impact spawning and nursery grounds, as eggs and larvae have relatively high susceptibility to sediment deposition. However, as set out in Section 5.2 above, seabed disturbance will be limited to the blast site meaning the increase in SSC will be localised to each individual UXO detonation. Although there will be an increase in SSC above background concentrations this is not expected to be of the same magnitude experienced during storm events. Additionally, the spawning and nursery areas present in the vicinity of the Development area are extensive and given the highly localised area that will be affected by each detonation it is unlikely that large proportions of any nursery and spawning grounds will be affected.

Mobile fish species are able to avoid localised areas disturbed by increased SSC. Juveniles and adults would be able to move to adjacent undisturbed areas within their normal distribution range and avoid any areas of increased SSC.

Due to the localised nature of the impact, the extensive feeding, nursery and spawning habitat available in the wider area, the effects of temporary habitat loss and/or disturbance is considered to be **negligible** and no mitigation is considered necessary.

5.4.3 Release of Contaminants

As discussed in Section 3.2 above, records of sediment contamination from across the Development area collected for the Moray East ES 2012 and Modified TI ES 2014 were all below guideline levels (Moray East, 2012; Moray East, 2014). Due to there being no exceedances of guideline levels of contaminants in sediments across the Development area and the dispersive nature of the environment the effect of resuspension of sediment contaminants on fish and shellfish ecology is considered to be **negligible**.

5.5 Marine Mammals

The impact significance as defined in Table 5-1 is determined for marine mammals based on the receptor sensitivity, value and magnitude of the effect:

- The sensitivity of a receptor is defined by its ability to accommodate change and on its ability to recover if affected, for example a receptor has a high sensitivity if it has very limited capacity to avoid, adapt to, accommodate or recover from the anticipated effect.
- The 'value' of a receptor forms an important element within the assessment, for instance, if the receptor is a protected species or has an economic value. It is important to understand that high value and sensitivity are not necessarily linked with a particular impact. A receptor could be of high value (e.g. an Annex II species), but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor by receptor basis.
- The significance of the potential effect is also assessed on the degree or intensity of the effect relative to the baseline conditions.
- The magnitude of the effect reflects the level of impact on the individuals, population and / or area of effect, taking into if the effect is likely to be permanent or temporary.

The resultant significance of impact assessed as major or moderate are considered to have a significant impact on the individuals and / or population, and impacts assessed as minor, negligible or no impact are considered to be insignificant, i.e. will not have a lasting effect on the individuals or population.

5.5.1 UXO Detonation and the Risk to the Injury and / or Disturbance to Marine Mammal Receptors

As described in Section 2.1 above, an estimated WCS 10 UXO could require detonation across the Development area (a WCS of four within the Moray East site and six within the OfTI Corridor). The UXO present at the Development site are most likely to be German EMA Buoyant mines, with a maximum UXO NEQ of 160 kg, or allied 500 or 1,000 lb HE bomb, with a maximum NEQ of 126 and 260 kg respectively. It has been predicted that these UXO would require a minimum of 5 to 10 kg HE per UXO for a controlled explosion using bulk charges. UXO unlikely to be present have a maximum NEQ of up to 227 kg for ground mines, and up to 220 kg for air-dropped bombs. There are also UXO which are considered highly unlikely to be encountered; of up to 700 kg NEQ for ground mines. The most realistic worst-case is therefore 260 kg NEQ, requiring a charge of 10 kg. Information on the effect of using a larger charge size is provided in [redacted] below, along with the additional mitigation requirements that would be needed.

5.5.1.1 The Risk of Injury to Marine Mammals

When an item of UXO is detonated on the seabed, a number of impacts to the surrounding area occur, including crater formation and the movement of sediment, both of which are localised impacts. Immediately following detonation, a rapid expansion of gaseous products are formed as a direct result of the detonation. This is known as the "bubble pulse" and once it reaches the surface it will rapidly dissipate. Fragmentation of the UXO will also occur (the ejection of shrapnel from the UXO casing), but is also a localised impact and does not pose a significant risk past 10 m from the UXO detonation location.

The impacts from a UXO detonation that have impacts further afield are the high amplitude shock and the attendant sound wave produced. These impacts have the potential to cause injury or death to marine mammals (e.g. Richardson *et al*., 1995; von Benda-Beckmann *et al*., 2015). This highest risk to marine mammals are:

- Trauma (direct or indirect blast wave effect injury) such as crushing, fracturing, haemorrhages, and rupture of body tissues caused by the blast wave, resulting in immediate or eventual mortality;

- Auditory impairment (from exposure to the acoustic wave), resulting in a temporary or permanent hearing loss such as temporary threshold shift (TTS) and permanent threshold shift (PTS); or
- Behavioural change, such as disturbance to feeding, mating, breeding, and resting.

Physical injury, or trauma, can result from either direct or indirect effects of the blast wave, potentially causing injury to body tissues; this usually occurs in close proximity to the source. Yelverton *et al.,* (1973) identified that the threshold at which physical injury and/or trauma has the potential to occur on all marine mammals is at a peak to peak SPL of 240 dB re 1µPa (Yelverton *et al*., 1973). Smaller species of marine mammal, such as seals and harbour porpoise, are at greater risk of injury from both the shock wave and blast injuries (Ketten 2004; von Benda-Beckmann *et al.,* 2015). After detonation, the shock wave will expand spherically outwards and in a straight line, unless the wave is reflected, channels or meets an intervening obstruction.

The charge size needed to detonate the UXO, the water depth at the UXO location, bathymetry of the area and seabed sediments all have an impact on how far the noise associated with the UXO detonation will travel. High levels of exposure of underwater noise associated with the attendant sound wave of a UXO detonation can cause instantaneous auditory injury in marine mammals; or PTS. This effect will continue to persist even after the noise has ceased. PTS also has the potential to be occur from lower sound levels if a marine mammal is exposed to the sound for a prolonged period of time. TTS can be brought on in marine mammals if they are exposed to lower sound levels. An individual would ordinarily be able to fully recover from this effect. Fleeing behaviours and disturbance effects can be seen in marine mammals with sound levels of the level that causes TTS.

Impact Thresholds

In order to ascertain whether PTS or TTS will occur in marine mammals, a set of thresholds for which the impact becomes a risk have been determined. These are commonly presented as both un-weighted peak Sound Pressure Level (SPL) and marine mammal hearing weighted (M-weighted) sound exposure levels (Sound Exposure Level (SELs)). Peak Sound Pressure Levels (SPLs) are the maximum sound level a marine mammal may be exposed to before there is a risk of the effect occurring. Therefore, at sound levels up to this level, the effect would not occur. SELs allow for the assessment to consider whether the total sound level that the animal receives as it flees the area will cumulatively lead to an effect over the period of time assessed. As dual criteria, the onset of PTS or TTS is considered to have occurred when either one of the two metrics is exceeded (JNCC, 2010, NMFS, 2016; 2018).

The National Marine Fisheries Service (NMFS) (2016; 2018) marine mammal thresholds group marine mammals into species groups, and applies filters to take into account for the groups specific hearing sensitivities. The NMFS (2016; 2018) criteria include unweighted peak (SPL_{peak}), weighted cumulative (SEL_{cum}) for the underwater noise thresholds at which both PTS and TTS have the potential to occur. Table 5-2 below outlines these noise impact thresholds for the relevant species groups considered within this assessment; high frequency cetaceans (HF) for harbour porpoise, mid frequency cetaceans (MF) for all dolphin species, low frequency cetaceans (LF) for minke whale and pinnipeds in water (PW) for both seal species.

Table 5-2 NMFS underwater noise thresholds for the onset of PTS for SPL_{peak} and SEL_{cum} criteria (NMFS, 2016; 2018)

Species group	PTS		TTS	
	SPL_{peak} (dB re 1µPa)	SEL_{cum} (dB re 1µPa^{2}s)	SPL_{peak} dB re 1µPa	SEL_{cum} (dB re 1µPa^{2}s)
HF	202	155	196	140
MF	230	185	224	170
LF	219	183	213	168
PW	218	185	212	170

Von Benda-Beckmann *et al* (2015) identified hearing impact thresholds from single UXO detonations in shallow water (less than 50 m) on harbour porpoise, and the likelihood of both TTS and PTS occurring at different SELs. Table 5-3 below outlines how likely it is for a harbour porpoise to be at risk of either TTS or PTS at different SELs.

Table 5-3 Thresholds related to temporary and permanent hearing loss caused by a single underwater explosion in shallow water (< 50-m depth), "very likely" indicates a probability exceeding 95%, and "unlikely" indicates a probability of less than 5%. "Increasingly likely" is then anything between 5 and 95% probability

SEL (unweighted dB re 1 μPa^2s)	Noise induced TTS	Noise induced PTS	Blast wave-induced ear trauma	Permanent hearing loss
> 203	Very Likely	Very likely	Very likely	Very likely
190 – 203			Increasingly likely	
179 – 190		Increasingly likely	Unlikely	Increasingly likely
164 – 179		Unlikely		Unlikely
<164	Unlikely			

Impact Ranges Associated with UXO Detonation

An assessment of UXO detonation operations in the southern North Sea was undertaken to determine distances of received levels of the sound wave, for a range of charge masses from 10 to 1,000 kg and in water depths from 20 to 30 m (Von Benda-Beckmann *et al*., 2015). Within the measured explosions, large differences in received levels were noticeable, with the SELs on average lower near the water surface than near the seabed or in the middle of the water column. The largest distance at which the peak overpressure corresponded to the risk of observed ear trauma was at approximately 500 m based on measured peak overpressure for a charge mass of 263 kg in water depth of 26 m (note that water depth at Moray East Site is 35 to 55m below Chart Datum and so is not directly comparable; underwater noise is likely to travel further in deeper water). Beyond 1,800 m, the peak overpressures fell below the limit at which no ear trauma occurred for a charge mass of 263 kg in water depth of 26 m.

A[redacted]s undertaken during wellhead decommissioning works on the peak underwater sound levels a[redacted]ces in the North Sea (Nedwell *et al*., 2001). The study found that the noise associated with the underwater explosions ranged from 223 to 232 dB re 1µPa (0-Peak) for a charge of 45 kg. At 400 m, the sound level recorded (223 dB re µPa (0-Peak)) was less than the SPL_{peak} PTS and TTS onset for MF cetaceans (dolphin species) only. For charges of 81 kg, sound levels were below the threshold for PTS (SPL_{peak}) onset in MF cetaceans at 600m (Nedwell *et al*., 2001).

As part of the Norfolk Vanguard OWF ES, specific underwater noise modelling was undertaken for the detonation of UXO (Norfolk Vanguard Ltd, 2018). There are many unknowns in the modelling of the underwater noise impact of UXO, mainly due to the unknowns relating to the age, exact position (and water depth), and sedimentation of the device, and this leads to a high degree of uncertainty when modelling the impact ranges. The impact ranges that were assessed are therefore considered to represent a WCS. The charge weights that were modelled include 250 kg and 430 kg. Table 5-4 below shows the WCS impact ranges for two of the modelled explosive charge sizes relevant for the EOD operations at the Development area. Note that these modelling results do not take into account water depths, and are based on unburied devices. The result of this is that the noise levels predicted though the modelling, particularly associated with the larger impact ranges, are likely to be overestimated as they are likely to be degraded and covered, at least partially, with sediment.

