EDF RENEWABLES

Neart na Gaoithe Offshore Wind Farm

Information to support a Marine Licence application: UXO clearance

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Information to support a Marine Licence application: UXO clearance

SIGN OFF		
Name (Role)	Signature	Date
Approved by: Ewan Walker NnGOWL Lead Consents Manager	[Redacted]	11/09/2019
Reviewed by: Polly Tarrant NnGOWL Consents	[Redacted]	01/09/2019
Prepared by: Steve Bellew GoBe Consultants	[Redacted]	07/08/2019

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Acronyms and Abbreviations

TERM	DESCRIPTION
ADD	Acoustic Deterrent Device
AEOI	Adverse Effects on Integrity
BEIS	Department of Business, Energy and Industrial Strategy
EIA	Environmental Impact Assessment
ESMA	East Scotland Management Area
FLO	Fisheries Liaison Officer
GIS	Geographical Information Systems
HRA	Habitats Regulations Assessment
LAT	Lowest Astronomical Tide
LOD	Low Order Deflagration
LSE	Likely Significant Effect
MCA	Maritime and Coastguard Agency
MPA	Marine Protected Areas
MMMP	Marine Mammal Mitigation Plan
MS-LOT	Marine Scotland Licensing Operations Team
NEQ	Noise Exposure Questionnaire
NLB	Northern Lighthouse Board
NNR	National Nature Reserve
NPL	National Physical Laboratory
OSP	Offshore Substation Platforms
PTS	Permanent Threshold Shift
RHiB	Rigid hull inflatable boat
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation

TERM	DESCRIPTION
SAR	Search and Rescue
SEL	Sound Exposure Level
SFF	Scottish Fishermen's Federation
SNH	Scottish Natural Heritage
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
TTS	Temporary Threshold shift
USBL	Ultra-Short Baseline
UXO	Unexploded ordnance
WTG	Wind Turbine Generator

Defined Terms

TERM	DESCRIPTION
Addendum	The Addendum of Additional Information submitted to the Scottish Ministers by NnGOWL on 26 July 2018.
Application	The Environmental Impact Assessment Report, Habitats Regulations Appraisal Report submitted to the Scottish Ministers by NnGOWL on 16 March 2018; the Addendum of Additional Information submitted to the Scottish Ministers by NnGOWL on 26 July 2018 and the Section 36 Consent Variation Report dated 08 January 2019.
Company	Neart na Gaoithe Offshore Wind Limited (NnGOWL) (Company Number SC356223). NnGOWL has been established to develop, finance, construct, operate, maintain and decommission the Project.
Consent Conditions	The terms that are imposed on the Company under the Offshore Consents that must be complied with
Consent Plans	The plans, programmes or strategies required to be approved by the Scottish Ministers (in consultation with appropriate stakeholders) in order to discharge the Consent Conditions.
Contractors	Any Contractor/Supplier (individual or firm) working on the Project, hired by NnGOWL.
EIA Report	The Environmental Impact Assessment Report, dated March 2018, submitted to the Scottish Ministers by NnGOWL as part of the Application.
Inter-array Cables	The offshore cables connecting the wind turbines to one another and to the OSPs.
Interconnector Cables	The offshore cables connecting the OSPs to one another.

TERM	DESCRIPTION
Marine Licences	The written consents granted by the Scottish Ministers under the Marine (Scotland) Act 2010, for construction works and deposits of substances or objects in the Scottish Marine Area in relation to the Wind Farm (Licence Number 06677/19/0) and the OfTW (Licence Number 06678/19/1), dated 4 June 2019 and 5 June 2019 respectively.
Offshore Consents	The Section 36 Consent and the Marine Licences.
Offshore Export Cable Corridor	The area within which the offshore export cables are to be located.
Offshore Export Cables	The offshore export cables connecting the OSPs to the landfall site.
OfTW	The Offshore Transmission Works comprising the OSPs, offshore interconnector cables and offshore export cables required to connect the Wind Farm to the Onshore Transmission Works at the landfall.
OfTW Area	The area outlined in red and blue in Figure 1 attached to Part 4 of the OfTW Marine Licence.
OnTW	The onshore transmission works from landfall and above Mean High Water Springs, consisting of onshore export cables and the onshore substation.
Original Application	The application letter, application form and Environmental Statement (ES) submitted to the Scottish Ministers by NnGOWL on 13 July 2012 for Section 36 Consent and Marine Licences together with the SEIS submitted to the Scottish Ministers by NnGOWL on 7 June 2013
Project	The Wind Farm and the OfTW.
Section 36 Consent	The written consent granted on 3 December 2018 by the Scottish Ministers under Section 36 of The Electricity Act 1989 to construct and operate the Wind Farm, as varied by the Scottish Ministers under section 36C of the Electricity Act 1989 on 4 June 2019.
Section 36 Consent Variation Report	The Section 36 Consent Variation Report submitted to the Scottish Ministers by NnGOWL as part of the Application as defined above on 08 January 2019.
Subcontractors	Any Contractor/Supplier (individual or firm) providing services to the Project, hired by the Contractors (not NnGOWL).
Wind Farm	The offshore array as assessed in the Application including wind turbines, their foundations and inter-array cabling.
Wind Farm Area	The area outlined in black in Figure 1 attached to the Section 36 Consent Annex 1, and the area outlined in red in Figure 1 attached to Part 4 of the Wind Farm Marine Licence.

1 Introduction

1.1 Project Background

1. Neart na Gaoithe Offshore Wind Farm Limited (NnGOWL) (Revised Design) received consent under Section 36 of the Electricity Act 1989 from the Scottish Ministers on 03 December 2018 (the S36 Consent) and was granted two Marine Licences by the Scottish Ministers, for the Wind Farm and the associated Offshore Transmission Works (OfTW), on 03 December 2018 (the Marine Licences).

2. The S36 consent and Wind Farm Marine Licence were revised by issue of a variation to the S36 Consent and Marine Licence 06677/19/0 on 4 June 2019, and the OfTW Marine Licence by the issue of Marine Licence 06678/19/1 on the 5 June 2019. The revised S36 Consent and associated Marine Licences are collectively referred to as 'the Offshore Consents'.

3. The Wind Farm Area is located to the northeast of the Firth of Forth, 15.5 km directly east of Fife Ness on the east coast of Scotland. The Wind Farm Area covers approximately 105 km^2. Offshore Export Cables will be located within the 300 m wide Offshore Export Cable Corridor, running in an approximately southwest direction from the Wind Farm Area, making landfall at Thorntonloch beach to the south of Torness Power Station in East Lothian.

4. The Offshore Consents allow for the construction and operation of the following main components, which together comprise the Project:

   - 54 wind turbines generating a maximum total output of 450 MW;
   - 54 jacket substructures installed on pre-piled foundations, to support the wind turbines;
   - Two alternating current (AC) substation platforms, referred to as Offshore Substation Platforms (OSPs), to collect the generated electricity and transform the electricity from 66 kV to 220 kV for transmission to shore;
   - Two jacket substructures installed on piled foundations, to support the OSPs;
   - A network of inter-array subsea cables, buried and/or mechanically protected, to connect strings of turbines together and to connect the turbines to the OSPs;
   - One interconnector cable connecting the OSPs to each other;
   - Two buried and/or mechanically protected, subsea export cables to transmit the electricity from the OSPs to the landfall at Thorntonloch and connecting to the onshore buried export cables for transmission to the onshore substation and connection to the National Grid network; and
   - Minor ancillary works such as the deployment of metocean buoys and permanent navigational marks.

5. It is currently anticipated that offshore construction will take approximately three years and will commence in Quarter 2 (Q2) 2020.

1.2 Document Purpose

6. The NnGOWL (Revised Design) S36 Consent and Marine Licences contain a variety of conditions that must be discharged through approval by the Scottish Ministers prior to the commencement of any offshore construction works. Offshore construction of the Wind Farm is due to commence in 2020

and NnGOWL is currently undertaking preparatory work to progress the necessary pre-construction conditions under the existing consents.

7. However, ahead of the main construction works, pre-construction seabed preparation will need to be undertaken. This includes the clearance of Unexploded Ordnance (UXO) which represent a potentially major risk to safety during the construction of the Project; NnGOWL therefore need to be able to clear any identified UXO that are deemed to represent a hazard, prior to commencement of the main construction activities within the vicinity of the wind turbine and substation foundations and the inter-array and offshore export cables.

8. UXO clearance activities are not included under the list of activities licenced by the existing Offshore Consents. Therefore, in order to undertake the UXO clearance within the Wind Farm Area and Offshore Export Cable Corridor, a Marine Licence is required from Marine Scotland Licensing Operations Team (MS-LOT) under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009.

9. In addition, the clearance of UXO by detonation (as well as the use of USBL on underwater Remotely Operated Vehicle (ROV) and/or survey equipment) means that a European Protected Species (EPS) Licence is required under the provisions of the Conservation of Offshore Marine Habitats and Species Regulations 2017, an application for an EPS Licence will be submitted alongside this Marine Licence application.

10. This Supporting Environmental Information Document has been prepared in support of the Marine Licence application to MS-LOT for the UXO clearance works. This document is intended to provide the regulatory authorities (and their statutory advisers, where relevant) with the necessary supporting information to inform the Marine Licensing process.

1.3 Consultation

11. NnGOWL consulted with MS-LOT and Scottish Natural Heritage (SNH) to discuss the preferred approach for UXO clearance works and to seek advice in advance of submitting an application for the Works. A teleconference was held with MS-LOT and SNH on 30 May 2019 to present the likely clearance techniques. SNH provided written advice directly to NnGOWL via email on 04 June 2019. Table 1-1 summarises the advice received and details where this has been addressed in the Supporting Environmental Information Document.

Table 1-1: SNH advice received prior to submission

CONSULTATION	SNH ADVICE	NNGOWL ACTIONS	WHERE ADDRESSED
SNH advised of EODEX Low Order Deflagration (LOD) Received by email on 17 May 2019	SNH passed on an introductory email from a company specialising in low order detonation for UXO clearance. At the meeting on the 30 May 2019 SNH recommended that NnGOWL explore the potential to use LOD during UXO clearance works.	NnGOWL consulted EODEX to determine whether this methodology would be appropriate for UXO detonations within the Wind Farm Area and Offshore Export Cable Corridor.	Section 2.3: Alternative Clearance Method: Low Order Deflagration (LOD)
SNH Advice in response to NnGOWL UXO briefing teleconference	Site-specific noise modelling should be carried out to determine the range of effects of Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) on the key species in the area.	Site-specific underwater noise modelling has been undertaken taking into account UXO that has the potential to be present across the Wind Farm Area and Offshore Export Cable Corridor.	Appendix A Summary of Noise Modelling for

CONSULTATION	SNH ADVICE	NNGOWL ACTIONS	WHERE ADDRESSED
Received by email on 04 June 2019	Noise modelling should consider the following criteria: 1. Thresholds for PTS should follow NMFS (2018) and Southall (2019); 2. TTS thresholds should be used as a measure of disturbance from UXOs using NMFS (2018) and Southall (2019), application of a 26 km disturbance zone is not appropriate for UXO assessments.	PTS and TTS thresholds as presented in NMFS (2018) and Southall (2019) has been used to determine impact ranges. TTS has been used to inform an assessment of disturbance resulting from UXO detonation.	UXO Clearance Appendix B - Genesis Underwater Noise Modelling Report
	Cumulative effects should take into account all 40 estimated UXO detonations.	The impact assessment considered the effects of detonating up to 50 UXOs over a seven month period.	Section 2: Description of the Proposed Works
	Appropriate mitigation including noise abatement should be considered.	The MMMP has been developed taking account of all available options and in light of the conclusions of the assessment on marine mammals as presented in this document.	Appendix C – Marine Mammal Mitigation Plan

1.4 Report Structure

12. This document provides information relating to UXO clearance across the Wind Farm Area and Offshore Export Cable Corridor. The structure and scope of sections is summarised below in Table 1-2.

Table 1-2: Document Structure.