Table 5-4 Impact ranges of UXO detonation modelled for Norfolk Vanguard (Norfolk Vanguard Ltd, 2018)

Species group	PTS (NMFS, 2016)		TTS (NMFS, 2016)	
	Impact range SPL_{peak} (m)	Impact range SEL_{cum} (m)	Impact range SPL_{peak} (m)	Impact range SEL_{cum} (m)
250 kg charge weight (source noise level of 292.4 dB SPL_{peak})				
HF	8,400	2,400	13,900	18,700
MF	570	40	1,050	730
LF	1,700	5,600	3,100	31,700
PW	1,900	1,200	3,400	11,400
430 kg charge weight (source noise level of 294.8 dB SPL_{peak})				
HF	10,400	3,300	16,800	23,000
MF	730	55	3,500	1,000
LF	2,200	7,500	3,900	37,300
PW	2,400	1,700	4,300	14,700

Beatrice OWF have also undertaken underwater noise modelling for the detonation of UXO within the OWF (BOWL, 2016). The Beatrice OWF is located adjacent to the north side of the Development area, and the underwater noise modelling can be assumed to cover the same environment, and be directly comparable. The Beatrice OWF identified that UXO would be present up to a maximum of 50 kg only. Table 5-5 includes the results of this underwater noise assessment.

Table 5-5 Impact ranges of UXO detonation modelled for Beatrice OWF

Species group	Impact range (m)		
	Injury / trauma (Yelverton *et al.*, 1973)	PTS SPL_{peak} (NMFS, 2016)	TTS SPL_{peak} (NMFS, 2016)
50 kg charge			
HF	81	3,898	7,184
MF	81	225	414
LF	81	690	1,271
PW	-	764	1,407

For the Hornsea Project Three OWF (Orsted Power UK Ltd, 2018), auditory injury (PTS) impact ranges for marine mammals associated with the detonation of UXO have been modelled, based on the impact ranges as modelled for Hornsea Project One, using the NMFS (2016; 2018) threshold criteria. The impact ranges modelled were based on a 227 kg and 260 kg charge. Table 5-6 below outlines both the impact range and the area of impact for each species group assessed. Note that only the impact range for harbour porpoise was modelled against the larger charge size of 260 kg. As for the modelling completed for Norfolk Vanguard presented above, the Hornsea Project Three modelling did not take into account the water depths present at the site.

Table 5-6 Impact ranges of UXO detonation modelled for Hornsea Project One Offshore Wind Farm, as reported in Hornsea Project Three Environmental Statement (Orsted Power UK Ltd, 2018)

Species group	Impact range SPL_{peak} (m^2)	Impact area SPL_{peak} (km^2)
227 kg charge		
HF	8,200	211.24
MF	550	0.95
LF	1.66	8.66
PW	1.83	10.52
260 kg charge		
HF	8,500	226.98

The recently published *Review of Consented Offshore Wind Farms in the Southern North Sea Harbour Porpoise SCI* (referred to as the BEIS RoC) (BEIS, 2018) included the underwater noise modelling of UXO detonations and the impacts specifically to harbour porpoise, using the NMFS (2016; 2018) criteria. The BEIS RoC identified the source noise levels associated with UXO with a number of different charge sizes. The most appropriate comparison to use from this report is for the modelled areas from a UXO device with a charge weight of 250 kg, identified to have a source noise level of 292 dB re 1 µPa @ 1m (0-Peak) (BEIS, 2018). For harbour porpoise PTS (202 dB re 1µPa SPL_{peak}; NMFS, 2016; 2018), the impact range was determined to be 9,711 m. A graph identifying the predicted SPL_{peaks} for the detonation of a range of charge sizes over distance was also created, and can be used to estimate the predicted impact range of a particular charge size at any threshold. See Figure 5-1 below for this graph, and Table 5-7 below for the associated estimated impact ranges taken from this graph for each species group.

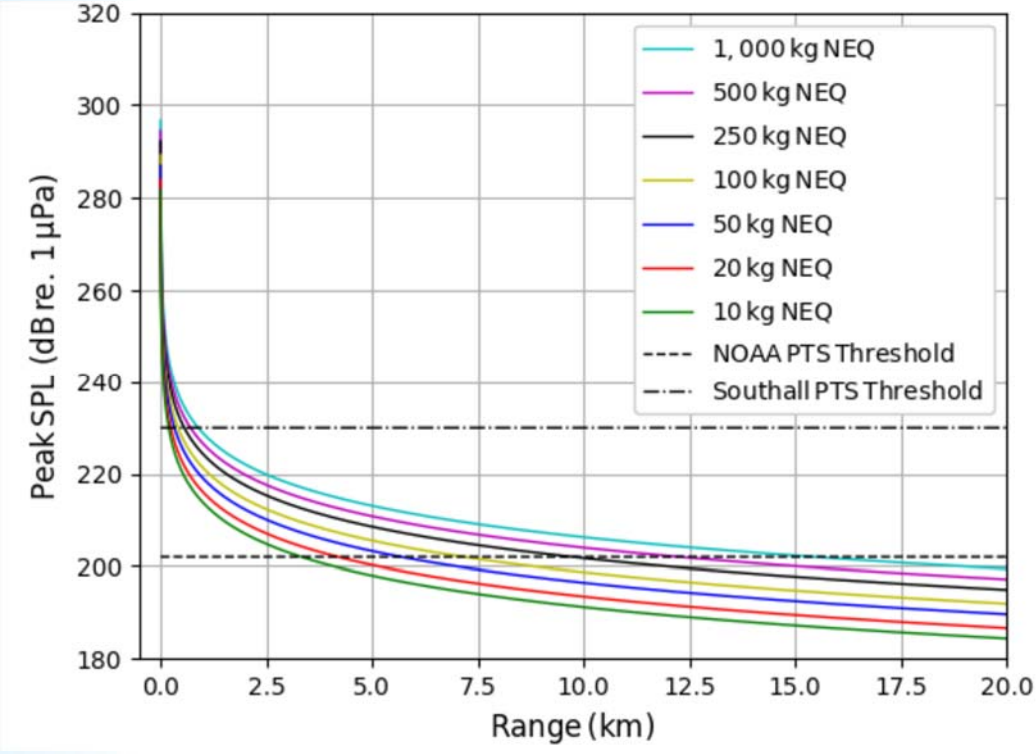

Figure 5-1 Predicted peak SPL for the detonation of different explosive weights (BEIS, 2018)

Table 5-7 Estimated impact ranges for each species group with a UXO charge size of 250 kg (estimated from the BEIS, 2018 noise modeling results as shown in Figure 5-1 above)

Species group	Impact range (m)		
	Injury / trauma (Yelverton *et al.*, 1973)	PTS SPL_{peak} (NMFS, 2016)	TTS SPL_{peak} (NMFS, 2016)
250 kg charge			
HF	250	9,711	~16,000
MF		~500	~1,000
LF		~1,500	~3,500
PW		~1,750	~3,750

Summary of UXO Detonation Impact Ranges

As outlined above, there are a number of sources of information available for the impact ranges associated with the detonation of UXO, and the best available literature has been used to inform the assessment. In order to determine the most appropriate to use within the following impact assessment, Table 5-8 summarises the impact ranges with the closest similarities to the potential detonations in the Development area (i.e. with similar charge sizes). The impact ranges taken forward for the impact assessment are shown in bold; these have been used as they represent the most realistic WCS. It must be noted that the impact ranges over longer ranges (associated with the larger charge sizes) should be used with caution. Peak noise levels are difficult to predict over these longer ranges and greater confidence can be expected with the SEL modelled ranges which are considerably shorter in distance (e.g. for harbour porpoise with a charge weight of 250 kg, the impact range using the NFMS (2016; 2018) SEL criteria is modelled at 2.4 km compared to 8.4 km using the NMFS (2016; 2018) SPL criteria (Norfolk Vanguard Ltd, 2018)). The impact ranges modelled using the SPL criteria are used to inform the assessment, but it should be noted that these are considered to an overestimation.

Table 5-8 Summary of identified impact ranges from published literature and reports

Species group	Impact range (m)		
	Injury / trauma (Yelverton *et al.*, 1973)	PTS SPL_{peak} (NMFS, 2016)	TTS SPL_{peak} (NMFS, 2016)
227 kg charge size			
HF	-	8,200 (211.24 km^2)[4]	-
MF		550 (0.95 km^2)[4]	
LF		1.66 (8.66 km^2)[4]	
PW		1.83 (10.52 km^2)[4]	
250 kg charge (source noise level of 292.4 dB SPL_{peak}[3])			
HF	250[1]	8,400[3] - 9,711[1]	13,900[3] - **~16,000[1]**
MF		~500[1] - **570[3]**	~1,000[1] – **1,050[3]**
LF		~1,500[1] – **1,700[3]**	3,100[3] – **~3,500[1]**
PW		~1,750[1] – **1,900[3]**	3,400[3] – **~3,750[1]**
263 kg charge size			
HF	-	**8,500 (226.98 km^2)[4]**	-

Species group	Impact range (m)		
	Injury / trauma (Yelverton *et al.*, 1973)	PTS SPL_{peak} (NMFS, 2016)	TTS SPL_{peak} (NMFS, 2016)
All marine mammals	**500***	-	-
430 kg charge weight (source noise level of 294.8 dB SPL_{peak}[3])			
HF	-	10,400[3]	16,800[3]
MF		730[3]	3,500[3]
LF		2,200[3]	3,900[3]
PW		2,400[3]	4,300[3]

*[1] BEIS, 2018; * von Benda-Beckmann et al., 2015; [3] Norfolk Vanguard Limited, 2018; [4] Orsted Power UK Ltd, 2018*

The likelihood of PTS and TTS occurring due to UXO detonation at certain source noise levels (as identified by Von Benda-Beckmann *et al.,* 2015; Table 5-3 above) indicate that marine mammals would be very likely to be at risk of PTS or TTS with any SEL of more than 203 dB re 1 μPa^2s. A charge weight of 270 kg (i.e. similar to the most likely WCS to be assessed for the UXO detonations), would have a source noise level of an UXO of over 292 dB re 1 µPa, as identified within the Norfolk Vanguard noise modelling for the clearance of UXO (see Table 5-4 above).

Impact Assessment for Injury Impact on Marine Mammals

The potential for impact from the detonation of UXO been assessed for each of the species groups, including high, mid and low frequency cetaceans (for harbour porpoise, dolphin species and minke whale respectively) and for pinnipeds in water (for both seal species). The following assessment includes the potential for physical trauma or injury from the initial blast wave, and for auditory injury (either permanent or temporary). This is based on the standard EIA Approach of assigning a magnitude of effect and assessing against the sensitivity of the receptor.

Each of the tables below shows the magnitude of the impact based on if the effect is permanence or temporary and the maximum number of individuals that could be impacted, with any significant effects (defined as being either moderate or major) shown in bold.

F[redacted]cies groups, the source noise level of a 270 kg charge, of at least 292 dB re 1 µPa (0-Peak) has the potential to cause physical injury and trauma, and auditory injury (either permanent or temporary) in all marine mammal species.

Physical Injury or Trauma

Von Benda-Beckmann *et al.* (2015) found that the detonation of a 263 kg charge could lead to a physical injury or trauma to a distance of 500 m. It is therefore considered that the potential for physical injury to occur on any marine mammal species will occur within this range. Table 5-9 below summarises the potential number of each marine mammal species that could be at risk of physical injury or trauma within this range based on the relevant density estimate, and the percentage of the management unit population that this represents.

The magnitude of effect is assessed as being medium for grey seal and bottlenose dolphin, low for harbour seal and negligible for all other species. It is considered that all species have a high sensitivity to physical injury or trauma due to the significance and permanence of any potential impact without mitigation. ***Therefore, the impact of physical trauma for grey seal and bottlenose dolphin, without mitigation, is assessed as major, for harbour seal as moderate (considered a significant effect without mitigation) and for all other species as minor, not considered to be a significant effect.***

Table 5-9 Risk of marine mammal species from physical injury or trauma

Species	Threshold of Impact	Range of Potential Impact*	Number at Risk of Impact (% of Reference Population)	Magnitude of Effect
Harbour seal	240 dB re 1µPa SPL_{peak} (Yelverton *et al*., 1973)	0.79 km^2	0.01 (0.001%)	Low
Grey seal			0.2 (0.015%)	**Medium**
Harbour porpoise			1.3 (0.0004%)	Negligible
Bottlenose dolphin			0.2 (0.12%)	**Medium**
Minke whale			0.02 (0.0001%)	Negligible
White-beaked dolphin			0.02 (0.0001%)	Negligible
Common dolphin			0.02 (0.00003%)	Negligible

** Note that this is based on the area of a circle if the actual impact area is not known*

Permanent Auditory Injury (PTS)

The risk of PTS on marine mammals was assessed using the NMFS (2016; 2018) noise threshold criteria for each marine mammal species group. The onset of auditory damage has been predicted to occur at 8.5 km for high-frequency cetaceans (harbour porpoise), at 570 m for mid-frequency species (dolphins), at 1.7 km for low-frequency cetaceans (whales) and at 1.9 km for pinnipeds in water (seals). Table 5-10 summarises the potential number of each marine mammal species that could be at risk of PTS within each specific range (as determined within Section 5.5.1.1) based on the relevant density estimate, and the percentage of the management unit population that this represents. All species are considered to have a high sensitivity to PTS from UXO detonation.

Table 5-10 Risk of marine mammal species of permanent auditory injury (PTS)

Species	Threshold of Impact	Range of Potential Impact*	Number at Risk of Impact (% of Reference Population)	Magnitude of Effect
Harbour seal	218 SPL_{peak} (dB re 1µPa)	11.34 km^2	0.16 (0.02%)	**Medium**
Grey seal			2.6 (0.2%)	**Medium**
Harbour porpoise	202 SPL_{peak} (dB re 1µPa)	226.98 km^2	385.9 (0.1%)	**Medium**
Minke whale	219 SPL_{peak} (dB re 1µPa)	9.08 km^2	0.3 (0.001%)	Low
Bottlenose dolphin	230 SPL_{peak} (dB re 1µPa)	1.02 km^2	0.3 (0.2%)	**Medium**
White-beaked dolphin			0.02 (0.0001%)	Negligible
Common dolphin			0.03 (0.00005%)	Negligible

** Note that this is based on the area of a circle if the actual impact area is not known*

The most sensitive species assessed is harbour porpoise, with an impact range of 8.5 km for PTS from a UXO of a similar charge size (of 263 kg) to the Development. The most dominant part of the UXO shockwave, and that which has the potential to have the biggest impact, are within the low frequencies, of less than 1 kHz. Harbour porpoise are known to vocalise at much higher frequencies than this, of above 100 kHz, however, the species do also produce sounds in the range of the UXO detonation (of 1 kHz) that are thought to be for communication (Verboom & Kastelein, 1997).

As can be seen in Table 5-10, a total of 386 harbour porpoise could be at risk of the onset of PTS due to the planned detonation at the Development. The likelihood of harbour porpoise being within the impact

range for PTS (i.e. within 8.5 km of the detonation) and the potential for auditory impact (from PTS) without mitigation is considered to be high. ***Based on the high sensitivity of harbour porpoise and the magnitude of medium, harbour porpoise are assessed as being at risk of a major impact due to PTS from UXO detonation without mitigation, which is considered to be significant.***

There is potential for onset of PTS in minke whale up to a distance of 1.7 km, resulting in the potential for 0.3 minke whale to be at risk of the onset of PTS within that area (based on a charge size of 250 kg; Table 5-8 Table 5-10). However, the abundance of minke whale in the Moray Firth is known to be much lower in the winter and spring period when the Development UXO detonation has been planned for. The JCP Phase III report states that minke whale abundance in winter and spring would be up to 30 within the *Moray Firth offshore development area*, with an estimated density of 0.004 individuals per km^2 (Paxton *et al*., 2016). Using this density estimate, the number of minke whale at potential risk of PTS onset within the 1.7 km impact range is 0.03. The likelihood of minke whale being within the impact range for PTS (i.e. within 1.7 km of the detonation) in the winter and spring period is considered to be low, however the potential for auditory impact (from PTS) without mitigation is considered to be moderate. ***Based on the high sensitivity of minke whale and the magnitude of low, minke whale are assessed as being at risk of a moderate impact due to PTS from UXO detonation without mitigation, which is considered to be significant.***

For the mid-frequency cetaceans species group, including bottlenose dolphin, white-beaked dolphin and common dolphin, the potential auditory injury range is predicted to be 570 m (based on a charge size of 250 kg; Table 5-8 Table 5-10). The number of individuals that are at potential risk of the onset of PTS within this impact range is assessed as 0.3, 0.02 and 0.03 of bottlenose dolphin, white-beaked dolphin and common dolphin respectively (Table 5-10). Bottlenose dolphin are a primary reason for the designation for the Moray Firth SAC, and have a relatively small and highly faithful population to the Moray Firth. Consideration of the potential risk to bottlenose dolphin in the SAC is included in Section **5.12** (it should be noted that the assessment on the SAC includes potential impacts on the bottlenose dolphins as they commute to the Forth and Inner Tay, as well as the Moray Firth area as the density estimate covers all areas that have the potential to be impact by the UXO clearance activities) The probability of any dolphin being present within the Development area is low as can be noted from the relatively low density estimates (Table 3-1), and the potential for PTS onset as a result of UXO detonation is moderate. ***Based on the high sensitivity of dolphin species and the magnitude of negligible to medium, dolphin species are assessed as being at risk of a minor to major impact due to PTS from UXO detonation w[redacted]itigation, which is considered to be significant for bottlenose dolphins (with a major impact) but not significant for other dolphin species (with minor impact).***

For harbour and grey seal, the onset of PTS could occur at a range of 1.9 km from the UXO detonation site (based on a charge size of 250 kg; Table 5-8 Table 5-10). Table 5-10 concludes that 0.2 and 2.6 harbour and grey seal respectively could be at risk of the onset of PTS within this impact range. Due to the overlap of the Development area and both species' foraging ranges, and for the potential for seals to be at sea during the planned timeframe for UXO detonation (i.e. it is not in their breeding or moult period), there is a risk of both seal species to be present at the Development area. ***Based on the high sensitivity of seal species and the magnitude of medium, seals are assessed as being at risk of a major impact due to PTS from UXO detonation without mitigation, which is considered to be significant.***

Temporary Auditory Injury (TTS)

The risk of TTS on marine mammals was also assessed using the NMFS (2016; 2018) noise threshold criteria for each marine mammal species group. The onset of temporary auditory injury (TTS) has been predicted to occur at 16 km for high-frequency cetaceans (harbour porpoise), at 1.05 km for mid-frequency species (dolphins), at 3.5 km for low-frequency cetaceans (whales) and at 3.75 km for pinnipeds in water (seals). Table 5-11 summarises the potential number of each marine mammal species that could be at risk of TTS within each specific range (as determined within Section 5.5.1.1) based on the relevant density estimate, and the percentage of the management unit population that this represents. All species are considered to have a medium sensitivity to TTS from UXO detonation.

Table 5-11 Risk of marine mammal species from temporary auditory injury (TTS)

Species	Threshold of Impact	Range of Potential Impact*	Number at Risk of Impact (% of Reference Population)	Magnitude of Effect
Harbour seal	212 SPL_{peak} (dB re 1µPa)	44.18 km^2	0.6 (0.07%)	Negligible
Grey seal			10.2 (0.8%)	Negligible
Harbour porpoise	196 SPL_{peak} (dB re 1µPa)	804.25 km^2	1,367.2 (0.4%)	Negligible
Minke whale	213 SPL_{peak} (dB re 1µPa)	38.48 km^2	1.2 (0.005%)	Negligible
Bottlenose dolphin	224 SPL_{peak} (dB re 1µPa)	3.46 km^2	1.0 (0.5%)	Negligible
White-beaked dolphin			0.07 (0.0005%)	Negligible
Common dolphin			0.09 (0.0002%)	Negligible

** Note that this is based on the area of a circle if the actual impact area is not known*

The most sensitive species assessed is harbour porpoise, with an impact range of 16 km for TTS. As seen in Table 5-11 above, a total of 1,367 harbour porpoise could be at risk of the onset of TTS due to the planned UXO detonation at the Development area. The likelihood of harbour porpoise being within the impact range for TTS (i.e. within 16 km of the detonation) and the potential for temporary auditory impact (from TTS) are considered to be high. However, the impact would be temporary only, covering a maximum period of up to 10 non-consecutive days (not including weather downtime) and would occur in a very small percentage of the North Sea MU population. ***Based on the medium sensitivity of harbour porpoise and the magnitude of negligible, harbour porpoise are assessed as being at risk of a minor impact due to TTS from UXO detonation without mitigation, which is not considered to be significant.***

There is potential for onset of TTS in minke whale up to a distance of 3.5 km, resulting in the potential for 12 minke whale to be at risk of the onset of TTS within that area (Table 5-11). Using the lower density estimate during the winter and spring months of 0.004/km^2, the number of minke whale at potential risk of TTS onset within the 3.5 km impact range is 0.15. The likelihood of minke whale being within the impact range for TTS is therefore considered to be low, however the potential for auditory impact (from TTS) without mitigation is considered to be moderate. In addition, the impact would be temporary only, covering a maximum period of 10 non-consecutive days, and would occur in a very small percentage of the Celtic and Greater North Sea MU population. ***Based on the medium sensitivity of minke whale and the magnitude of negligible, minke whale are assessed as being at risk of a minor impact due to TTS from UXO detonation without mitigation, which is not considered to be significant.***

For the bottlenose dolphin, white-beaked dolphin and common dolphin, the potential auditory injury range is predicted to be 1.05 km. The number of individuals that are at potential risk of the onset of TTS within this impact range is assessed as 1, 0.07 and 0.09 of bottlenose dolphin, white-beaked dolphin and common dolphin respectively (Table 5-11). Consideration of the potential risk to bottlenose dolphin in the Moray Firth SAC is included in Section 5.11 (it should be noted that the assessment on the SAC includes potential impacts on the bottlenose dolphins as they commute to the Forth and Inner Tay, as well as the Moray Firth area as the density estimate covers all areas that have the potential to be impact by the UXO clearance activities). The probability of any dolphin being present within the Development area is low as can be noted from the relatively low density estimates (Table 3-1), and the potential for TTS onset as a result of UXO detonation is moderate. However, the impact would be temporary only, covering a maximum period of 10 non-consecutive days, and would occur in a very small percentage of the relevant MU populations. ***Based on the medium sensitivity of dolphin species and the magnitude of negligible, bottlenose dolphin are assessed as being at risk of a minor impact due to TTS from UXO detonation without mitigation, which is not considered to be significant.***

For harbour and grey seal, the onset of TTS could occur at a range of 3.75 km from the UXO detonation site. Table 5-11 concludes that 0.6 and 10.2 harbour and grey seal respectively could be at risk of the onset of TTS. Due to the overlap of the Development area and both species' foraging ranges, and for the potential for seals to be at sea during the planned timeframe for UXO detonation (i.e. it is not in their breeding or moult period), there is a risk of both seal species to be present at the Development area. However, the impact would be temporary only, covering a maximum period of 10 days (not including weather downtime), and would occur in a very small percentage of the Moray Firth MU populations. ***Based on the medium sensitivity of seal species and the magnitude of negligible, seal species are assessed as being at risk of a minor impact due to TTS from UXO detonation without mitigation, which is not considered to be significant.***

Impact Assessment for Larger UXO Devices

As stated within Section 2.1 above, while considered highly unlikely, it is possible that UXO devices may be present up to 700 kg within the Development area that would require detonation. The following section outlines the impacts and mitigation procedures that should be taken if a UXO device is found with a charge weight of more than 260 kg (and up to 700 kg).