SECTION		OVERVIEW
1	Introduction	Provides an overview of the project background, the purpose of this document and a summary of the works.
2	Description of the Proposed Works	A description of the requirements for UXO clearance, an estimate of the seabed areas where works will be undertaken and the proposed clearance methodologies.
3	Environmental Appraisal	Provides a high-level overview of the receiving environment and an assessment of the potential impacts from the proposed works.
4	Characterisation of Cumulative Effects	Consideration of the potential cumulative effects of the proposed works.
5	Assessment of Likely Significant (LSE) and Adverse Effects on Integrity	Provides an assessment of the potential for the UXO clearance alone and in-combination with other plans or projects to result in a LSE or an adverse effect on the integrity of any relevant European designated site.
6	Conclusions	Provides a conclusion of the receptors that are potentially sensitive to the proposed works and a summary of the next steps involved with the acquisition of necessary consents and approvals for the work.

2 Description of the Proposed Works

2.1 Introduction

13. The presence of UXO in the Wind Farm Area and Offshore Export Cable Corridor represent a material risk to the safe construction of the Project. In order to enable safe construction of the Project, identified and confirmed UXO will, therefore, require removal prior to construction.

14. The following sections set out the description of the proposed works under the following sections:

- Potential for UXO;
- UXO clearance requirements;
- UXO clearance methodology;
- Proposed programme of works; and
- Health and safety and environmental management.

2.2 Potential for UXO

15. The potential for UXO to exist within the Wind Farm Area and Offshore Export Cable Corridor has been undertaken through the completion of a desk top risk assessment (RPS, 2019), and based in part on the review of previous desk studies on UXO potential within the Wind Farm Area and Offshore Export Cable Corridor (6 Alpha 2012; Bactec, 2010).

16. The potential sources of UXO within the Wind Farm Area and Offshore Export Cable Corridor have been identified as follows:

- Projectiles,
- Aerial delivered bombs,
- Sea mines,
- Depth charges,
- Torpedoes; and
- Dumped munitions.

17. Of these sources, aerially delivered bombs represent the UXO source the greatest potential size; German High Explosive (HE) bombs have a UXO charge in the range 500 – 1,000 kg. However, the likelihood of occurrence of these largest UXOs is considered to be low (unlikely), with the more frequently encountered UXO (possible to almost certain) expected to occur from dumped munitions of considerable smaller charge size.

2.3 Alternative Clearance Method: Low Order Deflagration (LOD)

18. During a consultation meeting with SNH and MS-LOT on the assessment requirements for this EPS Licence and the associated Marine Licence for the UXO clearance (as outlined in Section 1.3) NnGOWL was requested to ensure that the use of LOD methods were considered as a UXO clearance technique; rather than only high order detonation techniques[1].

[1] High Order detonation being a detonation of a UXO that results in an explosive ordnance producing the designed/intended explosive yield.

19. As part of the contractor selection and procurement for the UXO Clearance works (of which the preferred contractor is yet to be selected) NnGOWL requested that contractors demonstrate their capabilities in the low order techniques. However, none of the UXO clearance companies which supplied proposals to NnGOWL for the UXO clearance works were able to offer an alternative low order technique for UXO clearance.

20. In addition, NnGOWL met with the company EODEX[2] who had previously approached MS-LOT and SNH, to understand their LOD methods and ascertain its suitability for NnGOWL's UXO clearance works. EODEX propose to offer a LOD UXO clearance technique to the commercial offshore sector; taking the technology and experience from the military environment. However, NnGOWL will not consider EODEX and their LOD technique for the proposed UXO clearance works, because EODEX was not able to provide NnGOWL with evidence that their proposed technology is effective and reliable.

2.4 UXO Clearance Requirements

21. At the time of submission (and prior to completion and analysis of the site-specific surveys), the worst-case estimate for the number of UXOs that could be present within the construction areas outlined above and which require clearance (i.e. potentially including detonation) is up to 50 individual UXO items. It is imperative that a Marine Licence is in place to allow the clearance of identified UXO so as to avoid any delay to the start of the main construction works and to allow those works to proceed in a safe manner; as a result a Marine Licence is being applied for at this stage on the basis of worst case assumptions and prior to completion of UXO survey and inspection.

22. UXOs will need to be removed from the seabed, within the following areas:

- A 300 m x 300 m box around the centre of planned wind turbine locations; (including spare turbine locations);
- A 60 m wide corridor, 30 m each side of all planned inter-array and interconnector cable routes;
- A 400 m x 400 m box around the centre of planned offshore substation locations;
- The Offshore Export Cable Corridor including an additional box on the western side of the cable corridor to accommodate any future rerouting options around protruding bedrock (Figure 2-1)[3]; and
- 300 m x 300 m boxes around proposed anchor locations.

23. NnGOWL require the Marine Licence will cover the areas displayed in Figure 2-1, this includes a 500 m buffer around the Wind Farm Area and Export Cable Corridor (including the additional box) to allow for a contingency in the event that a UXO is located just outside the Wind Farm or Export Cable Corridor but deemed to be too close, for safety reasons, to the location of a seabed plough or a jack-up to be used for seabed preparation and construction of the Project.

[2] www.eodex.co.uk

[3] It is recognised that any rerouting of the offshore export cable outside of the current Offshore Export Cable Corridor as detailed in the current OfTW Marine Licence for the Project will be subject to additional marine licensing or variation of the current Marine Licence. The programme for updating the OfTW Marine Licence will be agreed with MS-LOT subject to the completion of current geophysical and geotechnical site investigations.

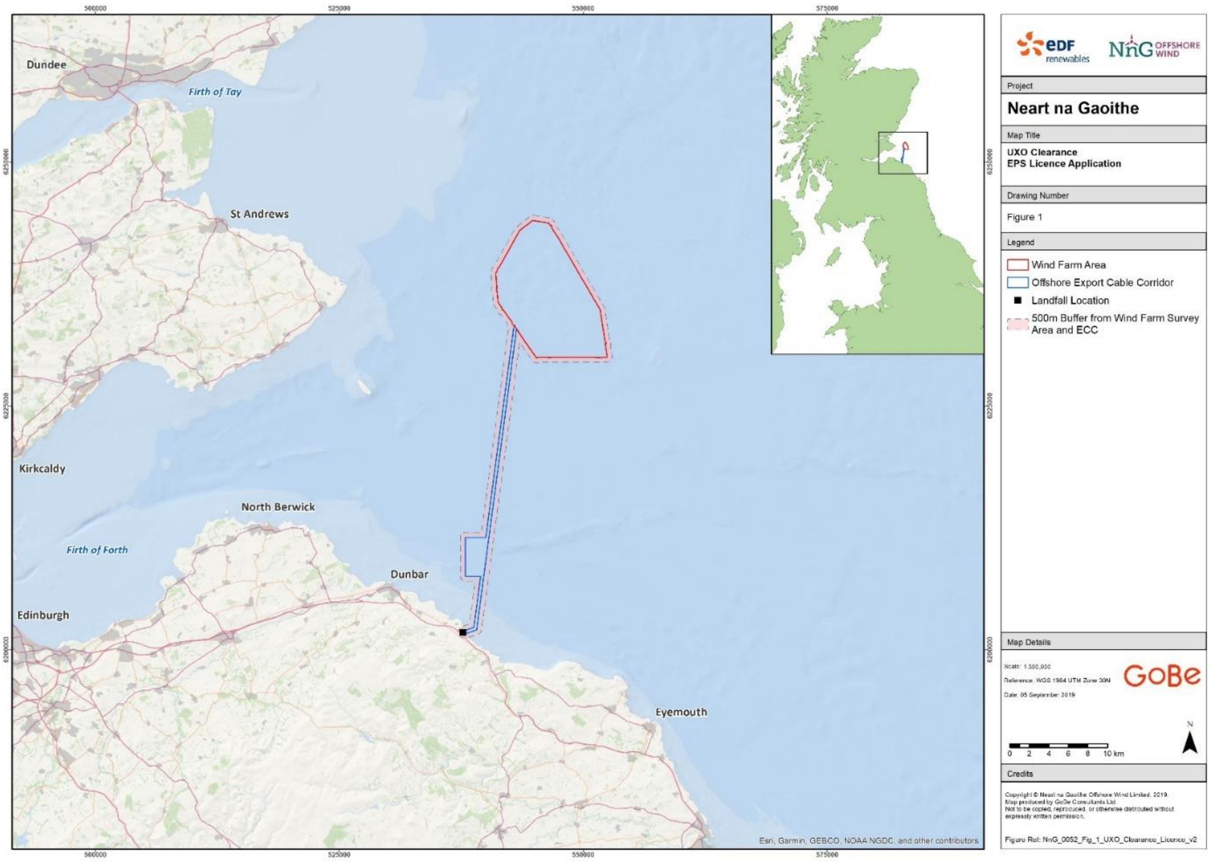

Figure 2-1: Neart na Gaoithe UXO Clearance Marine Licence Area

24. Detailed geophysical surveys are ongoing across the area of the proposed construction works (as defined above) and are to be completed by October 2019. The purpose of these surveys is, in part, to identify targets on the seabed. Targets identified during these geophysical surveys will then be subject to target visual inspection survey (using ROV) to confirm firstly the presence of UXO, and if present, acquire details on the UXO. It is only after the target inspection survey that NnGOWL will know the exact nature, including type, size and UXO present in the Wind Farm Area and Offshore Export Cable Corridor. Figure 2-2 provides an indicative timeline for UXO related survey, inspection and clearance process.

2019							2020				
Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May

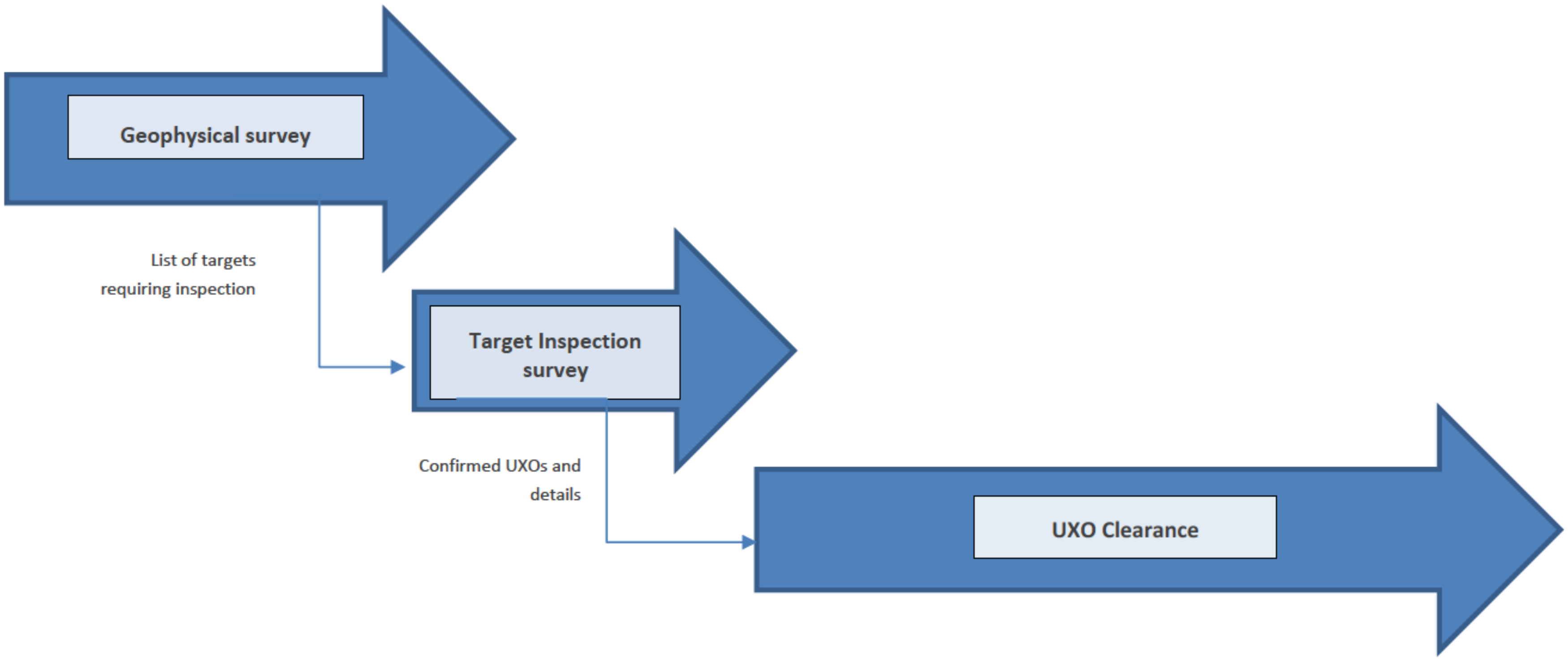

Figure 2-2: Timeline for surveys to inform UXO clearance

2.5 UXO Clearance Methodology

25. The following sections set out the proposed methodology for the clearance of UXO, including pre-clearance investigations and a number of options for clearance.