The modelling that was undertaken for Norfolk Vanguard considered devices of up to 700 kg NEQ in charge size. The results of this modelling for the NMFS (2016; 2018) PTS threshold show a potential PTS onset range of up to 11.5 km for HF cetaceans (harbour porpoise), up to 2.5 km for LF cetaceans (minke whale), up to 820 m for MF cetaceans (dolphin species), and up to 2.7 km for pinnipeds (harbour seal and grey seal) (Norfolk Vanguard Ltd, 2018).

For harbour porpoise, this would equate to a total of 706.3 individuals (0.2% of the reference population) at risk of PTS onset, resulting in an ***impact significance for harbour porpoise of major, without mitigation, based on the permanent nature of the impact, the sensitivity of the species and the magnitude of the effect***. For minke whale, a total of 0.6 individuals (0.003% of the reference population) could be at risk of PTS onset, having an ***impact significance for minke whale of moderate, without mitigation***. For dolphin species, the number of individuals that could be at risk of PTS onset are 0.6 (0.3% of the reference population), 0.04 (0.0003% of the reference population) and 0.05 (0.0001% of the reference population) for bottlenose dolphin, white-beaked dolphin and common dolphin respectively. For bottlenose dolphin, the impact significance is assessed as being ***of major for bottlenose dolphin, without mitigation, based on the permanent nature of the impact, the sensitivity of the species and the magnitude of the effect***, a[redacted]ite-beaked dolphin and common dolphin, the impact significance is assessed as ***being minor for both white-beaked dolphin and common dolphin, based on the permanent nature of the impact, the s[redacted] species and the magnitude of the effect*.** For seal species, the number of individuals that could be at risk of PTS onset are 0.3 (0.03% of the reference population) and 5.1 (0.4% of the reference population) for harbour seal and grey seal respectively. For seal species, the impact significance is assessed as ***being moderate for both harbour and grey seal, based on the permanent nature of the impact, the sensitivity of the species and the magnitude of the effect.***

Mitigation

A UXO Clearance Marine Mammal Mitigation Plan (MMMP) has been devised, in consultation with SNH, to mitigate the potential for both physical injury and trauma and auditory injury to occur in marine mammals. The UXO MMMP sets out the UXO mitigation procedure, the roles and responsibilities of personnel in the mitigation team, and the reporting requirements (see Appendix A: MMMP for UXO Clearance).

The mitigation follows the JNCC (2010) guidelines for minimising the risk of injury to marine mammals from using explosives. The mitigation sets out the need for two MMOs and one PAM-Op (if required and safe to do so) to carry out monitoring over a 1 km pre-detonation search zone for a minimum of one hour period prior to the UXO detonation.

Alongside the monitoring to ensure no marine mammals are within 1 km of the detonation site, there are additional measure to "deter" marine mammals beyond the mitigation zone of 1 km. This uses ADDs and

soft-start charges to encourage marine mammals to flee beyond the mitigation zone. In order to ensure that marine mammal species are "deterred" outside of the potential impact ranges, then a further soft-start charge weight of 250 g should be added to the soft-start procedure, totalling five soft-start charges. See Appendix A: MMMP for UXO Clearance for more information on these mitigation procedures.

A careful balance must be achieved between ensuring that marine mammals flee the injury zone and minimising the additional noise introduced into the marine environment. The activation of the ADD must be done 25 minutes prior to the detonation event, and not be activated for any longer than the stated period.

Summary

For the planned EOD operations at the Development, the potential for physical injury or trauma or auditory damage (either permanent or temporary) to occur in marine mammals' ranges from moderate to high in the absence of mitigation.

The implementation of the MMMP as summarised above will ensure that the risk of physical injury and trauma and the risk of PTS onset is negated fully, resulting in no risk to marine mammals of physical or permanent auditory injury.

5.5.1.2 The Risk of Disturbance to Marine Mammals

For all cetaceans and seal species, a fleeing response is assumed to occur at the same noise levels as TTS. Southall *et al.* (2007) states that the onset of behavioural disturbance could occur at the lowest level of noise exposure that has an effect on hearing (i.e. at TTS-onset). Although, this is not a specific behavioural effect, exposures to lower noise levels from a single pulse are not expected to cause disturbance.

The Statutory Nature Conservation Bodies (SNCBs) currently recommend that a potential disturbance range of 26 km (with approximate area of 2,124 km^2 based on the area of a circle) around UXO detonations (of any charge size) should be used to assess harbour porpoise disturbance. Disturbance from any UXO detonation would be temporary and for a short-duration (i.e. the detonation period).

For the estimated WCS it is predicted that there could be up to ten UXO detonations for the Development. As a precautionary worst-case scenario, the maximum number of days of UXO detonations could be up undertaken on is up to ten days, excluding weather downtime. This is based on one detonation per day.

The estimated number of harbour porpoise that could potentially be disturbed during underwater UXO detonation, based on a 26 km radius, is 3,611 individuals, equating to 1% of the North Sea MU population. A high number of harbour porpoise are at risk of behavioural disturbance from UXO detonation, however, it represents a small percentage of the population as a whole, and the impact would be temporary only. The magnitude of this impact on harbour porpoise would be low taking into the temporary nature of the impact, and the sensitivity of the species to disturbance impacts is medium. Therefore, ***the impact of disturbance to harbour porpoise is assessed as minor, which is not considered to be a significant impact***. For other species, the risk of behavioural disturbance from UXO detonation is considered the be same as for TTS, as shown in Table 5-11. Therefore, ***the risk of disturbance to all other marine mammal species is low***.

5.5.1.3 Indirect Impacts to Marine Mammals from the Detonation of UXO

The risk of sediment disturbance, increases in SSC and release of sediment contaminants on marine mammals

The EOD operations within the Development area has the potential to result in the disturbance of the seabed and increases in SSC in the water column. This effect would be highly localised and would not result in any significant areas of the seabed being disturbed, or significant levels of sediments being released into the water column. Following disturbance, the levels of suspended sediment are not expected to be significantly higher than background levels, and the sandy and coarse sand sediments present at the site will settle on the seabed again relatively rapidly.

Marine mammal species are able to avoid small areas that have been disturbed by the increase in SSC, and the mitigation measures in place to deter marine mammals from the area mean that any individuals that they are unlikely to be exposed to elevated levels of suspended sediment concentrations during and directly after the detonation event.

As shown in Section 5.4 above, levels of sediment contamination across the Development area did not show any levels above guideline levels. This, and the dispersive and dilutive nature of the environment, mean that any minor elevated levels of contaminants in the water column following UXO clearance activities are unlikely to result in any adverse effects on marine mammals. Therefore, the risk to marine mammals from changes to the sediment processes at the site (including increases in SSC and contaminants) are negligible, and no further mitigation is considered necessary.

The Impact of Changes to Prey Availability for Marine Mammals due to UXO clearance activities

As discussed in Section 5.4, there are no significant impacts expected to occur in fish species as a result of the UXO clearance activities, due to either behavioural disturbance of the fish species from the area, temporary habitat loss or the release of SSC. Therefore, any potential indirect effects to marine mammals that target these species are expected to be negligible.

The Impact of Vessel Collision for Marine Mammals due to UXO clearance activities

As shown in Section 5.4, the number of vessels present in the Development area are 18 in the summer, and 16 in the winter periods. The UXO clearance activities are expected to require three vessels to undertake the works, increasing the number of vessels present in the area by 15%. A total of 20 vessels within vicinity of the Development area would not pose a risk to marine mammals, and is therefore considered negligible to all species.

5.6 Ornithology

5.6.1 Disturbance and Displacement

The detonation of UXO within the Development area has the potential to cause disturbance or displacement to birds in the vicinity of the detonation. Noise associated with the UXO detonation will be underwater and not expected to lead to airborne noise above ambient noise levels. Therefore, impacts w[redacted]mited to diving birds that are underwater at the time of each individual detonation.

A[redacted]ulting from disturbance and displacement from UXO clearance activities are considered to be short-term, temporary and reversible in nature, lasting only for the duration of EOD operations, with birds expected to return to the area once clearance activities have ceased. Therefore, impacts are considered to be **negligible**.

5.6.2 Indirect Disturbance due to Reductions in Prey

Potential impacts from UXO clearance activities to bird prey species has potential to indirectly impact birds. Given that potential impacts to benthic ecology and fish and shellfish ecology have been determined to be minor or negligible (Section 5.3 and Section 5.4 above) it is reasonable to conclude that the indirect impact on seabirds occurring in or around the Development are during the UXO clearance activities would be **negligible**.

5.7 Marine Archaeology

EOD operations have the potential to affect marine archaeology through direct and indirect impact to the seabed. It is also possible that finds of archaeologist interest may be identified as a result of UXO investigation activities.

Seabed disturbance may cause physical effects to marine archaeology assets through deposition of SSC. However, as set out in Section 5.2 the increases in SSC from the detonation activities are anticipated to be short term and localised with the associated sediment deposition also localised and discrete.

During UXO clearance works AEZs will be avoided, unless otherwise agreed with MS-LOT in consultation with Historic Environment Scotland. Additionally, any object that is identified as potential archaeology during UXO investigation activities will be reported in adherence with the project Marine Archaeological Reporting Protocol (MARP).

Due to the planned avoidance of AEZs, implementation of the embedded mitigation measures for archaeology, and the short term and localised nature of increased SSC, the effects of UXO clearance activities on marine archaeology is considered to be **negligible**.

5.8 Commercial Fisheries

UXO clearance activities may interfere, displace or restrict commercial fishing activity. A temporary safety distances of 1,500 m radius will be implemented around EOD operations which may result in the restriction of access to fishing grounds. Any exclusion zone will be implemented over a short period of time (a few hours) and across a small area (surrounding the UXO) in relation to the wider available fishing area within Moray Firth, and is required for safety purposes. Once the area has been deemed safe following detonation then the exclusion zone will be removed and fishing activity will be able to resume within the previously restricted area. Therefore, it is considered that the impact would be short term, temporary and reversible.

Evidence shows that the majority of landings occur in May and September which partially overlaps with the time expected for UXO detonation (Moray Firth, 2012). However, the number of vessels recorded in the Development area is relatively low. Therefore, any interference and displacement of fishing activity is considered to be minimal.

There are a number of existing embedded mitigation measures which will reduce the magnitude of any impact to commercial fisheries receptors. As set out in Section 4 above, mitigation measures include NtM and consultation with the fishing industry through a FLO to ensure that the fishing industry is as far as practicable aware of the location and timing of any activity and will be able to plan in order to minimise disruption.

Due to the short duration of impact and the measures in place to ensure that the fishing industry is aware of the UXO clearance activities, the effects of interference, restriction and displacement is considered to be **minor**. Therefore, additional mitigation over and above the embedded mitigation is not required.

5.9 Shipping and Navigation

EOD operations have the potential to impact shipping and navigation activities within Moray Firth through obstructions to exiting navigational activities in the vicinity of the detonation locations. As shown in Section 3.9, 14 vessels per day were recorded within 10 nm of the Moray East site during winter (Moray East, 2012) and an average of 16 unique vessel passed through the OfTI area during winter (Moray East, 2014).

There are a number of embedded mitigation measures which will reduce the magnitude of any impact to shipping and navigation receptors (see Table 4-1). The safety distances and presence of a guard vessel are designed to ensure the safety of other mariners. NtM, combined with radio navigation broadcasts, will ensure that mariners are aware of the location and nature of the works, including the details of the safety distances.

The impact would be short term, temporary, reversible and restricted to the UXO detonation location. Due to the low level of commercial vessel traffic recorded in the Development area and due to the

embedded mitigation measures which are designed to ensure the safety of mariners during UXO clearance activities, it is considered that the effect on shipping and navigation receptors will be **minor**.

5.10 Infrastructure and Other Users

UXO clearance activities have the potential to temporarily affect existing infrastructure and other users in the Moray Firth including the two operational oil fields and Beatrice offshore wind farm and recreational users. An example of such disturbance is oil and gas receptors in the vicinity of the Moray East site have the potential to be impacted for through interference with support vessel activity in the area.

There are a number of embedded mitigation measures in place to reduce the impact to infrastructure owners and other sea users (Section 4). Mitigation measures include:

- close liaison with infrastructure owners and other sea users regarding potential measures that may be necessary to ensure the assets are protected;
- implementation of a 1,500 m safety zone, to ensure safe operation of EOD operations and to ensure the safety of other activity (e.g. oil and gas activity) in the vicinity of the operations; and
- NtMs, to alert other users of the timing and location of UXO clearance activity.

The UXO clearance activities will be temporary and of short duration. Due the implementation of the above embedded mitigation measures, the effects of UXO clearance activities on other marine users in the Moray Firth is considered to be **negligible**. No additional mitigation is considered necessary.

5.11 Designated Sites (including in-combination effects)

Further information on potential effects to Atlantic salmon as qualifying features of the Berriedale and Langwell Waters SAC and River Spey SAC are provided in Section 5.4 above. Details of the potential effects on bottlenose dolphin as the qualifying feature for the Moray Firth SAC and for harbour seals as the qualifying feature for the Dornoch Firth and Morrich More SAC are provided in Section 5.5 above. P[redacted]ffects on qualifying features of East Caithness Cliffs SPA, North Caithness Cliffs SPA, Troup, Pennan and Lion's Heads SPA and Moray Firth pSPA have been considered in Section 5.6 above. Consideration of Likely Significant Effects (LSE) is given in Section 6.

5.12 Cumulative Impacts

As set out in Section 3.10 above, the main activity occurring within the vicinity of the Development is Beatrice OWF, due to the close proximity to the Development area. There is potential for cumulative impacts from the UXO detonation activities in conjunction with construction activities of the Beatrice OWF.

Construction of Beatrice OWF commenced in May 2016, with offshore construction starting in April 2017. It is expected that the wind farm will be operational in 2019. As the majority of the construction phase is now complete the typically noisy activities such as piling and dredging are complete, therefore there is no pathway for cumulative impacts with underwater noise released from UXO detonation. Similarly, seabed preparation such as trenching, laying cable and foundation have now been completed therefore there is also no pathway for cumulative impacts with increased SSC and deposition from UXO clearance activities. As construction of Beatrice OWF is not scheduled to complete until March 2019 there is potential for cumulative impacts through increased vessel activity in the area from construction vessels for Beatrice OWF and vessels required for UXO clearance activities. However, if the embedded mitigation measures

set out in Section 4 are followed cumulative impacts in relation to vessels would be mitigated. If mitigation measures are adhered to **negligible cumulative impacts** are predicted.

6 Consideration of Likely Significant Effects

6.1 Moray Firth SAC

The bottlenose dolphins of the Moray Firth SAC are mainly found in the coastal area of the Moray Firth, and most commonly at the entrance to the Moray Firth (see Section 3.5.1.4 for more information). There are therefore relatively lower levels of bottlenose dolphin presence within the Development area (it should be noted that the assessment on the SAC includes potential impacts on the bottlenose dolphins as they commute to the Forth and Inner Tay, as well as the Moray Firth area as the density estimate covers all areas that have the potential to be impact by the UXO clearance activities). Bottlenose dolphin have a relatively low sensitivity to underwater noise from UXO detonations, and the noise assessment predicted that, without mitigation, physical injury or trauma could occur out to a maximum distance of 500 m (based on a UXO charge size of 263 kg) and permanent auditory injury (PTS) could occur out to 570 m from the detonation site, from a UXO with a charge size of 250 kg. This would result in potentially 0.2 individuals being at risk of physical trauma or injury (0.1% of the estimated Moray Firth SAC population as stated in Section 3.5.1.4), and 0.3 individuals from PTS (0.15% of the Moray Firth SAC population). An additional assessment on the potential for a UXO device of up to 700 kg NEQ has also been undertaken for the onset of PTS in bottlenose dolphin. The assessment showed that a total of 0.6 individuals would be at risk of PTS onset as a result of the detonation of a device of up to 700 kg.

Mitigation for the potential of physical injury or trauma and permanent auditory injury (PTS) will include the monitoring of the detonation site and up to 1 km away (i.e. the mitigation zone) for a period of 1 hour that will ensure there are no bottlenose dolphin present within the physical and permanent auditory impact ranges prior to detonation. The mitigation has in-built precautionary elements that ensure potential and possible sightings of marine mammals are treated as confirmed and the mitigation carried out as such. As well as this, an ADD device will be deployed for 25 minutes and five soft-start charges will be detonated prior to the UXO detonation to ensure any marine mammals, including bottlenose dolphin, are deterred from the impact area of a detonation up to 700 kg. With this mitigation, the potential for physical or auditory injury to occur is considered to be ***negligible***.

Behavioural reactions to underwater noise associated with the detonation of UXO are likely to occur up to a distance of 1.05 km, for a device of up to 270 kg, and up to 1.5 km for a device of up to 700 kg; this could potentially impact 1.0 or 2.1 bottlenose dolphin (0.5 or 1.1% of the Moray Firth SAC population) respectively. The above described mitigation will ensure that there are no bottlenose dolphin within up to [redacted] of the detonation site prior to the event.

[redacted]ove, there is not predicted to be a population-level effect on bottlenose dolphins in the Moray Firth, and therefore, it is considered that ***there would be no potential for Likely Significant Effect (LSE) on the Moray Firth SAC***.

6.2 Dornoch Firth and Morrich More SAC

Harbour seals of the Dornoch Firth and Morrich More SAC are distributed throughout the Moray Firth and are likely to occur within the Development during the EOD operations. The planned EOD operations which could occur at any time from mid-February to May 2019 do not coincide with the key haul-out periods for harbour seal in the Moray Firth. See Section 3.5.1.1 for more information.

The noise assessment predicted that, without mitigation, physical injury and trauma could occur out to a maximum distance of 500 m, and auditory injury could occur out to 1.9 km from the detonation site of a UXO with charge size of 263 kg, and up to 2.7 km for a UXO of 700 kg. There is therefore the potential for 0.01 harbour seal to be at risk of physical injury or trauma (equating to 0.007% of the 2016 harbour seal count at the SAC, or 0.001% of the Moray Firth MU) and 0.16 at risk of PTS onset (0.1% of the most recent count in the SAC, and 0.02% of the Moray Firth MU), and up to 0.3 (0.03% of the reference population) with a charge size of 700 kg.

The mitigation will ensure there are no marine mammals (including seal species) within 1 km of the detonation site. The mitigation has in-built precautionary elements that ensure potential and possible sightings of marine mammals are treated as confirmed and the mitigation carried out as such. An ADD device will be deployed for 25 minutes prior to detonation to ensure any marine mammals, including harbour seal, are deterred from the impact area. With this mitigation, the potential for physical or auditory injury to occur is considered to be ***negligible***.

Behavioural reactions to underwater noise associated with the detonation of UXO are likely to occur up to a distance of 3.75 km for a device charge size of up to 263 kg, and up to 4.8 km for a charge size of up to 700 kg, potentially impacting 0.6 harbour seal (or 0.4% of the SAC count, and 0.06% of the Moray Firth MU population) or up to 1 harbour seal (0.7% of the SAC population, and 0.1% of the Moray Firth MU population) respectively. The above described mitigation will ensure that there are no harbour seal within 1 km of the detonation site prior to the event, and that all marine mammals are deterred to a distance of 4.95 km from the detonation site.

Based on the above, there is not predicted to be a population-level effect on harbour seal in the Dornoch Firth and Morrich More SAC, and therefore, it is considered that ***there would be no potential for LSE on the Dornoch Forth and Morrich More SAC***.

6.3 Southern Trench pMPA

The minke whale in the Southern Trench pMPA are mainly present in the summer months only (see Section 3.5.1.5 for more information). There are therefore relatively lower densities of minke whale present in the winter period compared to the summer. However, as a worst-case scenario, the densities in the summer months have been used in this assessment.

The noise assessment predicted that, without mitigation, physical injury or trauma could occur out to a maximum distance of 500 m (based on a UXO charge size of 263 kg) and permanent auditory injury (PTS) could occur out to 1.7 km from the detonation site, from a UXO with a charge size of 250 kg. This would result in potentially 0.2 individuals being at risk of physical trauma or injury, and 0.3 individuals from PTS. An additional assessment on the potential for a UXO device of up to 700 kg NEQ has also been undertaken for the onset of PTS in minke whale. The assessment showed that a total of 0.6 individuals would be at risk of PTS onset as a result of the detonation of a device of up to 700 kg.

Mitigation for the potential of physical injury or trauma and permanent auditory injury (PTS) will include the monitoring of the mitigation zone for a period of 1 hour that will ensure there are no minke whale present within the physical and permanent auditory impact ranges prior to detonation. The mitigation has in-built precautionary elements that ensure potential and possible sightings of marine mammals are treated as confirmed and the mitigation carried out as such. As well as this, an ADD device will be deployed for 25 minutes and five soft-start charges will be detonated prior to the UXO detonation to ensure any marine mammals, including minke whale, are deterred from the impact area of a detonation up to 700 kg. With this mitigation, the potential for physical or auditory injury to occur is considered to be negligible.

Behavioural reactions to underwater noise associated with the detonation of UXO are likely to occur up to a distance of 4.4 km for a device of up to 700 kg, potentially impacting 1.8 minke whale. The above described mitigation will ensure that there are no minke whale within this impact range of the detonation site prior to the event.

Based on the above, there is not predicted to be a population-level effect on minke whale in the Moray Firth, and therefore, it is considered that ***there would be no potential for significant impact on the minke whale in the Southern Trench pMPA***.

6.4 Loch Fleet NNR

The impact on harbour seal as assessed above for the Dornoch Forth and Morrich More SAC can also be used for the harbour seal within the Loch Fleet NNR, as it would be based on the same population and the impacts would be the same. Based on the this, there is not predicted to be a population-level effect on harbour seal in the Loch Fleet NNR, and therefore, it is considered that ***there would be no potential for significant impact on the seals within the Loch Fleet NNR.***

6.5 Berridale and Longwell waters SAC, River Spey SAC and River Thurso SAC

The Berridale and Longwell waters SAC, River Spey SAC and River Thurso SAC are all designated for Atlantic Salmon and River Spey is also designated for Sea Lamprey. As set out in Section 5.4 salmon migrate route through the Moray Firth either as adults returning to rivers to spawn or as smolts on their way out of rivers into the Firth. Smolt migration takes place between March and June and adult salmon migration into the rivers from early summer to autumn (Moray East, 2014). Therefore, UXO clearance activities will only occur during a short period when smolt are migrating through the Moray Firth. There is a lack of information about key migration times for Sea Lamprey however, they are thought to spawn in the River Spey, meaning their spawning grounds would not overlap with the Development area (JNCC, 2018).

As discussed in Section 5.4 above, due to the short duration and localised nature of the impact and the activity occurring outside the peak spawning and migration periods for most key species **no LSE are predicted** to the designated features of the Berridale and Longwell waters SAC, River Spey SAC and River Thurso SAC.