2.5.1 Investigation of Potential UXO

26. Prior to any clearance of UXO, each target that has been identified from the planned geophysical surveys will be subject to detailed investigation. The survey data will be processed by specialist UXO consultants to identify the targets that require this further investigation using, for example, ROV.

27. The ROV inspection may require some limited excavation of the seabed to facilitate the visual assessment of the potential UXO. Following excavation, identification of each potential UXO target is generally made visually by on-board UXO specialists monitoring the ROV camera footage / detection systems. An immediate risk assessment is carried out by the UXO manager on board the vessel to enable a decision on the appropriate response for each target identified.

28. Excavation of the seabed will only be required when the target is hidden from the ROV cameras due to complete or partial burial. An ROV-mounted pump will excavate the sediment around the target to enable a visual investigation. Should it be required the worst case would be to expose a target buried to 2 m below seabed level with sediment excavated around the target to ensure sufficient visual assessment of a potential target.

2.5.2 Micro-siting To Avoid UXO

29. In some cases, it may be possible to somewhat micro-site some elements of the Project infrastructure so as to safely avoid identified UXO, thereby avoiding the need for any intrusive clearance. This will be considered for each UXO identified but for the purposes of this Marine Licence application it is assumed that clearance of up to 50 UXO will be required.

2.5.3 Relocation of UXO ('lift and shift')

30. Relocation of a confirmed UXO target will be considered if the UXO is in close proximity to an area where construction work needs to be subsequently carried out, where a UXO item is located in close proximity to an existing asset (i.e. cables/pipelines) or where UXO are located within the wind turbine boxes and resulting detonation could impact the seabed and subsurface geology, resulting in impacts for pile installations. UXO will be relocated to an area within the Wind Farm Area and clear of any other known constraints (i.e. archaeological sensitivities, other assets etc).

31. Where it is identified that a UXO is to be relocated, and it has been confirmed that it is safe to move (following a threat and risk analysis), the relocation of UXO will be carried out using an ROV (or diver as a last resort), and a Remotely Controlled Airlift Assembly and a small support craft (a rigid hull inflatable boat (RHiB)).

2.5.4 UXO Detonation

32. The contractor that will undertake the UXO clearance activities is still to be selected. Consequently, the precise details of the methods to be used for UXO clearance (detonation) are not yet available and will depend on the outcome of the contract tendering process currently being undertaken. The available methods for UXO detonation include some that are potentially less noisy (using methods that 'burn out' the detonator but leave the main charge undetonated) as well as more conventional (in the marine

environment) donor charge detonation of the whole UXO. For the purposes of this Marine Licence assessment, it is assumed that each of the up to 50 UXO are detonated using the conventional donor charge method giving rise to the large explosive event.

33. In the case where a target is confirmed as UXO, and it cannot either be avoided by micro-siting or cleared by re-location of the UXO, explosive detonation of the UXO will be required. The detonation of the target UXO will be undertaken from a specialist vessel, only operating during daylight hours, although the specialist vessel could operate during the night time hours to undertake preparation activities. Depending on the nature of the operation, additional vessels may be required (e.g. guard vessels).

34. During the detonation process the mitigation set out in the UXO-specific MMMP (see Section 3.6.3) will be followed, including use of Marine Mammal Observers (MMO), Acoustic Deterrent Devices (ADDs) and where safe to do so, a soft-start protocol which involves the detonation of small 'scare' charges prior to the main detonation.

35. Typically, an explosive charge of between 7 and 25 kg will be placed next to the UXO by an ROV and the detonation will be undertaken remotely. Once the charge has been detonated, a visual inspection will be undertaken using the ROV to confirm that the UXO has been successfully detonated. During this inspection the ROV shall recover items of blast debris greater than 30 cm in size, these will be inspected but the ROV prior to recovery to deck to ensure that the items are free from explosives.

36. If, after a maximum of three attempts, the UXO has not been detonated, a dynamic risk assessment will be carried out. Once the device is confirmed safe, a decision will be taken whether to remove (where practicable) for disposal on shore at an authorised disposal facility, relocate or leave in situ.

37. Following clearance of each UXO, an as-left survey will be carried out from the ROV to confirm that there are no further UXO in the area and that the item was fully destroyed. The as-left survey will be undertaken using cameras, magnetometer and very high frequency obstacle sonar.

38. When safe and practicable, it may be possible to combine detonations where multiple UXO are located in close proximity. In this instance, the UXOs will be relocated using the 'lift and shift' methodology described above, then the UXOs will be detonated at the same time in a single location. In addition, where smaller UXO are identified close to each other, the same principle of a single donor charge being used to detonate multiple UXO in close proximity to one another may apply. UXOs being detonated in this way are considered to detonate in quick succession and will therefore not have an additive effect to one another.

39. It is important to note that NnGOWL has made the decision to maintain a total combined explosives weight that will not exceed 500 kg where multiple detonations are being proposed.

40. Representative examples of the equipment and their purpose that could be used during the clearance works are presented in Table 2-1 below.

Table 2-1: Operating frequency and sound source level of representative UXO clearance survey equipment.

REPRESENTATIVE EQUIPMENT	OPERATING FREQUENCY	SOURCE LEVEL REPORTED BY MANUFACTURER (DB)
Very High Frequency Obstacle Sonar - for visual inspection pre and post detonation		
Aris Explorer 3000	1.8 – 3.0 MHz (1,800 kHz to 3,000 kHz)	200-206

REPRESENTATIVE EQUIPMENT	OPERATING FREQUENCY	SOURCE LEVEL REPORTED BY MANUFACTURER (DB)
Blue view P900	900 kHz	No available
Ultra-Short Baseline (USBL) positioning equipment – positioning		
HiPAP 452	21-31 kHz	Maximum 190*

* note the HiPAP USBL has the capability to operate to up to 207 dB. However, if the HiPAP USBL is selected for the proposed survey it would only operate to a maximum sound source level of 190 dB with operating frequency of 21-31 kHz

2.6 Archaeological Mitigation and Reporting

41. Archaeological Exclusion Zones (AEZ) are identified in the Project Written Scheme of Investigation (WSI), which is applicable to all pre-construction activities. The vessel master and UXO contractor will be briefed on the exact locations of all AEZs and a chart of these location provided to ensure limited interference with AEZs. UXO clearance 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". Additionally, any object that is identified as potential archaeology during UXO investigations activities will be reported in adherence with the protocol for archaeological discoveries outlined in the WSI.

42. In some cases, where an exclusion zone cannot be sufficiently refined, there may be a need to relocate archaeological material (i.e. anchors or debris associated with wrecks). If all other options have been explored and it is confirmed that relocation is required, a method statement will be produced by NNGOWL which would be agreed with Historic Environment Scotland by the project archaeologist prior to the works commencing. The method would likely involve obtaining a record of the object to assess significance prior to the re-position and recording of the relocated location.

2.7 Vessels and Access

43. All works will be boat-based and undertaken at sea. The vessels will transit from an appropriate port to the site via the safest and quickest route, and once on site will move between contact locations only.

44. The UXO clearance works may require up to three vessels on-site and two guard vessels to cover both the shallow inshore and offshore areas. The vessels on-site may deploy a small RHiB to deploy the ROV. Dynamic positioning is likely to be the most appropriate method for maintaining station during clearance operations. For any inshore operations, it is possible that vessels would use anchoring or jack-up methods to maintain station.

2.8 Programme and Timing

45. The UXO clearance works are proposed to be undertaken along the timeline set out in Figure 2-2. Survey works commenced in May 2019, with UXO clearance works scheduled to commence in November 2019 and completed by May 2020.

2.9 Health and Safety and Environmental Management

46. NnGOWL's vision is to be an industry leader in Health, Safety and Environment (HSE) performance setting project safety standards across the Renewables industry where with Zero Harm is a core value of the business. NnGOWL has developed a project-specific HSE Plan that applies to all project operations, and which has the following objectives:

- NnGOWL will collectively deliver and construct the Project safely and without harm to the environment, where every opportunity is taken to eliminate risk through engineering and task design to protect the individuals working on the project, those who will operate the asset through its life cycle and the environment in which it operates;
- NnGOWL will manage the Project in a manner where the wellbeing of all personnel engaged on the Project are a priority;
- NnGOWL will ensure suitable and sufficient asset information is handed over upon completion of the Project to ensure the safe operation and maintenance of the asset though its operational life;
- NnGOWL will empower everyone on the Project to challenge actions and behaviours where there are opportunities for improvement to protect our employees, supply chain partners, members of the public and/or the environment;
- NnGOWL will be a learning organisation, taking experience previous projects and current performance to drive our performance; and
- NnGOWL will deliver the Project sustainably where respect for the Environment will be seen as a key deliverable.

47. The HSE Plan is underpinned by project-specific HSE Management Standards, covering a number of topics including the HSE Management System and Governance, Risk Management, Competency and Training, Observation and Incident Standards and Reporting and Emergency Response. All contractors will be obliged to comply with the HSE Plan.

3 Environmental Appraisal of UXO Clearance Activities

3.1 Introduction

48. This section provides an overview of the baseline environment and an environmental assessment of the seabed preparation works. It is intended to represent a concise summary of information drawn largely from that collated to inform the Environmental Statements (ES) and Supplementary Environmental Information Statement (SEIS) (NnGOWL, 2013) produced to support the Original EIA (NnGOWL 2012) and the Application for the Project Offshore Consents including the Environmental Impact Assessment (EIA) Report (NnGOWL, 2018).

49. Effects on environmental receptors (as outlined in the following sections) associated with the UXO clearance works will be:

- Temporary habitat disturbance during investigation of UXO and resulting from UXO detonation deployment;
- Disturbance due to presence of construction vessels; and
- Underwater noise resulting from UXO detonation.

50. When considering effects from these sources, there a number of important points to consider which have a bearing on both the magnitude of effect and sensitivity of the receptor:

- The footprint of the UXO works will be localised and the impact on the seabed will be significantly smaller than that resulting from the main construction works assessed within the Original ES (NnGOWL 2012) and in the EIA Report (NnGOWL, 2018);
- The footprint of the works will be relatively small in relation to the known distribution of similar benthic habitats;
- The total duration of the UXO clearance works (including survey and target investigations) will be approximately 10 months (weather dependent) within the licence period;
- The actual undertaking of the UXO detonations at each location will be a quick process with the source of the disturbance being instantaneous (i.e. a single explosion in most cases) (with a maximum of two detonations per day);
- Mitigation has been designed into the works (through the application of the UXO MMMP); and
- The UXO disposal works will be intermittent and will be conducted over a relatively short duration.

51. The assessment criteria and EIA terminology used in the EIA Report (NnGOWL 2018) have been adopted for the purpose of this document. Further information and detail are presented within Chapter 6 of the EIA Report – EIA Methodology.

3.2 Screening of Potential Effects

52. The Original ES (NnGOWL, 2012) and the EIA Report produced to support the Application for the revised design (NnGOWL, 2018) have been reviewed to identify the environmental receptors that may be sensitive to the proposed UXO clearance works. Each of the relevant receptors that have the potential to be affected have been subject to a screening exercise; Table 3-1 sets out the results of this screening

having considered the potential impacts that may arise, namely the temporary habitat disturbance during excavation and detonation, presence of vessels and the generation of underwater noise.

Table 3-1: Screening of potential environmental receptors.

RECEPTOR	DISTURBANCE TO SEABED	PRESENCE OF VESSELS	UNDERWATER NOISE	JUSTIFICATION
Marine Processes	✓	×	×	There is no impact pathway for underwater noise and the presence of associated vessels to affect marine processes.
Benthic Subtidal and Intertidal Ecology	✓	×	×	The presence of vessels and underwater noise will have no potential to significantly impact the benthic and epibenthic environment, particularly as a result of the limited temporal and spatial scale of the works relative to the receiving environment.
Fish and Shellfish Ecology	✓	×	✓	Due to the limited temporal and spatial scale of the works (relative to the receiving environment) there is no potential for significant impacts on fish ecology with respect to the presence of associated vessels.
Marine Mammals	×	×	✓	As a result of the localised and short term nature of the works, it is not considered that there will be any significant direct or indirect impacts on marine mammal species with respect to disturbance to the seabed. Secondary effects on marine mammals resulting from reduced prey resource are therefore not considered further within this assessment. Due to the limited temporal and spatial scale of the works (relative to the receiving environment) there is no potential for significant impacts on marine mammal ecology with respect to the presence of associated vessels
Ornithology	×	✓	✓	As a result of the localised and short-term nature of the works, it is not considered that there will be any significant direct or indirect impacts on ornithology with respect to disturbance to the seabed.
Nature Conservation (National)	✓	✓	✓	All potential impacts associated with the works have the potential to impact upon nature conservation.
Commercial Fisheries	✓	✓	✓	All potential impacts associated with the UXO clearance works have the potential to impact, directly or indirectly, upon commercial fisheries.

RECEPTOR	DISTURBANCE TO SEABED	PRESENCE OF VESSELS	UNDERWATER NOISE	JUSTIFICATION
Shipping and Navigation	×	✓	×	There is no potential pathway of effect upon shipping and navigation resulting from disturbance to the seabed or underwater noise.
Marine Archaeology and Ordnance	✓	×	×	There is no potential pathway of effect upon archaeological receptors resulting from the presence of associated vessels or underwater noise.
Aviation and MOD	×	×	×	There are no aviation and MOD receptors that could be impacted by the works.
Infrastructure	×	×	×	Any interaction with infrastructure and other users will be managed during the works to avoid and therefore there is no potential for significant impacts on this receptor.

3.3 Physical Environment

3.3.1 Summary of baseline

53. A range of studies and site-specific surveys have been completed by NnGOWL to establish the physical characteristics of the Wind Farm Area and Offshore Export Cable Corridor. These studies informed the EIA process for the Project and are presented in the Original ES (NnGOWL, 2012) and form the basis for this section of the report.

3.3.1.1 Bathymetry

54. Bathymetry across the Wind Farm Area ranges from 40 m to 58 m below Lowest Astronomical Tide (LAT). The shallowest water is located in the southern half of the Area, along a linear ridge orientated northwest to southeast, which rises 2 m above seabed level to 40.5 m. The deepest water, at approximately 58 m, occurs in the west of the Wind Farm Area close to the boundary within a channel orientated northwest-southeast.

55. Water depths in the Offshore Export Cable Corridor reach 58 m LAT adjacent to the Wind Farm Area boundary. Depths in the nearshore section of the Offshore Export Cable Corridor out to approximately 2 km from the shoreline are highly variable due to the presence of exposed folded bedrock that comprises the seabed here. Further offshore, out to approximately 7 km, the seabed gradient decreases and is generally flat and featureless, especially where soft-sediment makes up the seabed surface. Linear ridges, comprising east-west outcropping igneous dykes, are notable from 7.2 km to 8.5 km in 45 m to 50 m depths. These features rise up to 3 m above the surrounding seabed. From 8.5 km to 25.7 km the seabed deepens gradually to approximately 50 m to 60 m. From approximately 25 km northward to the Wind Farm Area, the bathymetry shallows to 46 m LAT.

3.3.1.2 Geological Characteristics

56. Studies undertaken as part of the Original EIA (NnGOWL, 2012) reported that the sediments mainly comprise muddy sand, fine to very fine sand and gravelly sand. These are underlain by Quaternary sediments, which reach up to 73 m thick in two palaeochannels that cross the site. The bedrock beneath this consists of Carboniferous limestones in the east and sandstones in the west. Along the Offshore Export Cable Corridor, the sediment is mainly muddy sand, but this is interrupted by a series of igneous dykes about 10 km offshore. The seabed then transitions to bedrock at the coast, consisting of Carboniferous limestone.

3.3.1.3 Tidal Processes

57. The hydrodynamic conditions are relatively uniform across the Wind Farm Area and Offshore Export Cable Corridor, with a mean spring tidal range of 4.6 m. Current speeds reach approximately 0.6 m/s on the flooding mean spring tide, and 0.4 m/s on the flooding mean neap tide. The flood tide is stronger than the ebb tide. The 50-year return storm surge current is of comparable strength, at about 0.6 m/s. The absence of bedforms across the offshore site and along the cable route suggests little sediment transport and a relatively stable seabed, classed as ‘slightly mobile’.

3.3.1.4 Wave Regime

58. The Wind Farm Area and Offshore Export Cable Corridor receives waves most frequently from a north-northeasterly direction (22.5 degrees); mean wave periods range between 2 and 9 seconds; and significant wave heights are up to about 6 m. Waves also arrive from both the southeastern and southwestern quadrants but these form only a minor component of the wave direction spectrum.

59. The wave climate across the Wind Farm Area and Offshore Export Cable Corridor is uniform, with little spatial variation in either significant wave height or mean/peak wave period. The significant wave height is shown to vary between 1.2 m and 1.4 m (50%ile) and 5.2 m and 5.4 m (99%ile), with the mean wave period varying between 4.5 s and 5.0 s (50%ile) and 8.5 s and 9.0 s (99%ile), and peak wave period varying between 9.5 s and 10.0 s (50%ile) and 14.0 s and 15.0 s (99%ile).

3.3.2 Assessment of potential effects on the physical environment

60. The proposed works will result in the localised disturbance of seabed sediment (relative to the receiving environment and size of UXO), from the explosion and the potential for excavation prior to detonation, with the sediment being locally released into the water column and subsequently settling back to the seabed, with some limited potential for the dispersion of finer sediment as a plume.

61. The Original ES (NnGOWL, 2012) assessed the realistic worst-case scenario for the installation of WTGs, foundations, and cable installation with regard to sediment disturbance and the increase in suspended sediment concentration

62. The Original ES (NnGOWL, 2012) concluded that there would be short-term increases in suspended sediment concentrations (SSC) that may temporarily exceed background levels; however, the resulting plumes would not be advected beyond the near field and rapidly dispersed by the tidal regime in the area and will settle out within a few hours of disturbance. The Original ES (NnGOWL, 2012) concluded that the resulting deposition would occur over the whole Wind Farm Area and Offshore Export Cable Corridor. Settled material will be the same as that occurring naturally and will be subject to the natural processes of erosion/deposition experienced at the site. For UXO clearance, the limited amount of sediment disturbed means that any plume effects will be limited, with coarser sediment settling rapidly

back to the seabed and finer sediments being dispersed as a sediment plume of limited extent and concentration.

63. Any craters created during detonation process (or prior UXO investigation by excavation) are expected to be backfilled over time by natural processes with the rate at which this occurs varying spatially according to sediment transport regimes in the local area.

64. As a result, the effects on the seabed due to sediment disturbance are considered to be of negligible significance. Based on the conclusions of the Original ES (NnGOWL, 2012) and in consideration of the methods being employed for UXO clearance and the scale of the UXO clearance works, effects are expected to be temporary and localised to the immediate vicinity of the works.

3.4 Benthic Environment

3.4.1 Summary of Baseline

65. The dominant sediment type found in the Wind Farm Area is slightly gravelly muddy sand, although patches of coarser sediment (e.g., sandy gravel and gravelly sand) were also recorded within the Wind Farm Area. Benthic characterisation surveys undertaken to inform the EIA (NnGOWL, 2018) reported that the Wind Farm Area is characterised by the biotope complex SS.SMu.CSaMu (circalittoral sandy mud) with epifaunal species present including seapens (e.g., *Virgularia mirabilis*) and brittlestars (e.g., Amphiura spp.). Infaunal species include polychaetes (e.g., *Spiophanes bombyx*) and bivalves (e.g., *Mysella bidentata*, *Abra* spp. and *Nuculoma* spp.).

66. Video analysis indicated biotopes more typical of soft sediments with polychaete tubes, megafauna burrows, seapens (e.g., *Pennatula phosphoracea* and *V. mirabilis*) and *Chaetopterus* tubes. These features suggest the presence of the Priority Marine Feature 'burrowed mud' and the component biotope SS.SMu.CFiMu.SpnMeg (Seapens and burrowing megafauna in circalittoral fine mud), covering a proportion of the Wind Farm Area.

67. A series of rocky substrates corresponding to the exposure of the Wee Bankie Formation were also observed during video analysis with areas of a highly variable seabed comprising a mix of habitat types. These included large boulders and cobbles supporting a mosaic of the biotopes CR.MCR.EcCr.FaAlCr.Pom (faunal and algal crusts with *Pomatoceros triqueter* and sparse *Alcyonium digitatum* on exposed to moderately wave-exposed circalittoral rock) and CR.MCR.EcCr.FaAlCr.Adig (*A. digitatum, P. triqueter*, algal and bryozoan crusts on wave-exposed circalittoral rock).

68. The Offshore Export Cable Corridor is characterised by deep circalittoral mud and gravelly muddy sand, typical of the outer Firth of Forth. Further inshore, the cable route is characterised by deep circalittoral coarse sediment and low energy rock habitats.

69. The habitat complexes along the Offshore Export Cable Corridor closer to the Wind Farm Area comprised muddy sand biotope complexes. Further inshore, the area is characterised by coarse sediment (e.g, SS.SCS.CCS) comprising cobbles, pebbles, gravel and coarse sand. Conspicuous fauna identified from the video images comprised keel worms Pomatoceros spp. and crustaceans such as *Munida rugosa*.

70. Discrete areas of both the Wind Farm Area and the Offshore Export Cable Corridor supported dense areas of the brittlestar *Ophiothrix fragilis* which fitted the biotope SS.SMx.CMx.OphMx.

71. The Project does not overlap with any conservation sites designated for benthic habitats or species.

3.4.2 Assessment of potential effects on the benthic environment

72. Potential effects on benthic ecology during UXO clearance activities may arise from direct physical disturbance to the seabed and / or habitat loss or alteration, increases in Suspended Sediment Concentrations (SSC) and subsequent sediment deposition. These impacts may have direct effects on certain benthic species, particularly filter feeders and visual predators.

73. The Original ES (NnGOWL, 2012) assessed the majority of biotopes recorded within the turbine array as having a negligible vulnerability to temporary habitat disturbance, as the fauna there is either burrowing or tolerant of higher sediment loads than those predicted to occur during the construction of the Project.

74. The Original ES (NnGOWL, 2012) stated that the magnitude of temporary sediment disturbance as a result of the main construction activities would be low as it would be short term and localised, and of minor significance (with a low uncertainty ascribed to the assessment).

75. Whilst there is the potential for localised direct habitat disturbance as a result of the UXO clearance activities, it is expected that any impacts on the seabed will be highly localised, especially when set in the context of the habitats and species present. Given the localised nature of the works and the low sensitivity of the benthic communities it is considered that there will be no significant impacts on benthic habitats from the UXO clearance works.

3.5 Fish and Shellfish Ecology

3.5.1 Summary of baseline

76. The fish and shellfish assemblage within the Wind Farm Area and Offshore Export Cable Corridor is typical of coastal areas in this region of the North Sea (Barne et al., 1997; Eleftheriou et al., 2004).

77. Demersal species that inhabit the muddy sand and gravel habitats in the region include cod, haddock, monkfish, flatfish species and sandeel. Pelagic species that may be present in the area include herring, sprat and mackerel. Elasmobranchs such as lesser spotted dogfish, tope and thornback rays are also common within the wider region. A number of these species have feeding, nursery and spawning habitats that overlap with the Wind Farm Area and Offshore Export Cable Corridor (Coull et al., 1998; Ellis et al., 2012).

78. Freshwater riverine habitats along the east coast of Scotland and England support a number of migratory species that may pass through the wind farm area during the ocean-going phase of their lifecycle (Malcolm et al., 2010). Migratory species include Atlantic salmon, sea trout, eel and lamprey species.