6.6 East Caithness Cliff SPA, North Caithness Cliffs SPA, Troup, Pennan and Lion's Head SPA and Moray Firth pSPA

East Caithness Cliff SPA, North Caithness Cliffs SPA, Troup, Pennan and Lion's Head SPA and Moray Firth pSPA are within the vicinity of the Development therefore the designated features of the sites have the potential to be impacted by the EOD operations. As set out in Section 5.6 the UXO clearance activity within the Development area has the potential to cause disturbance or displacement to birds in the vicinity of the Development area, underwater when the detonation events are occurring.

Any impacts resulting from disturbance and displacement from EOD operations are considered to be short-term, temporary and reversible in nature, lasting only for the duration of EOD operations, with birds expected to return to the area once clearance activities have ceased.

There is potential for indirect impacts from EOD operations to the qualifying features of the East Caithness Cliff SPA, North Caithness Cliffs SPA, Troup, Pennan and Lion's Head SPA and Moray Firth pSPA due reductions in prey species. Given that potential impacts to benthic ecology and fish and shellfish ecology have been determined to be minor or negligible (Section 5.3 and 5.4) it is reasonable to conclude that the indirect impact on seabirds occurring in or around the Development are during the UXO activities would be negligible.

Therefore, **no LSE are expected** to the designated features of the East Caithness Cliff SPA, North Caithness Cliffs SPA, Troup, Pennan and Lion's Head SPA and Moray Firth pSPA due to EOD operations.

7 Summary

Moray East is undertaking surveys for UXO prior to commencement of construction to identify any potential UXO on the seabed. Selected potential UXO identified (that cannot be avoided during construction and operation and maintenance activities) will then be targeted for a detailed survey by ROV to confirm whether or not any objects are UXO hazards and therefore represent a risk to those activities.

If identified as a UXO hazard Moray East's preference is to avoid the UXO where practicable by micrositing around it. However, if avoidance is not possible, the target will be subject to EOD operations. Detonation by controlled explosion to destroy the UXO hazard will be used as a last resort should avoidance not be possible. Through this process any risk to subsequent construction activities will be removed.

This Environmental Report has been prepared in support of a Marine Licence application for the UXO clearance activities and has provided an assessment of the potential environmental impacts of the licensable activities. A summary of the environmental effects is presented in Table 7-1 below.

Table 7-1 Summary of potential impacts

Receptor	Potential Impact	Assessment of effect (post mitigation)
Physical Processes	Increase in SSC and deposition	Minor
Benthic Ecology	Temporary habitat loss and/or disturbance	Minor
	Increase in SSC and deposition	Negligible
	Release of contaminated sediment	Negligible
Fish and Shellfish	Behavioural disturbance	Negligible
	Temporary habitat loss and/or disturbance	Negligible
	Release of contaminated sediment	Negligible
Marine Mammals	Injury	No impact
	Disturbance (harbour porpoise)	Minor
	Disturbance (all other marine mammals)	Negligible
	Increase in SSC and release of contaminants	Negligible
	Changes to prey availability	Negligible
	Vessel collision	Negligible
Ornithology	Behavioural disturbance	Negligible
	Reduction in prey availability	Negligible
Marine Archaeology	Direct disturbance and sediment deposition	Negligible
Commercial Fisheries	Interference with commercial fishing activities	Minor
Shipping and Navigation	Obstructions to exiting navigational activities	Minor
Infrastructure and Other Users	Interference with existing users	Negligible
Cumulative Impacts	Cumulative impacts with other activities	Negligible

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Appendix A: MMMP for UXO Clearance

A.1 Introduction

This UXO Marine Mammal Mitigation Plan (MMMP) has been prepared to support both the Marine Licence (ML) and European Protected Species (EPS) Licence application by Moray Offshore Windfarm (East) Ltd (Moray East) for the mitigation of Explosive Ordnance Disposal (EOD) operations within the Development area; comprised of the Moray East site and the OfTI Corridor. Further details on the EOD operations planned, including the number and type expected to be found within the Development area, can be found in Section 2 of the Environmental Report. A worst-case of ten UXO devices may require detonation, with up to four in the Moray East site, and six in the OfTI Corridor. This is planned to take place over 10 non-consecutive days anytime from February to May 2019, excluding any weather downtime.

The methods and procedures required for the effective mitigation of impacts associated with the clearance of any UXO for marine mammal species expected to found in the area. In particular, the MMMP will mitigate against the potential risk of physical injury and / or trauma, and PTS exposure on marine mammals.

The JNCC guidance for "*minimizing the risk of injury to marine mammal from use explosives*" (JNCC, 2010) has been consulted in the process of developing this MMMP to determine the best approach for mitigation, and to ensure best practice measures are followed (JNCC, 2010). In addition, this UXO MMMP has been informed by previous work undertaken for Moray East and the Beatrice OWF piling protocol included in the Piling Strategy (Moray East, 2016).

The mitigation procedures outlined in this MMMP include;

- Establishment of a mitigation zone of 1 km.
- The monitoring of the mitigation zone by dedicated and trained Marine Mammal Observers (MMOs) during daylight hours and when conditions allow suitable visibility, pre and post-detonation.
- The deployment of Passive Acoustic Monitoring (PAM) devices, if required, and if the equipment can be safely deployed and retrieved.
- The activation of Acoustic Deterrent Devices (ADDs).
- A soft-start procedure using scare charges.
- All detonations to take place in daylight and, when possible, in favourable conditions with good visibility (sea state 3 or less).
- The controlled explosions of the UXO will be undertaken by specialist contractors, using the minimum amount of explosives required in order to achieve safe disposal of the device.
- The fusing of multiple devices; if there are multiple UXO in close proximity (e.g. within 20 m of each other) then one may be moved to be detonated with the other. In this case, the charges should be fused together, allowing for a millisecond of delay between the device detonations in order to reduce the cumulative impact of the shock wave.

A.2 Technical Applicability of Bubble Curtains

In theory, the bubbles change the physical condition of the water and the outward propagation of the acoustic/shock waves. However, there is currently no evidence to show that bubble curtains can successfully mitigate the noise and pressures released during EOD operations. Although commonly used within Europe to mitigate long lasting operations such as percussive piling, the high frequency pulse of noise and pressure released from a UXO detonation has not been shown to sufficiently be reduced by bubble curtain technology (Ordtek, 2018).

Current mitigation methods, for the protection of mammals and fish, are well established and have been shown to be effective in removing mammals and fish from the areas where they would be negatively affected by UXO detonations, providing them with sufficient protection and safeguarding from the noise of EOD operations.

Acoustic and explosive deterrent methods have been seen to disperse mammals to a distance of 1 km from a scheduled detonation site (the mitigation zone), as shown in Section A.3.3.1.1 Information on Acoustic Deterrent Device Effectiveness below, as well as numerous reports from live operations where mammal observations are undertaken as standard procedure. In addition, it has been noted within JNCC literature (JNCC, 2010) that the limited exposure of noise and pressure caused by UXO detonations has not been seen to negatively affect marine mammals.

No marine mammal injuries or deaths have been observed or reported by UXO and EOD consultancies or contractors when not using bubble curtains, nor have any been reported within industry press (Ordtek, 2018). In addition, the cost and time associated with bubble curtain use should be considered against any merits to ensure the mitigation is reasonable in relation to the risk presented. The deployment of bubble curtains is costly, due to the requirement of an additional vessel, as well as being highly weather sensitive, which can cause delays to operations preventing additional stages of development progressing (Ordtek, 2018).

In light of the foregoing together with the conclusion that there are no LSE or significant effects predicted where the proposed mitigation without the use of bubble curtains is adopted then it is considered that the proposed mitigation is adequate to reduce the risk to marine mammals.

A.3 UXO Mitigation Procedures

A.3.1 Mitigation Zone

The mitigation zone is the area at which a pre-detonation search is required to be undertaken for by MMOs and / or a PAM-Op. This is based on the minimum required distance as specified within the JNCC guidelines (2010) of 1 km. See below for more information on MMO and PAM operations within the mitigation zone.

The mitigation zone (of 1 km) is measured out from the detonation site with a 360° coverage, with the overall diameter of the mitigation zone being 2 km. Plate A.1 below provides a simple diagram of the mitigation zone in relation to the detonation site.

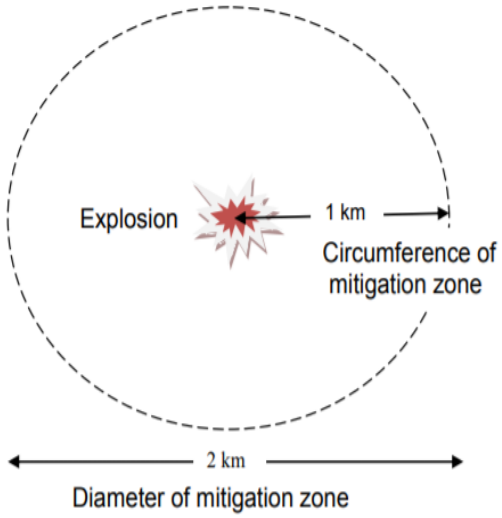


Plate A.1 Representative mitigation zone of 1 km (JNCC, 2010).

A.3.2 Pre-Detonation Search

The pre-detonation search is required to ensure that there are no marine mammals present within the mitigation zone (of 1 km radius) prior to the detonation event, confirming that no marine mammals are within the range at which they would be at risk of injury (permanent auditory or physical).

The pre-detonation search should commence at least 1 hour prior to the detonation event, with at least 2 dedicated and trained MMOs to observe from two different viewing platforms at the closest location possible to the detonation site. This ensures that the entire mitigation zone can be monitored at all times. The MMOs should be in close contact to ensure any sighting of a marine mammal within the mitigation zone is communicated.

During periods of low visibility (due to adverse weather and/or sea states of 4 or higher), the use of PAM will be required as an additional measure to monitor the mitigation zone. The PAM hydrophones should be located as close as possible to the detonation site. It is possible to deploy from the vessels already located at the site, however it should be noted that they may be too far from the detonation site at point of explosion to provide effective monitoring of the entire mitigation zone. For the Moray East EOD operations the MMOs and PAM-Op will be either on the launch or the guard vessel, within a maximum distance of 300 m of the detonation location, during the pre-detonation search period.

A PAM system (the software PAM Guard should be used) may not always be able to determine the range of a marine mammal detection, or for all species expected to be present in the area. If this is the case, the PAM-Op will need to use experience and expert judgement to determine the range of the individual/s detected and whether it is within the 1 km mitigation zone. If the PAM-Op is unsure of whether an individual/s is within the mitigation zone or not, the precautionary principle should always be applied and it therefore should be assumed that the marine mammal/s is within the mitigation zone.

A pre-detonation search should commence prior to all detonation events or sequences, or after any break in the detonation event or sequence, and at the end of a detonation event or sequence. The visual (by MMO) and / or acoustic watch (by PAM-Op if required due to poor conditions) will commence at least 1 hour prior to the detonation event, and across the entire mitigation zone using the methods outlined above. This will continue until 1 hour has passed and no marine mammals have been detected within the mitigation zone; the MMO/PAM-Op will then advise that detonation can commence.

If a marine mammal is detected within the mitigation zone during the pre-detonation search, then the c[redacted]ment of the detonation will need to be delayed. Once a marine mammal has been sighted w[redacted]tion zone, it should be monitored and tracked until it is clear of the mitigation zone, and the relevant EOD technical advisor notified. It must be clear of the mitigation zone for at least 20 minutes before the soft start procedure can commence.

If the marine mammal/s remains clear of the zone for at least 20 minutes, and the 1 hour pre-search has also been completed, then the soft start procedure can commence. A precautionary approach should always be used, and if the MMO/PAM-Op cannot be sure whether the individual is within the zone or not, or whether there is a confirmed sighting/detection of a marine mammal within the mitigation, then the operation should be delayed accordingly until the MMO/PAM-Op is sure that there are no marine mammals are present within the 1 km mitigation zone.