79. A number of shellfish species are also typically found in the region and have distribution that overlaps the Project Area including Nephrops and squid.

80. Several of the fish and shellfish species found to characterise the region are of commercial importance locally and regionally, and some are also of conservation importance due to their rarity or sensitivity, such as Atlantic salmon which is a qualifying feature of a number of designated Special Areas of Conservation (SACs) on the east coast of Scotland and in the north east of England.

3.5.2 Assessment of potential effects on the fish and shellfish ecology

81. Potential effects on fish and shellfish during UXO clearance activities may arise from direct physical disturbance to the seabed and / or habitat loss or alteration, increases in SSC with subsequent sediment deposition and underwater noise.

82. The UXO clearance works also have the potential to affect fish and shellfish resources as a consequence of direct disturbance to seabed and associated spawning, nursery or feeding habitats, particularly for demersal species, as well as increases in SSC.

83. The Original ES (NnGOWL, 2012) concluded that the effects associated with installation of turbines, subsea cables and associated structures in relation to habitat disturbance, increases in SSC and subsequent deposition, will be of minor significance for all fish and shellfish receptors. This assessment takes into account the low magnitude of the effect due to temporal (during construction) and spatial (local to the source) limitation. Given the much more limited scale of the UXO clearance works it can therefore be concluded that there will be no significant impacts on fish and shellfish species from disturbance to seabed and increases to SSC.

84. The detonation of UXO will also generate underwater noise which has the potential to cause hearing damage to fish, either permanently or temporarily and physical disturbance to fish species in the immediate vicinity of the detonation. The potential for physical injury to occur is dependent on the hearing ability of the fish. Fish hearing is based on detecting particle motion directly stimulating the inner ear.

85. Noise modelling has been undertaken for the UXO clearance works (Genesis, 2019) (see Appendix B). Criteria have been defined by Popper et al. (2014) for potential injury to fish, based on a review of publications related to impacts to from various high-energy sources including underwater explosives. Different injury thresholds are derived in Popper et al. (2014) for the following categories:

- Fishes with no swim bladder or other gas chamber;
- Fishes with swim bladders in which hearing does not involve the swim bladder or other gas volume; and
- Fishes with swim bladders in which hearing does involve a swim bladder or other gas volume.

86. The modelling of UXO has generated predicted distances for fish mortality, using the Popper et al (2014) criteria. These are summarised in Table 3-2.

Table 3-2: Predicted distances from UXO detonations where the threshold for potential mortality to fish is exceeded (Genesis, 2019).

FISH GROUP	EXPLOSIVE WEIGHT (KG)	DISTANCE TO POTENTIAL MORTALITY THRESHOLD (M) [1]
All Fish Species	10	220
	25	300
	50	380
	100	480
	250	650
	500	810
	1,000	1,020
[1] Predicted distances have been rounded up to the nearest 10 m.		

87. Genesis (2019) note that predicted sound levels from potential UXO detonations have been derived for underwater explosives in the water column. UXO detonations at the seabed are likely to result in lower sound levels than equivalent detonations in the water column since the seabed sediment will absorb some of the sound energy. Therefore, the predicted sound levels are likely to overestimate sound levels from potential UXO detonations within the Project.

88. The Original ES (NnGOWL, 2012) identified cod and herring, as being the two main sensitive fish receptors to underwater noise disturbance. Herring spawning areas are located to the north, off the Aberdeenshire coast and to the south coinciding with the inshore region of the Offshore Export Cable Corridor with no evidence of spawning activity across the wider wind farm area. High intensity nursery grounds for cod and whiting are present across the wind farm area. The Original ES (NnGOWL, 2012) also considered salmonid species, which are not sensitive to sound pressure but react to the particle motion element of noise. No diadromous fish species have nursery or breeding areas directly within the Firth of Forth, however, they are known to travel through the area.

89. The ranges predicted by the underwater noise modelling are likely to lead to some localised mortality of fish present in the immediate vicinity of the UXO clearance works where detonations are required. Disturbance of fish at a greater distance can also be expected. However, given the limited number of detonations required, the very short duration, intermittent and the localised nature of the impact, impacts on the fish populations in the vicinity of the works are not expected to be significant.

90. Whilst there are no specific measures that can be applied to mitigate potential effects on fish, the implementation of mitigation proposed for marine mammals (see Section 3.6.3) including the implementation of a 'soft start' approach before detonation of the UXO should trigger avoidance reactions in mobile fish species in the immediate vicinity of the detonations and may reduce the levels of mortality. It should also be noted that detonation will only occur if the UXO cannot be avoided or removed, as a result there is the potential that the number of UXO detonated will be much lower than considered in this assessment.

3.6 Marine Mammals

3.6.1 Summary of baseline

91. Site specific marine mammal surveys were undertaken over a period of three years between November 2009 and October 2012 to determine the number and distribution of marine mammals within the Wind Farm Area and an 8 km buffer (NnGOWL, 2018).

92. Six species of marine mammals were recorded from the survey work: harbour porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorostrata*), white-beaked dolphin (*Lagenorhynchus albirostris*), killer whale (*Orcinus orca*) and grey (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*). The most abundant species recorded was harbour porpoise which was recorded regularly throughout the year. The second most frequently recorded marine mammal was grey seal with the majority of grey seal sightings in the spring and autumn periods. The remaining species, white-beaked dolphin, minke whale, killer whale and harbour seal were recorded infrequently and in low numbers. There were no records of bottlenose dolphins during site-specific survey, however, due to the known distribution and presence of the Moray Firth population, it is considered likely that they will be present in nearshore waters, including within the Offshore Export Cable Corridor (Brookes, 2017).

93. The results from the baseline surveys indicate that the Wind Farm Area does not support particularly high numbers or densities of marine mammals (Figure 3-1).

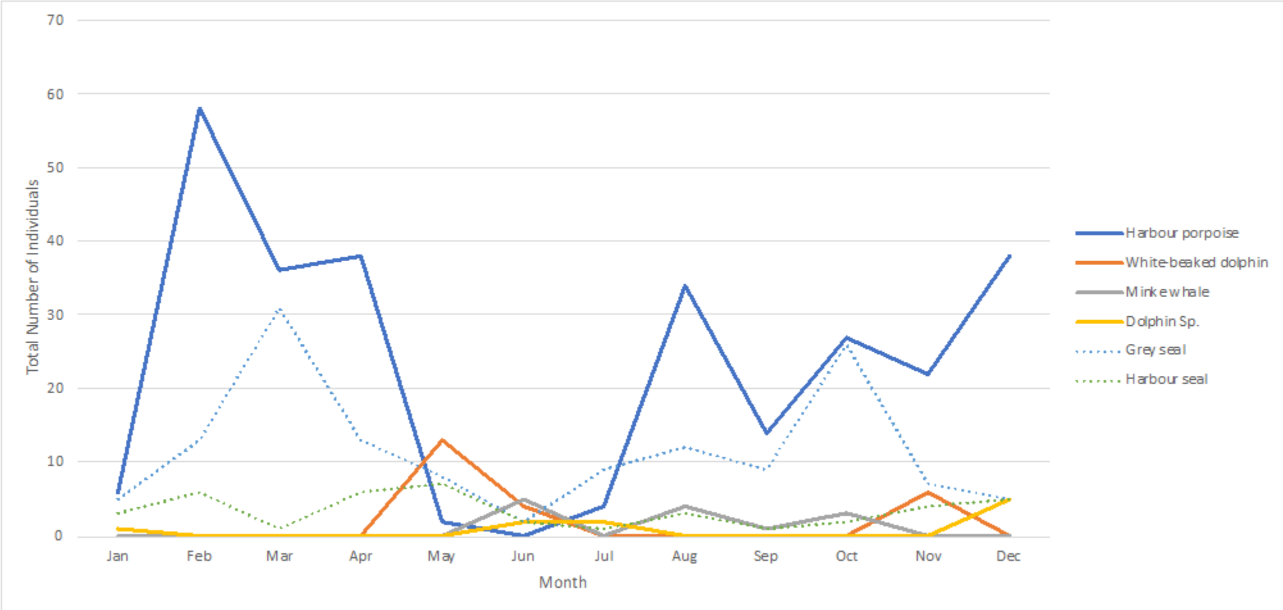

Figure 3-1: Total numbers of marine mammals recorded each month from three years of survey

3.6.2 Assessment of potential effects on marine mammals

94. Increased vessel traffic associated with UXO clearance works has the potential to affect marine mammals. The potential impacts from vessel noise and the presence of vessels on marine mammals were assessed in the Original ES (NnGOWL, 2012) as being not significant (and were identified as not requiring further assessment for the 2017 ES, given the duration on site of construction vessels associated with foundation and turbines installation and commissioning is likely to be reduced due to reduced scale of the Project).

95. As the UXO clearance works will be temporary and the operations localised, and involving only a small number of vessels, it is predicted that effects on marine mammals from increased vessel traffic associated with UXO clearance works will not be significant.

96. The principle source of impact from the clearance of UXO on marine mammals relates to the underwater noise generated where in-situ detonation is required. The effects of exposure to underwater noise from UXO detonation may manifest in a number of ways, including physical injury or death, PTS and TTS, masking effects and behavioural changes. Due to the short term discrete nature of the UXO disposal works, significant behavioural changes and masking are unlikely to occur.

97. The noise assessment presented in Genesis (2019) indicates that the scale of any potential impact from UXO is dependent on the charge size and the species impacted. A summary of the noise modelling results is presented in Appendix A. Based on the results from the noise modelling the estimated number of each species of marine mammal predicted to be impacted by traumatic injury, PTS and TTS are presented in Table 3-3, Table 3-4 and Table 3-5.

Table 3-3: Estimated number of marine mammals at risk of potential mortality (traumatic injury) from the clearance of 1,000 Kg Noise Exposure Questionnaire (NEQ) detonation without any mitigation.

SPECIES	DENSITY (IND./KM^2)	NO. OF INDIVIDUALS IMPACTED	MANAGEMENT UNIT POPULATION	PROPORTION OF MANAGEMENT UNIT IMPACTED
Harbour porpoise	0.599	0.20	227,298 (95% CI 176,360 - 292,948) **333,808**	<0.001
Bottlenose dolphin	0.07	0.02	195 (95% HDPI 162 – 253)	0.01
White-beaked dolphin	0.24	0.07	15,895 (95% CI 9,107 – 27,743) **35,908**	<0.001
Minke whale	0.039	0.01	23,528 (95% CI=13,989-39,572) **11,819**	<0.001
Grey seal	0.14	0.04	9,607 (95% CI 8,028 – 11,958)	<0.001
Harbour seal	0.04	0.01	311 (95% CI 254 - 415)	0.003

Estimated area of impact = 0.3 km^2 (presuming a circular radius of noise).
Regional Management Unit population is based on IAMMWG (2015). Bottlenose dolphin population is based on the Moray Firth to Tay east coast population from Cheney *et al*. (2013).
Figures in bold are the latest management unit population estimates (JNCC 2017).
Grey and Harbour seal population is East Coast Management Area.

Table 3-4: Estimated number of marine mammals at risk of potential PTS from the clearance of UXO (without any mitigation) and the proportion of the Management Unit population affected

SPECIES	DENSITY (IND./KM^2)	ESTIMATED NUMBER OF INDIVIDUALS IMPACTED AND THE PROPORTION OF MANAGEMENT UNIT AFFECTED BY EACH CHARGE WEIGHT						
		10 kg	25 kg	50 kg	100 kg	250 kg	500 kg	1,000 kg
Harbour porpoise	0.599	22 (0.007)	42 (0.012)	66 (0.020)	103 (0.031)	192 (0.058)	304 (0.091)	482 (0.144)
Bottlenose dolphin	0.07	0.01 (0.005)	0.02 (0.010)	0.02 (0.010)	0.04 (0.018)	0.08 (0.041)	0.11 (0.055)	0.18 (0.091)
White-beaked dolphin	0.24	0.13 (<0.001)	0.30 (0.001)	0.30 (0.001)	0.54 (0.001)	1.21 (0.003)	1.65 (0.005)	2.72 (0.008)
Minke whale (peak SPL)	0.039	0.04 (<0.001)	0.08 (0.001)	0.12 (0.001)	0.21 (0.002)	0.40 (0.003)	0.59 (0.005)	0.96 (0.008)
Minke whale (weighted SEL)	0.039	0.10 (<0.001)	0.14 (<0.001)	0.24 (0.002)	0.35 (0.003)	0.59 (0.004)	0.83 (0.007)	1.18 (0.010)
Grey seal	0.14	0.22 (<0.001)	0.36 (<0.001)	0.63 (0.01)	0.86 (0.01)	1.76 (0.02)	2.75 (0.03)	4.23 (0.04)
Harbour seal	0.04	0.06 (0.02)	0.10 (0.03)	0.18 (0.05)	0.25 (0.07)	0.50 (0.15)	0.79 (0.23)	1.21 (0.35)

Proportion of the Management Unit population impacted in parenthesis.
Estimated number of individuals impacted is calculated based on a circular radius of noise obtained from noise modelling results.
Minke whale SEL results presented as these are the worst-case.

Table 3-5: Estimated number of marine mammals at risk of potential TTS (disturbance) from the clearance of UXO (without any mitigation) and the proportion of the Management Unit population affected

SPECIES	DENSITY (IND./KM^2)	ESTIMATED NUMBER OF INDIVIDUALS IMPACTED AND THE PROPORTION OF MANAGEMENT UNIT AFFECTED BY EACH CHARGE WEIGHT						
		10 kg	25 kg	50 kg	100 kg	250 kg	500 kg	1,000 kg
Harbour porpoise	0.599	75 (0.027)	139 (0.042)	219 (0.066)	348 (0.104)	644 (0.193)	1,022 (0.306)	1,627 (0.487)
Bottlenose dolphin	0.07	0.04 (0.018)	0.05 (0.028)	0.08 (0.041)	0.14 (0.072)	0.27 (0.136)	0.37 (0.191)	0.64 (0.326)
White-beaked dolphin	0.24	0.54 (0.001)	0.84 (0.002)	1.21 (0.003)	2.15 (0.006)	4.07 (0.011)	5.68 (0.016)	9.71 (0.027)
Minke whale (peak SPL)	0.039	0.15 (0.001)	0.28 (0.002)	0.44 (0.004)	0.71 (0.006)	1.33 (0.011)	2.06 (0.017)	3.31 (0.028)
Minke whale (weighted SEL)	0.039	8.85 (0.07)	14.82 (0.12)	21.33 (0.18)	30.57 (0.26)	47.54 (0.40)	65.94 (0.56)	89.31 (0.75)
Grey seal	0.14	0.63 (0.01)	1.27 (0.01)	1.94 (0.02)	3.21 (0.003)	5.70 (0.06)	9.31 (0.10)	14.8 (0.15)
Harbour seal	0.04	0.18 (0.05)	0.36 (0.10)	0.55 (0.16)	0.92 (0.26)	1.63 (0.47	2.66 (0.77)	4.23 (1.22)

Proportion of the Management Unit population impacted in parenthesis.
Estimated number of individuals impacted is calculated based on a circular radius of noise obtained from noise modelling results.
Minke whale SEL results presented as these are the worst-case

3.6.2.1 Harbour porpoise

98. Based on existing information it is predicted that the most sensitive species likely to be present across the Wind Farm Area and Offshore Export Cable Corridor during UXO clearance will be harbour porpoise, as they have the greatest hearing sensitivity and consequently the lowest thresholds for the onset of PTS and TTS. They are also the most frequently recorded marine mammal during the period of proposed UXO clearance.

99. Depending on the size of the UXO, noise modelling indicates that there will be a relatively low risk of traumatic injury occurring for any explosive up to 1,000 kg NEQ with the extent of any impact predicted to occur no further than 340 m from the site of detonation (Appendix A: Table A- 1). To reduce the risk of any traumatic injury to marine mammals occurring the use of MMOs, PAM, ADD will be used on all detonations and soft-start procedures will be used as mitigation on all detonations with a charge weight

of greater than 50 kg to ensure no marine mammals are present within the immediate area of the works prior to any detonation of UXO (See Appendix C – Marine Mammal Mitigation Plan and Section 3.6.3).

100. There is a higher risk of PTS occurring over a wider area. In the event that UXO with a NEQ of 50 kg is detonated, the onset of PTS on harbour porpoise may occur out to 5.9 km. Should a 1,000 kg NEQ explosive be detonated then the onset of PTS could occur out to 16 km (Appendix A: Table A- 2).

101. In the event that the UXO weighing up to 50 kg NEQ is cleared from the site then it is predicted that up to 66 harbour porpoise may be impacted with levels of noise capable of causing the onset of PTS. In the unlikely event a substantial piece of UXO is identified of up to 1,000 kg NEQ then potentially up to 482 harbour porpoise may be impacted with levels of noise capable of causing the onset of PTS (Appendix A: Table A- 2). As a worst-case based on the maximum modelled explosive charge no more than 0.14% of the harbour porpoise regional management unit population is at risk of being impacted with levels of noise capable of causing the onset of PTS.

102. The risk of TTS (used as a proxy for the area of disturbance) is greater than the risk of permanent auditory injury and the area of potential impact is larger. An item of UXO with a charge size of 50 kg could cause the onset of TTS on harbour porpoise out to 10.8 km. Should a 1,000 kg NEQ UXO be detonated then the onset of TTS could occur out to 23.3 km (Appendix A: Table A- 2).

103. It is estimated that up to 218 harbour porpoise could be impacted in the event that 50 kg NEQ explosive is detonated, approximately 0.066% of the regional management unit harbour porpoise population. The number of harbour porpoise at risk of TTS should a 1,000 kg detonation occur is estimated to be 1,627 individuals, 0.487% of the management unit population (Table 3-5).

104. The potential effects of TTS and disturbance are predicted to be relatively short-lived. Studies undertaken on harbour porpoise indicate that, depending on the exposure level and duration, hearing ability returns between 4 and 96 minutes after the sound causing the impact has ceased (Kastelein et al. 2012). Similarly, evidence from other impulse noise activities, e.g. pile-driving and seismic surveys indicate any displaced individuals may return to the area typically within 24 to 48 hrs following cessation of activities (Pirotta et al. 2014, Thompson et al. 2013, Tougaard et al. 2006).

105. Harbour porpoise occur widely across the North Sea and is not a species restrained by limited specific habitat preferences. Harbour porpoise are known to forage widely and prey on a wide selection of fish species (Sveegaard 2011); they are therefore adaptable and capable of temporarily relocating to new areas.

106. Proposed mitigation measures in place will reduce the risk of any harbour porpoise occurring in the area within which traumatic or permanent auditory injury is predicted to occur (See Section 3.6.3).

3.6.2.2 White-beaked dolphin/bottlenose dolphin

107. White-beaked dolphin could occur within the area of the UXO clearance activities and bottlenose dolphin are known to occur regularly in nearshore waters. Peak numbers of white-beaked dolphin occurred during May, with 12 recorded during the Year 2 surveys. However, no white-beaked dolphin were recorded at all during the Year 1 surveys and no more than one was recorded in each of the surveys undertaken during Year 3. Between November and April only one white-beaked dolphin was recorded, in January.

108. No bottlenose dolphin were recorded during the three years of surveys.

109. Modelling indicates traumatic injury is unlikely to occur beyond 340 m from the sound source based on a large 1,000 kg NEQ charge (Appendix A:Table A- 1).

110. In the event that UXO with a charge weight of 50 kg is detonated the onset of PTS in dolphins may occur out to 300 m and should a 1,000 kg explosive be detonated then the onset of PTS could occur 900 m (Appendix A: Table A- 2).

111. Without any mitigation there is a very low risk of any dolphins being impacted at levels of noise capable of causing PTS. No bottlenose dolphins have been recorded within 900 m of the Wind Farm Area, although they could occur along the export cable route. It is estimated that less than one bottlenose or white-beaked dolphin would be impacted from a 50 kg NEQ UXO. For a larger detonation of up to 1,000 kg NEQ UXO less than one bottlenose dolphin and no more than three white-beaked dolphins could be affected (Table 3-4).

112. The onset of TTS in dolphins may occur out to 600 m from the site of detonation for a 50 kg NEQ UXO and 1.7 km for a 1,000 kg NEQ UXO detonation (Appendix A:Table A- 2). In the event an item of UXO with a charge weight of 50 kg is detonated less than one bottlenose dolphin or white-beaked dolphin is predicted to be impacted. In the event a 1,000 kg NEQ UXO is detonated it is still predicted that less than one bottlenose dolphin will be affected and less than ten white-beaked dolphins (Table 3-5). The effects of TTS and disturbance are predicted to be temporary with hearing function and behaviour returning to normal shortly after the impact has occurred.

113. Dolphins will be displaced over a wider area immediately following any UXO detonation. However, displaced dolphins will be able to temporarily relocate elsewhere and are predicted to return once the activity has finished.

114. Proposed mitigation measures in place will reduce the risk of any white-beaked or bottlenose dolphins occurring in the area within which traumatic or permanent auditory injury is predicted to occur (See Section 3.6.3).

3.6.2.3 Minke whale

115. No minke whales were recorded during the period of proposed activities between November and May.

116. The results from the noise modelling indicates that in the event that UXO with a NEQ of 50 kg is detonated, the onset of PTS on minke whale may occur out to 1,000 m from the site of detonation based on Peak SPL, or 1.4 km based on weighted SEL. Should a 1,000 kg NEQ explosive be detonated then the onset of PTS could occur from between 2.8 km and 3.1 km (Appendix A:Table A- 2). Less than two minke whales are estimated to be at risk of the onset of PTS from UXO clearance (Table 3-4).

117. The onset of TTS in minke whale may occur out to between 1.1 km and 27 km depending on the charge weight of the UXO detonated (Appendix A:Table A- 2 and Table A- 3). Under the worst-case scenario the onset of TTS could occur in up to 90 minke whales, equivalent to 0.75% of the Management Unit population (Table 3-5).

118. Minke whales are low frequency specialists and therefore the low frequency spectrum from explosives will be audible to minke whales at a greater distance compared to some other species of cetacean. This could cause a wider level of disturbance or behavioural impact. However, the impacts will be of short duration and once the clearance survey is complete there will be no on-going impacts on minke whales.

119. Proposed mitigation measures in place will reduce the risk of any minke whales occurring in the area within which traumatic or permanent auditory injury is predicted to occur (See Section 3.6.3 and Appendix C).

3.6.2.4 Grey seal

120. Grey seals were the second most frequently recorded marine mammal during the three years of surveys. Peak numbers occurred during October and March with relatively low numbers during the period between June and August.

121. The results from the noise modelling indicate that the onset of PTS could occur within 0.7 km and 3.1 km depending on the charge weight (Appendix A: Appendix A:Table A- 2). Less than five grey seal are predicted to be at risk of PTS (Table 3-4). The onset of TTS is predicted to occur between 1.2 km and 5.8 km and impact on no more than 19 individuals. However, it is noted that the densities of grey seals may be higher in nearshore waters and therefore, in the event that UXO is cleared along the export cable route in nearshore waters, the number of grey seals impacted may be higher.

122. Proposed mitigation measures in place will reduce the risk of any grey seals occurring in the area within which traumatic or permanent auditory injury is predicted to occur.

3.6.2.5 Harbour seal

123. Harbour seals were infrequently recorded during the three years of site specific surveys with no more than three individuals recorded during any one survey.

124. The results from the noise modelling indicate that the onset of PTS could occur within 0.7 km and 3.1 km depending on the charge weight (Appendix A:Table A- 2). No more than one harbour seal is predicted to be at risk of PTS (Table 3-4). The onset of TTS is predicted to occur between 1.2 km and 5.8 km and impact less than five individuals. However, as with grey seals, densities of harbour seal may be higher in nearshore waters and therefore, in the event that UXO is cleared along the export cable route in nearshore waters, the number of harbour seals disturbed may be greater.

125. Proposed mitigation measures in place will reduce the risk of any harbour seals occurring in the area within which traumatic or permanent auditory injury is predicted to occur.

3.6.2.6 Conclusions

126. There is a recognised risk of a potential impact to cetaceans from the proposed preconstruction UXO clearance activities planned for between November 2019 and May 2020. There is uncertainty in the level of impact due to the unknown nature of the UXO that may require removal. Ongoing UXO detection surveys will provide greater clarity in the number and type of UXO that may need to be cleared.