All MMOs and PAM-Ops present must move clear of the detonation site to a safe distance prior to soft-start detonation.

A.3.3 Deterrence Activities

Deterrence activities are required in order to ensure that marine mammals are not present within the assessed impact ranges when detonation activates commence. The use of a device to deter a marine mammal from the detonation site will therefore be used. Acoustic Deterrence Devices (ADDs) will be used in conjunction with MMOs / PAM-Ops (who can act as the ADD operator) and will be operated for a short

time to deter marine mammals from the detonation area. The effectiveness of the ADDs for each species is provided below, and the ADD operating procedures are outlined in Section A.2.3.2.

A.3.3.1 Acoustic Deterrence Activities

A.3.3.1.1 Information on Acoustic Deterrent Device Effectiveness

The Lofitech seal scarer has been shown to be the most consistent and effective at deterring seal species from an area, as well as for harbour porpoise and more recently has been shown to be effective at deterring minke whale. The Lofitech seal scarer has successfully been used in a number of projects for a range of industries, including for aquaculture projects and the offshore wind industry. The Lofitech device has been designed to have a source noise level of 189 dB, with numerous field measurements confirming the device to have recorded source levels of 179 to 194 dB (Coram *et al.,* 2014).

A number of different trials have shown that the Lofitech Seal Scarer device is effective at deterring harbour and grey seals to a distance of 1 km from the device location (Brandt *et* al., 2012; 2013, Harris *et* al., 2014, Gordon *et al.*, 2015; Coram *et al.,* 2014); meeting the 1 km mitigation zone. There was no habituation of harbour seals in field trials that occured over several weeks (Gordon *et al*., 2015).

The noise source level from the Lofitech device (of a maximum 194 dB re 1 µPa) is also lower than the injury thresholds for seals in water, with PTS onset at 218 dB re 1µPa SPL_{peak} and TTS onset at 212 dB re 1µPa SPL_{peak} (NMFS, 2016; 2018). Cumulative exposure is not considered for the use of ADDs as the individuals would vacate the area before any risk of cumulative exposure.

Studies have also shown the device to be effective for harbour porpoise up to 7.5 km with an immediate response on activation of the device (Bradnt *et al*., 2012, 2013; Gordon *et al.*, 2015). Harbour porpoise were not habituated to the device over trials of 4-6 months (Brandt *et al*., 2012). The device noise source levels are below the sound level required for PTS onset in harbour porpoise (202 dB re 1µPa SPL_{peak}) and TTS onset (196 dB re 1µPa SPL_{peak}) under the NMFS criteria (NMFS, 2016; 2018).

The Lofitech seal scarer has been proven to effect minke whale behaviour up to 1 km from the source (McGarry *et al*., 2017). Within 15 minutes of ADD activation, minke whale were shown to travel to a minimum distance of 1.7 km from the ADD location, with a maximum deterrence range of 4.5 km detected. The device noise source levels are below the sound level required for PTS onset in minke whale (219 dB re 1µPa SPL_{peak}) and TTS onset (213 dB re 1µPa SPL_{peak}) under the NMFS criteria (NMFS, 2016; 2018). Mean swim speeds of minke whale away from the active device was found to be 15 km/h (± 4.7 km/h), which is significantly higher than the assumed 1.5 m/s used to determine the required ADD activation period (McGarry *et al*., 2017).

There is no information available on the effectiveness of the Lofitech Seal Scarer device on dolphin species. However, studies on the effectiveness of ADDs in captive dolphins has shown startle responses in bottlenose dolphins at ADD source levels of 135 dB re 1µPa RMS (Janik & Götz, 2013). It could therefore be assumed that the deterrence range of bottlenose dolphins from an ADD emitting a sound source level of 190 dB re 1 µPa with a high frequency could be more than 4 km (McGarry *et al*., 2017). However it should be noted that this is untested.

In light of the scientific evidence of its effectiveness as shown above, it is proposed that the Lofitech seal scarer will be used for the mitigation of the EOD operations. If a different ADD is chosen to be used at a later date, agreement would be sought from MS-LOT prior to the commencement of any EOD operations.

A.3.3.1.2 Acoustic Deterrent Device Procedure

An ADD should be positioned within the water column in close proximity to the detonation site; the ADD-Op will be either on the launch or guard vessel, within a maximum distance of 300 m of the detonation location during the pre-detonation search. The ADD should be switched on for a set number of emissions (identified below) during the pre-detonation search and turned off immediately once the detonations have commenced in order to reduce the level of noise in the area. The MMOs and/or PAM-Op should maintain their pre-detonation search during ADD activation.

Assuming a marine mammal swims at 1.5 ms^{-1}, it would take an individual a total of 11 minutes to leave the 1 km mitigation zone, if it was located at the detonation site at the activation of the ADD. As an additional precautionary approach, ADD activation will be for 25 minutes during the pre-detonation search, immediately prior to the detonation event to allow for any marine mammals that are within the mitigation zone to leave the area and move further away than the worst-case impact ranges for designated site species, including bottlenose dolphin, minke whale and harbour seal.

Two ADDs will be needed, with 1 on each end or side of the vessel. The best location to deploy the two ADDs, and the method to provide power to the devices, will be decided through a pre-deployment survey of the vessel by the operational manager, the rigger and an electrical supervisor. Once the best location/s for the ADDs have been determined, the control unit and power supply should be temporarily installed. For deployment of the ADDs, the transducer part of the device should be lowered over the side of the deck (they should not be activated at this time) to a water depth that is below the draft of the vessel to ensure the sound can be emitted in all directions and not dampened by the presence of the vessel.

Once the ADDs are in position, they should be tested for operational efficiency. A low sensitivity hydrophone should be lowered over the side of the vessel near the ADDs and the signals tested. The ADD-Op should also ensure that the communications are in place between themselves, the MMOs, the PAM-Op (if present) and the EOD technical advisor.

The ADD will be activated for 25 minutes directly prior to the soft start procedure, during the pre-detonation search. The ADD cannot be used during transit to another detonation event, and must be activated prior to the soft start procedure for any detonation event or sequence. Once the ADD has been activated for a period of 25 minutes, then the ADD-Op will recover the ADDs and undertaken routine checks to ensure all are still working correctly, ready for the next deployment and activation. If the MMO/PAM-Op and ADD-Op are the same person, then the ADD should be deployed and tested prior to the 1 hour pre-detonation search, and activated at the appropriate time.

The pre-detonation search procedures still apply during this time, and if any marine mammals are sighted within the 25 minute ADD activation time, the soft start procedure cannot commence until 20 minutes with no marine mammal presence within the mitigation zone, and until the 1 hour pre-detonation search has been completed. Note that the ADD should not be activated for longer than the stated period of 25 minutes to limit the potential for additional noise impact, unless a marine mammal is detected within the soft-start procedure (see below for more information). The MMO/PAM-Op should maintain their pre-detonation search during the ADD activation time.

A.3.3.2 Soft-Start of UXO

A sequence of small to large charge size in order (very small explosives with charges of 50 g, 100 g, 150 g and 200 g) will be implemented to allow additional time for marine mammals to leave the area of potential impact; this is known as a “soft-start” procedure.

The soft-start charge sequence is based upon the most likely scenario of UXO devices of up to 260 kg requiring detonation. In the unlikely event that charges greater than 260 kg require detonation (and up to 700 kg), an additional small charge will be added of 250 g. The introduction of additional small charges must ensure a balance between the deterrence of marine mammals beyond the potential range of injury, and minimizing the additional noise introduced into the environment.

When the EOD Technical Advisor provides notification that the soft-start is due to commence in 25 minutes, the ADD device will be deployed, five minutes after the ADD de-activation (or as soon as is reasonable considering safety constraints), the four small charge detonations should commence at five minute intervals, with a further interval of five minutes before the detonation of the UXO. This gives a total deterrence time of 50 minutes, and based on a swimming speed of 1.5 m/s (Otani *et al.* 2000), marine mammals should clear a radius of 4.5 km over this duration.

Once the soft-start has commenced, and a marine mammal is detected within the 1 km mitigation zone by the MMO and/or PAM-Op, the soft-start sequence should be paused, the ADD reactivated until the

marine mammal is clear of the mitigation zone for a period of 20 minutes. Once the MMO and/or PAM-Op has confirmed that the marine mammal has been clear for 20 minutes, then the soft-start procedure can recommence with the next charge.

Where charges are to be detonated together, then appropriate fusing should be used wherever practicable to allow for a functional delay (of a few milliseconds only) to reduce the cumulative impact of multiple charges.

Whilst this range (of the cleared range of 4.5 km due to ADD activation) is not beyond the predicted impact range for the 270 kg and 700 kg charge for the risk of PTS onset in harbour porpoise (with ranges of 8.4 and 11.5 km respectively, based on the NMFS (2016; 2018) criteria as reported within Norfolk Vanguard Ltd (2018), it is important to note that this range is sufficient for all other marine mammal species to avoid their respective permanent auditory impact ranges up to a UXO charge size of 700 kg. When considering the predicted impact range for harbour porpoise, it is important to recognize a number of highly precautionary assumptions relating to the predicted impact ranges. No account is made of the different noise propagation profiles throughout the water column (note that the Norfolk Vanguard modelling outputs are based at mid-water depths where ranges are greatest and with no sedimentation of the device; the actual noise levels at the water's surface (where marine mammals are expected to be fleeing) would be much lower than the modelling suggests). The modelling results also take no account of the "bubbling" effect which, as identified in the von Benda-Beckmann *et al.,* (2015) paper, is likely to add further to the over-estimation of impact ranges. Taking all these factors into account, it highly likely that the predicted PTS onset ranges for harbour porpoise are significantly over-estimated. This point is further emphasized in the von Benda-Beckmann *et al.*, (2015) paper where it cites significant uncertainty in the predicted impact ranges beyond 2 km.

In the highly unlikely event that a device of over 260 kg and up to 700 kg is required to be detonated, then an additional soft-start charge would be required, deployed at a five minute interval following the standard soft-start sequence. This additional charge would be 250 g. This allows marine mammals to flee further from the detonation site, ensuring they are beyond the increased potential permeant injury onset range, with a deterrence distance of 4.95 km (as referred to in Section 6.2 above).

A.3.3.2.1 Duration of Deterrence Activities

Herschel *et al.* (2013) presented an analysis of the potential for the ADD to cause a risk of PTS in marine mammal species. In order for seals to receive sound levels that would provide a risk of PTS (as defined by the NMFS 2016 criteria of 218 dB), they would need to remain within 60 m of the device for a period of 10 hours, or within 7 m of the device for 8 minutes. For a harbour porpoise to be at risk of PTS onset (as defined by the NMFS 2016 criteria of 202 dB), an individual would need to remain within 76 m of the device for a period of 10 hours, or remain within 9 m of the device for a period of 8 hours. The likelihood of a marine mammal remaining within this area is very low, and, given the presence of an aversive signal, such residence times at these distances from ADDs are considered extremely unlikely.

A.3.5 Post-Detonation Search

The MMOs should maintain a post-detonation search within the mitigation zone for at least 15 minutes after the final detonation, to look for evidence of injury to marine life, including any fish kills (following the JNCC (2010) guidance). Any other unusual observations should be also noted within the report.

A.3.6 Reporting

Reports should be completed detailing the marine mammal mitigation activities and timings, and any detections, and should be submitted to JNCC after the operation has been completed. Reports should be

sent directly to seismic@jncc.gov.uk. These reports should include information on the relevant UXO clearance activities, date and location, information on charge sizes, start times of detonations, start and end of pre and post-detonation watches (MMO) and acoustic monitoring (PAM-Ops), details of explosive activity during the relevant watches. The reports would be reviewed by Moray East and Moray East's ECoW in the first instance prior to their formal issue to JNCC and/or MS-LOT.