127. There is potential for four species of cetacean to occur within the Wind Farm Area and Offshore Export Cable Corridor during the proposed survey. However, site specific surveys and other studies indicate that minke whales and white-beaked dolphins are scarce during the period and are unlikely to be present; consequently, the proposed activities will have limited effects on these species. Two species: harbour porpoise and, nearshore, bottlenose dolphin may be present in the area at relatively low densities. Of the species likely to occur, the harbour porpoise is predicted to be the most sensitive due to its greater hearing sensitivity.

128. Noise modelling indicates that there is potential for both PTS and TTS to occur although the extent of any impact varies across species and with the size of the UXO. The results from the modelling indicate that, without any form of mitigation, no more than 0.14% of any cetacean species management unit population will be affected by the onset of PTS and less than 1% of a population be affected by TTS based on the maximum sized UXO item of 1,000 kg NEQ.

129. Proposed mitigation measures in place as described in the MMMP (Appendix C – Marine Mammal Mitigation Plan) will reduce the risk of any marine mammals occurring in the area within which impacts capable of causing traumatic or permanent auditory injury are predicted to occur. It is therefore predicted that no marine mammals will be impacted by traumatic or permanent auditory injury.

130. There is potential for displacement and disturbance over a wider area. Studies have shown that following displacement from impulsive noise sources cetaceans return to the area within a relatively short period of time, often within 24 to 48 hrs and therefore any impacts caused by displacement are temporary and will not cause any long-term effects.

131. Once the planned UXO clearance activities have been completed there will be no additional disturbance arising from either the detonation of UXO or the associated vessels. Consequently, there will be no long-term noise impacts.

132. It is therefore concluded that although there may be localised short term disturbance to marine mammals during the period of UXO clearance, the impacts will be temporary and will not be significant.

3.6.3 Mitigation Measures

133. Mitigation will reduce the risk of any marine mammals being present in an area within which traumatic injury or permanent threshold shift are predicted to occur and therefore reduces the risk of any significant effects. Details of the proposed mitigation that will be used throughout the UXO clearance campaign are presented in the MMMP (Appendix C – Marine Mammal Mitigation Plan . A brief summary of the proposed mitigation is presented below.

134. The proposed mitigation is:

- Leave *in situ* or avoid the UXO;
- Remove or relocate UXO, including relocating smaller items of UXO into a cluster for a single detonation;
- The use of MMOs and PAM;
- The use of a Lofitech Acoustic Deterrent Device (or an ADD with similar specifications and capability); and
- The use of a 'soft start' using a series of smaller charges increasing in weight over a period of time for all UXO with charge weight of greater than 50 kg.

135. In the event that UXO is required to be detonated the proposed mitigation is predicted to be effective at ensuring that there is minimal risk of any marine mammal occurring in the area at which permanent auditory injury is predicted to occur for any UXO. This is on the basis that:

- The use of MMOs and PAM will ensure that no marine mammals are at risk of traumatic injury;
- The use of ADD will ensure that there is a very low risk of any marine mammals being within the range at which the onset of PTS will occur for charge sizes of 50 kg or less;
- The use of a 'soft start' prior to any detonations will further reduce the risk of any marine mammals being within the range at which the onset of PTS will occur for all charge sizes between 50 kg and 1,000 kg; and

- In the event that a UXO with a significant charge weight of greater than 750 kg is required to be detonated the appropriate soft-start procedures will be discussed with MSS and SNH prior to clearance.

3.7 Ornithology

3.7.1 Summary of baseline

136. Three years of monthly boat-based surveys were undertaken to inform the EIA for the Project between 2009 and 2012 (NnGOWL, 2018). A total of 29 seabird species were identified during the site-specific surveys. The three most abundant species recorded during the surveys were gannet (*Morus bassanus*), puffin (*Fratercula arctica*) and guillemot (*Uria aalge*). Together, these three species accounted for 62.3% of all birds recorded in the offshore site in Year 1, and 77.1% of all birds recorded in the offshore site in Year 2. All three species were recorded in all months.

137. Thirteen species of seabird were considered to be key species and were assessed in greater detail on account of the high numbers present at certain times of year, the likely high connectivity to Special Protection Areas (SPAs) (nine species), and their sensitivity to potential effects. These key species were fulmar (*Fulmarus glacialis*), sooty shearwater (*Puffinus griseus*), gannet, little gull (*Hydrocoloeus minutus*), lesser-blacked gull (*Larus fuscus*), herring gull (*Larus argentatus*), great black-backed gull (*Larus marinus*), kittiwake (*Rissa tridactyla*), Arctic tern (*Sterna paradisaea*), guillemot, razorbill (*Alca torda*), puffin and little auk (*Alle alle*). All other species occurred only sporadically and in low or very low numbers.

3.7.2 Assessment of potential effects on ornithology

138. UXO disposal could impact on ornithological receptors through disturbance from the presence of vessels in the area and also from noise generated by the UXO detonations. Noise associated with the detonations will be underwater and would not be expected to lead to significant increases in airborne noise.

139. UXO clearance activities (vessel activity and detonations) have the potential to impact on ornithological receptors through displacement of seabirds from foraging habitat and may also cause flying birds to detour their flight routes. As no significant impacts are considered on fish, shellfish or benthic receptors (see Section 3.4 and Section 3.5), secondary effects resulting from disturbance to prey species are not considered further in this assessment.

140. The Original ES (NnGOWL, 2012) concluded that for vessel disturbance, all the regularly occurring seabird species that forage in the proposed offshore site are considered to have low susceptibility to disturbance and consequently, that the impacts on ornithological receptors arising from increased vessel activity and construction noise would not be significant. Given the smaller scale and shorter duration of the UXO clearance operations, it is considered that there will be no significant effect on the ornithological receptors as a result of vessel activity and UXO detonations.

3.8 Marine Archaeology and Cultural Heritage

3.8.1 Summary of baseline

141. A desk-based study and archaeological assessment of geophysical and geotechnical survey data was carried out to identify potential archaeological assets that may be affected and to establish their current

condition. This work also provided information upon which to base the assessment of archaeological potential (NnGOWL, 2012).

142. The desk-based assessment reviewed existing maritime records to identify potential wrecks in the Wind Farm Area or within the Offshore Export Cable Corridor and compared the locations with magnetic anomalies picked up in the geophysical survey of the site. There are nine recorded or charted wrecks and obstructions from the Seazone dataset located within the Wind Farm Area and one live wreck within the Offshore Export Cable Corridor.

143. Eight anomalies of high archaeological potential and seven of medium archaeological potential were identified across the proposed Wind Farm Area through the archaeological review of site-specific geophysical survey data. All eight anomalies of high archaeological potential are located within the wind farm footprint and correspond with six known wreck sites recorded in the SeaZone/UKHO records. The remains of two military submarines designated as Protected Places under the Protection of Military Remains Act 1986 lie within the Wind Farm Area.

3.8.2 Assessment of potential effects on marine archaeology and cultural heritage

144. Identified archaeological sites within the Wind Farm Area are subject to Archaeological Exclusion Zones (AEZs) within which seabed works will not occur. The AEZs are identified in the Project Written Scheme of Investigation (WSI), which is applicable to all pre-construction activities. UXO clearance works will not occur within the AEZ areas. Impacts on known archaeology will therefore not occur.

145. The potential for interaction with unexpected archaeological features is also recognised, it is also possible that finds of archaeologist interest may be identified as a result of UXO investigation activities. Any such discoveries that come to light during the course of the works will be addressed by following the protocol for archaeological discoveries outlined in the WSI.

146. Given the mitigation detailed within the WSI, and the avoidance of the AEZs, it can be concluded that there will be no significant effect on marine archaeological receptors as a result of the UXO clearance works.

3.9 Shipping and Navigation

3.9.1 Summary of baseline

147. A shipping survey conducted in 2010 found that between 16 and 17 vessels per day pass within 10 nautical miles (NM) of the Project, with an average of 2 per day passing though the Wind Farm Area (NnGOWL,2018). A busy shipping route lies to the south of the wind farm, intersecting the Offshore Export Cable Corridor. This is mainly used by tankers and cargo vessels heading in/out of the Firth of Forth. Navigational features include a general practice and submarine exercise area that overlies the Wind Farm Area and Offshore Export Cable Corridor, and the Forth Ports Ltd authority area which is 8.4 NM west of the Wind Farm Area.

148. The Wind Farm Area is north and east of areas of high fishing vessel activity and approximately 4 NM west of recreational racing and sailing areas. Some recreational craft may be seen during summer daylight hours on a route that passes through the Wind Farm Area; and two similar routes intersecting the Offshore Export Cable Corridor.

3.9.2 Assessment of effects on shipping and navigation

149. During UXO clearance works, there will be a maximum of 5 vessels operating offshore at any one time. Standard mitigation measures will be implemented during the works to minimise any impact on shipping and navigation. Such measures include advanced warning of the UXO clearance activities promulgated by the issuing of Notices to Mariners (NtMs) and advertisement through the Kingfisher Fortnightly Bulletin as well as Navigation Information broadcasts, and the use of an offshore Fisheries Liaison Officer (FLO).

150. Given these mitigation measures, and the fact the works will be of a temporary duration and localised in nature, with only a maximum of 5 vessels in operation, it is concluded that there will be no significant effect on shipping and navigation as a result of the UXO clearance works.

3.10 Commercial Fisheries

3.10.1 Summary of baseline

151. The principal fishing activities were identified through assessment of available data and consultation with local fishery stakeholders to inform the EIA (NnGOWL, 2018). The active fisheries in the region are:

- Potting for crustacea species such as lobster, brown crab and velvet crab, and seasonally deploying hook and lines for mackerel;
- Bottom otter trawls targeting Nephrops using single or twin gears;
- Boat dredges targeting scallops; and,
- Other (hydraulic) dredging vessels targeting razor shell and soft-shelled clam

152. Consultation with fishermen suggested that fishing grounds for Nephrops coincide with the Wind Farm Area and Offshore Export Cable Corridor although the fishery primarily targets grounds further inshore. The Nephrops fishery also seasonally targets squid within the same area. Potting regularly occurs across the Wind Farm Area and Offshore Export Cable Corridor and is ubiquitous in the region. Vessels targeting this area are predominantly located within the Anstruther and Eyemouth Fishery Districts.

153. Pittenweem is the principal fishing port in the area, followed by Dunbar and Eyemouth. Other ports that receive fewer catch landings are Crail, Methil and Leven, Anstruther, St Andrews, and West Wemyss.

3.10.2 Assessment of effects on commercial fisheries

154. The UXO clearance works have the potential to impact upon commercial fisheries operations through temporary exclusion from fishing grounds and through the disturbance to the seabed as a result of detonations or through UXO excavation works.

155. The Original ES (NnGOWL, 2012) assessed the potential for displacement during construction as a continual phase for a maximum of 3 years' duration. The Original ES concluded effects of minor adverse significance for all fleets, with the exception of potting vessels across the Wind Farm Area and demersal otter trawlers across the Offshore Export Cable Corridor which were assessed as moderate significance. A number of mitigation measures will be implemented for the project in relation to commercial fisheries which, together with liaison with fisheries representatives, reduced the magnitude of this effect to low and the residual effect to minor adverse significance.

156. Any craters created during detonation are expected to be backfilled by natural processes with the rate at which this occurs varying spatially according to sediment transport regimes in the local area.

157. The UXO clearance works will be highly localised in nature and occur over a relatively short period when compared to the main wind farm construction works. It can therefore be concluded, with the fisheries mitigation already in place for the Offshore Consents, that there will be no significant effect on commercial fisheries receptors from the UXO clearance works.

158. The Fisheries Liaison Officer (FLO) will be responsible for liaising with local fishermen regarding the UXO clearance works and also for posting the appropriate notices, including the Kingfisher Fortnightly Bulletin and NtM.

3.11 Nature Conservation Designations

3.11.1 Summary of baseline

159. A number of European designations are located along the east coast of Scotland and north east of England that are designated as protected areas for nature conservation or biodiversity purposes and which have the potential to have connectivity to the Wind Farm Area and Offshore Export Cable Corridor, see Figure 3-2.