Marine Mammal Recording Forms can be found on www.jncc.gov.uk/page-1534 and all parts should be completed (including the cover page, operations sheet, effort sheet, and sightings sheet). Deckforms can be used if preferred with the information transferred to the spreadsheet at the end of the watch. Details of any ADD used and observations of their efficacy, and any problems encountered and instances of non-compliance with the JNCC guidelines and variations form the agreed procedure should also be reported.

In the event of a marine mammal sighting and/or detection, the MMO and/or PAM-Op should report the following information;

- Species, number of individuals, age, sex and size (e.g. juvenile or adult);
- Physical description of individuals features if cannot be identified to species level;
- Behaviour when first sighted (e.g. travelling, foraging, resting);
- Bearing and distance;
- Time, vessel position, vessel speed, vessel activity;
- Water depth (if known), sea state, visibility, glare; and
- Any other vessels in the area.

The ADD-Op should maintain a detailed record of all ADD deployments, including all ADD deployment, activation and recovery times, a record of each verification of ADD activation and a note of any issues encountered with regards to the ADD deployment and activation.

A.4 Roles and Responsibilities

There are a number of people that would be required in the compliance with this MMMP for UXO detonation activities, including;

- [redacted]Marine Mammal Observers (MMOs);
- [redacted]Passive Acoustic Monitoring Operator (PAM-Op);
- Acoustic Deterrent Device Operator (ADD-Op);
- Explosive Ordnance Disposal Technician

More information on each of the specific responsibilities above are outlined below, including information on the experience of each that would be required.

A.4.1 Marine Mammal Observers

Dedicated and JNCC accredited MMOs will need to be present and on-watch for the pre-detonation and for the post-detonation searches (see Section A.3.6 Reporting). Dedicated means that this should be the persons sole responsibility (however in this case it should be noted that the MMO could also act as the ADD operator, although the ADD procedure would more likely be undertaken by the PAM-Op). Two MMOs will be required to cover the entire mitigation zone, with good viewing platforms to allow for 360° coverage. The MMOs must be able to determine the extent of the 1 km mitigation zone from their location, unless poor visibility does not allow.

The MMOs will need to be equipped with binoculars, a ranging stick and the JNCC reporting forms. The MMOs should scan the mitigation zone with the unaided eye, and use binoculars when needed to determine detail (such to look in detail at the area where a possible sighting has been made). Binoculars should not be used continually as they restrict peripheral vision and views close to the vessel.

Clear communication channels between the MMOs, the PAM-Op (if present), the ADD-Op and the EOD technical advisor are required, and the communication procedures should be established and agreed prior to any detonation event with regards to the communication of any detection within the mitigation zone, the deployment of ADDs, and when the mitigation zone is clear for detonation to take place. The EOD technical advisor team should assign a person responsible for communication with the mitigation team. The MMOs, PAM-Op (if present) and ADD-Op should be notified of a detonation even 24 hours prior to detonation, and should be on site at minimum 1.5 hours prior to detonation.

The MMOs specific responsibilities are;

- To commence a pre-detonation search at least 1 hour prior to detonation to ensure no marine mammal/s are within the 1 km mitigation zone prior to detonation.
- In the event that marine mammal/s is detected within the 1 km mitigation zone during the pre-detonation search, to communicate to the named member of the EOD technical advisor, and to ensure no detonation commences until at least 20 minutes have passed since the marine mammal/s detection within the 1 km mitigation zone and the 1 hour pre-detonation search has been completed.
- Notify the named member of the EOD technical advisor once the marine mammal/s has left the mitigation zone, and again once the mitigation zone is clear for detonation (i.e. there have been no marine mammals within the mitigation zone for 20 minutes and the 1 hour pre-detonation search has been completed).
- Complete a post-detonation search for at least 15 minutes after the last detonation to look for any evidence of injury to marine life, including fish kills. This will take place in the same location as the pre-detonation search.

A.4.2 Passive Acoustic Monitoring Operator

PAM is able to detect the vocalizations of marine mammals, and works best for echolocating species that are near-continually vocalizing such as harbour porpoise and dolphin species. PAM will be required in periods of low visibility to complement the monitoring by the MMOs. PAM-Ops should be experienced and trained in PAM hardware and software, as they will be required to determine the range of a detected marine mammal to the hydrophone location (note that this will be located between 100 and 300m from the EOD operation) if the PAM software is unable to, and to interpret the detected sounds.

The PAM-Ops responsibilities will be the same as those for the MMO outlined in Section A.4.1 Marine Mammal Observers. A dedicated PAM-Op will also be responsible for the deployment, maintenance and operation of the PAM hydrophone, including any spares, and notifying the ADD operator of any issues during the testing of the ADD.

A.4.3 Acoustic Deterrent Device Operator

A trained ADD-Op will be responsible for the ADD maintenance, operation and reporting procedures. This could be an existing member of the crew who has been specifically trained in the MMMP procedures and ADD operation who is available to carry out the ADD mitigation procedure in addition to their existing duties, or personnel specifically employed to operate the ADDs only, or this could be undertaken by the MMO and/or PAM-Op. The ADD-Op will need to ensure that the device has fully charged batteries, be

available for the deployment and operation of the device, provide communication with all parties and to record all necessary information for the reporting.

The ADD-Op will be responsible for;

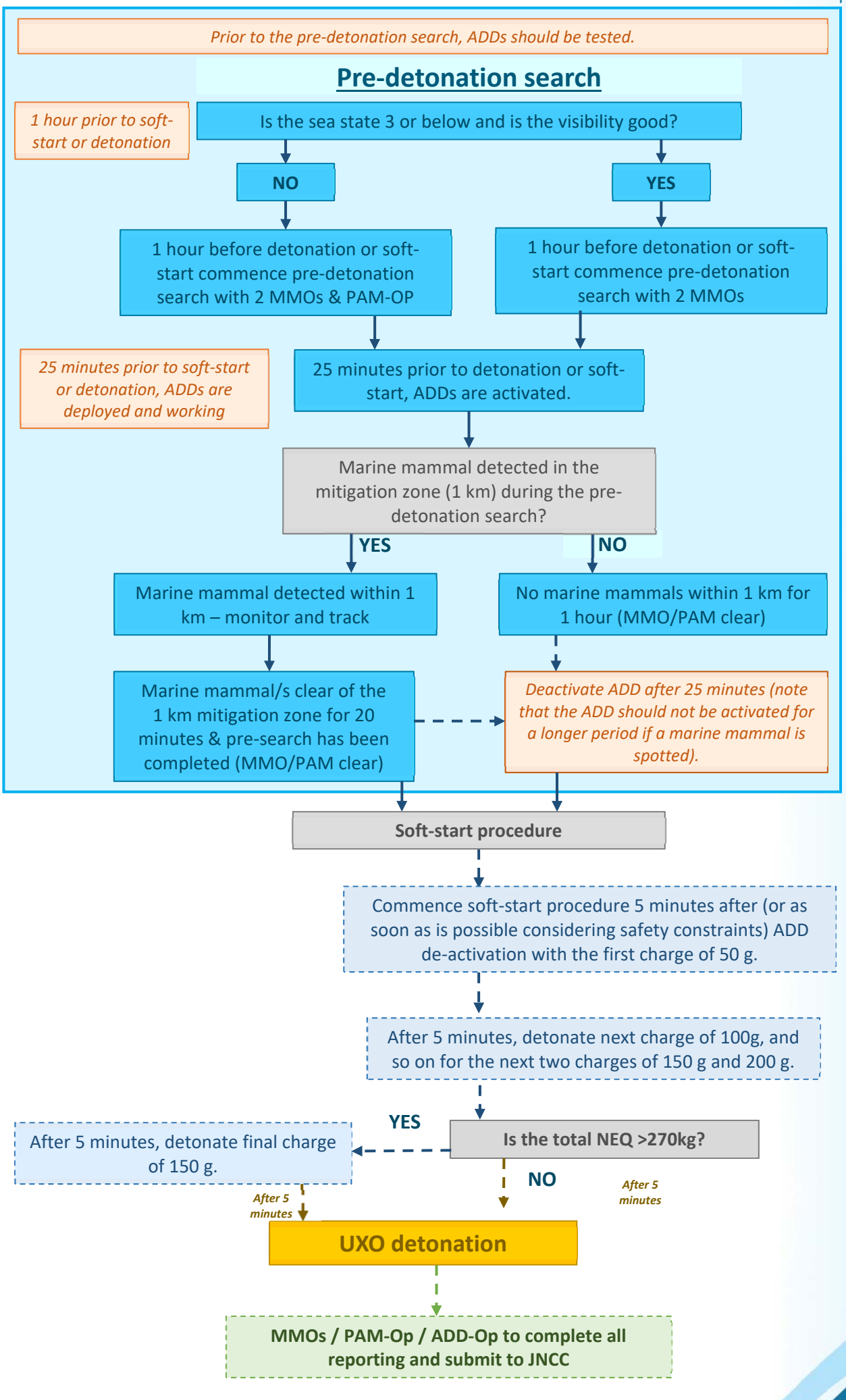
- Determining the best location for ADD deployment along with the operational manager, the rigger and an electrical supervisor, and ensuring the control unit and power supply are temporarily installed ready for deployment.
- Deploying the ADD over the side of the vessel, to a depth lower than the draft of the vessel, and testing the device is working using low sensitivity hydrophones ready for ADD activation 25 minutes prior to detonation. This can be done by the PAM-Op if present.
- Activate the ADD 25 minutes prior to the detonation event, during the pre-detonation search.
- Once the ADD has been activated for a period of 25 minutes, it should be recovered and routine checks on the device undertaken to ensure ready for the next deployment.

A.3.4 Explosive Ordnance Disposal Supervisor

The EOD Supervisor has the overall responsibility for the detonation operation, and to ensure that the soft-start charges are used, and will be based on the inspection vessel. The EOD Supervisor will be the main point of communication between the mitigation team (MMOs, PAM-Op (if present) and the ADD-Op) and the EOD support teams (who are responsible for carrying out the EOD operations). The EOD Supervisor will be in control of initiating, delaying or pausing the detonation activities.

A.5 Outline Mitigation Procedure

The outline mitigation procedure (as outlined above) is summarized below in Plate A.2 below.


Prior to the pre-detonation search, ADDs should be tested.
Pre-detonation search
1 hour prior to soft-start or detonation
Is the sea state 3 or below and is the visibility good?
NO
YES
1 hour before detonation or soft-start commence pre-detonation search with 2 MMOs & PAM-OP
1 hour before detonation or soft-start commence pre-detonation search with 2 MMOs
25 minutes prior to soft-start or detonation, ADDs are deployed and working
25 minutes prior to detonation or soft-start, ADDs are activated.
Marine mammal detected in the mitigation zone (1 km) during the pre-detonation search?
YES
NO
Marine mammal detected within 1 km – monitor and track
No marine mammals within 1 km for 1 hour (MMO/PAM clear)
Marine mammal/s clear of the 1 km mitigation zone for 20 minutes & pre-search has been completed (MMO/PAM clear)
Deactivate ADD after 25 minutes (note that the ADD should not be activated for a longer period if a marine mammal is spotted).
Soft-start procedure
Commence soft-start procedure 5 minutes after (or as soon as is possible considering safety constraints) ADD de-activation with the first charge of 50 g.
After 5 minutes, detonate next charge of 100g, and so on for the next two charges of 150 g and 200 g.
YES
Is the total NEQ >270kg?
After 5 minutes, detonate final charge of 150 g.
NO
After 5 minutes
After 5 minutes
UXO detonation
MMOs / PAM-Op / ADD-Op to complete all reporting and submit to JNCC

MORAY EAST
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