160. Section 5 of this document presents an assessment of the potential impacts of the proposed works on relevant European proposed, candidate and designated sites.

161. As such, only nationally designated sites such as Sites of Special Scientific Interest (SSSIs), Marine Protected Area (MPAs) and National Nature Reserves (NNRs) are considered within this section.

162. The Original ES (NnGOWL, 2012) considered all sites of nature conservation interest in the vicinity of the Wind Farm Area and Offshore Export Cable Corridor that could be affected by the construction, operation and decommissioning of the project. A network of Sites of Special Scientific Interest (SSSIs) and National Nature Reserves (NNRs) in Scotland are managed under the provisions of the Nature Conservation (Scotland) Act 2004 and the Wildlife and Countryside Act 1981 (as amended). These protect species and habitats of nature conservation importance. However, they are largely terrestrial and do not extend below the low water mark and will therefore not be affected by any offshore development.

163. There are a number of SSSIs located along the coast of eastern Scotland which encompass a variety of intertidal habitats. The closest of these is the Isle of May SSSI, which covers an area also designated as an SAC. The site has grey seal as a notified feature which aligns with the SAC qualifying feature. No SSSIs fall within the Offshore Export Cable Corridor. The Firth of Forth complex nature conservation MPA designated for ocean quahog aggregations, offshore subtidal sand and gravels, shelf banks and mounds and moraines representative of the Wee Bankie Key Geodiversity Area is located in offshore waters but does not directly overlap with the Wind Farm Area and Offshore Export Cable Corridor, see Figure 3-2

3.11.2 Assessment of effects on Nature Conservation

164. The UXO disposal works have the potential to affect marine geological receptors through increases in SSC and associated sediment deposition. However, no significant impacts were identified to marine geological, oceanographic, or physical processes receptors. As stated in Section 3.4 and Section 3.5 of this document, the UXO clearance works have the potential to impact benthic ecology (including shellfish), and fish ecology receptors, however no significant effects are expected. Similarly, no significant

effects are expected on ornithological receptors as a result of disturbance from the presence of vessels in the area or from underwater noise generated by the UXO detonation (Section 3.7).

165. Due to the lack of significant effects on the receptors discussed above (which are features of nature designated sites) and the localised, temporary nature of the UXO disposal works, it can be concluded that there will be no significant effects on nationally designated sites.

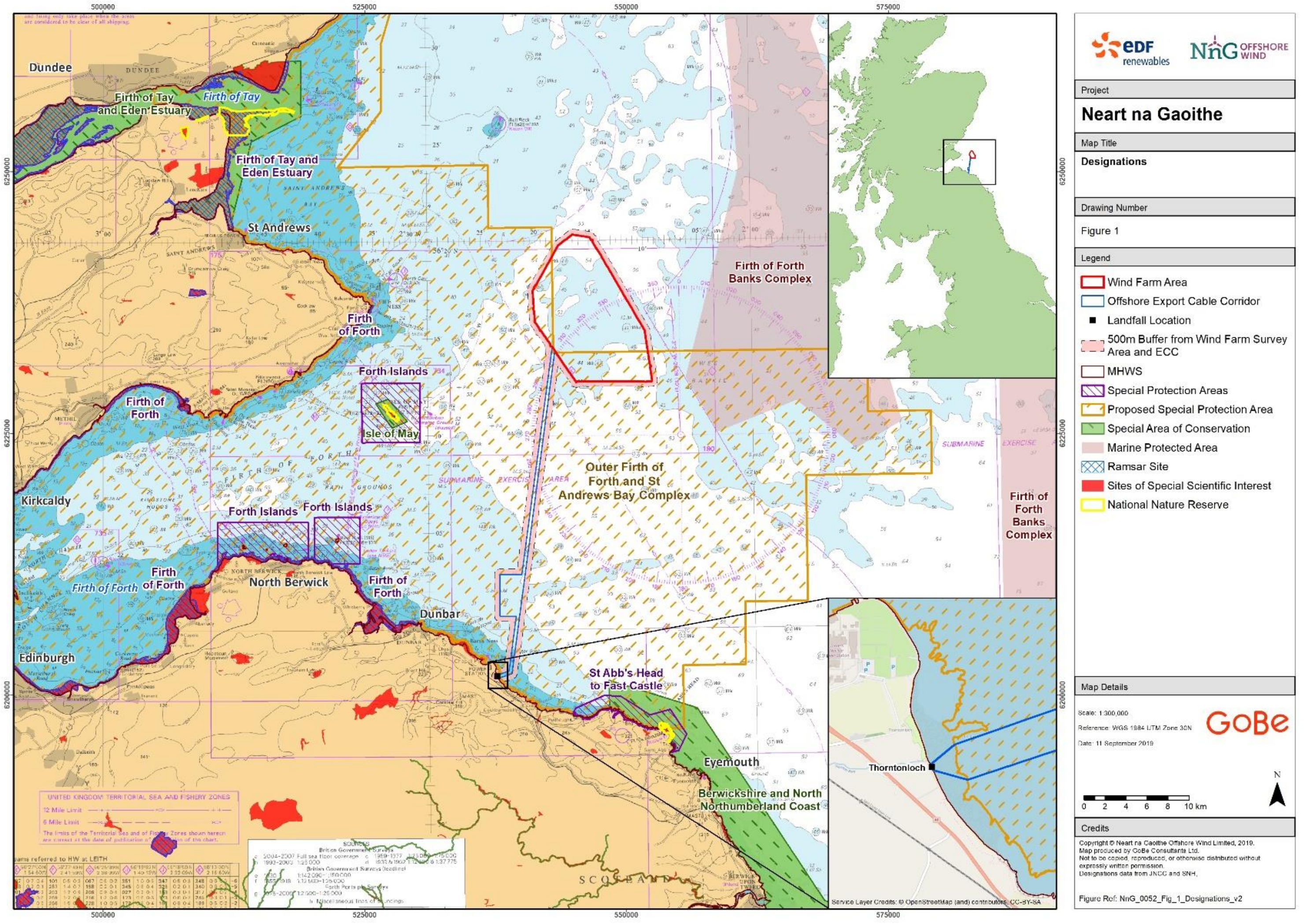

Figure 3-2: Location of nature conservation designated sites

4 Characterisation of Potential Cumulative Effects

166. The assessment of cumulative effects presented in the Original ES (NnGOWL, 2012) included both current and proposed projects, plans and activities (still considered valid for this assessment). The assessment included not only other existing, proposed or planned offshore wind farms but also other types of development or activities taking place in the wider area. This information has been utilised in order to provide consideration of any potential cumulative effects from the UXO clearance works. Potential cumulative impacts identified within the Original ES (NnGOWL, 2012) included potential disturbance of fish and marine mammals, displacement of birds, and restricted access for fishing vessels as a result of the construction and operation of a number of offshore projects.

167. The characterisation of effects, as presented within Section 3 of this report, has identified that all effects will be highly localised and short term in nature and will not result in significant adverse impacts on any receptors, with the exception of marine mammals. When these effects are then considered in the context of the information on the current and proposed projects, plans and activities detailed in the Original ES, the potential for the UXO clearance works contributing in a cumulative manner is also considered to be unlikely.

168. In addition, the UXO clearance works need to be considered cumulatively with the existing licensed works for the Project – i.e. the main construction of the Project and licence applications (Marine Licence for seabed preparation) particularly in respect of seabed disturbance and vessel disturbance.

169. With respect to seabed disturbance, the UXO clearance works will occur at broadly the same locations as the main construction (i.e. the foundation locations and along the cable routes). As a result, the total amount of seabed habitat affected will not be increased by the UXO clearance works when compared to the main construction, although the works will represent another disturbance event. Given the overall area of habitat affected will not be substantially increased and the habitats subject to temporary disturbance will recover, no significant cumulative effect is predicted.

170. In terms of fish ecology, the main potential effects arise from underwater noise arising from UXO detonations, but noting that foundation piling was assessed as the worst case in the EIA Report but will not now be used so that overall the levels of underwater noise and spatial and temporal effects on fish species (including lethal, injury and disturbance effects) will now be substantially less than described in the EIA Report. As such significant cumulative effects are not expected to occur.

171. For offshore ornithology, the UXO clearance works will lead to some disturbance from clearance works and vessel activity but within the same footprint as the main construction works, and in addition will occur within the winter-spring period (out with the main breeding season); as a result cumulative effects are not predicted to be significant.

172. When considering the potential for disturbance or displacement of commercial fishing activity from vessels engaged in UXO clearance works, alongside existing licensed works for the Project and the application for seabed preparation works within the Wind Farm Area and Offshore Export Cable Corridor, the numbers of vessels within the Wind Farm Area and Offshore Export Cable Corridor will increase. The EIA Report (NnGOWL, 2018) concluded that effects on commercial fishing from construction vessels transiting to and from areas undergoing construction works related to the construction of the Project were not considered significant; however impacts relating to displacement from construction activities and loss or restricted access to fishing grounds were assessed as moderate significance.

173. The Original ES (NnGOWL, 2012) assessed the potential for displacement during construction for fishing vessels as a continual phase for a maximum of 3 years' duration, as opposed to the UXO clearance works which will occur over a circa 7 month period. Fishing vessels will not be able to safely resume activities

until the seabed is returned to an acceptable level for fishing to be safely resumed, although the frequency and duration of the cumulative impact is considered moderate, the fishing grounds impacted are low intensity on a regional scale. The UXO clearance works will occur broadly within the same footprint as the main construction works, and as a result the total area of fishing grounds affected during the construction phase will not be increased. A number of measures will be implemented for the Project in relation to commercial fisheries which, together with liaison with fisheries representatives will mitigate any impacts.

174. Activities identified as having the potential for a cumulative impact on marine mammals between November 2019 and May 2020 are presented in Table 4-1 and the planned project schedules are presented in Figure 4-1.

175. None of the projects have determined that there will be a significant effect on marine mammals from their activities alone or cumulatively in each of their applications.

176. The potential for cumulative impacts to arise from the use of USBL are considered remote as the sound levels are below that which could cause injury and the extent of disturbance from USBL equipment is predicted to be very localised (NOAA 2018, Natural Power 2018).

177. The Aberdeen Harbour Expansion Project has marine mammal mitigation in place, including the use of a double bubble curtain for any blasting activities which significantly reduces the potential area of disturbance.

178. There is potential for cumulative impacts to bottlenose dolphin from construction at the Moray East Offshore wind farm the total of less than one bottlenose dolphin at risk of the onset of PTS or TTS from the UXO clearance (see Table 3-3 and Table 3-4) indicates that any cumulative contribution from the UXO clearance will be negligible.

179. The levels of sound reported from drilling are below that which would be predicted to cause either PTS or TTS and although audible to marine mammals, studies indicate no adverse behavioural response to drilling noise.

180. Consequently, it is concluded that there will not be a significant effect from potential cumulative impacts.

Table 4-1: Projects with potential for causing cumulative impacts on marine mammals.

PROJECT	COMPLETION DATE	SOUND SOURCES	ESTIMATED IMPACT
Moray East Offshore Wind Farm Construction	Ending June 2020	Pile-driving	Mitigation in place will ensure no risk of permanent auditory injury. Potential for cumulative disturbance impacts.
Aberdeen Harbour Expansion Project	Ending after March 2020	Drilling, Dredging, Rock-blasting, ADD	Drilling noise may have a very localised impact within 100 m from activities. Dredging noise may have a localised area of impact with the onset of PTS within tens of metres and displacement within *c.*500 m. Rock blasting potential for wider area of impact. Double bubble curtain in place may significantly reduce the area of PTS to within the harbour works area. Potential for wider area of disturbance. ADD area of displacement potentially up to

PROJECT	COMPLETION DATE	SOUND SOURCES	ESTIMATED IMPACT
			*c.*7.5 km.
NnGOWL Offshore Geotechnical survey	Ending November 2019	USBL	Very localised, if any.
NnGOWL Seabed Preparation	November 2019 – June 2021 (9 month discontinuous duration during this period)	Up to five USBL	Very localised, if any.
NnGOWL offshore wind farm construction	April 2020 – December 2022	Drilling	Localised

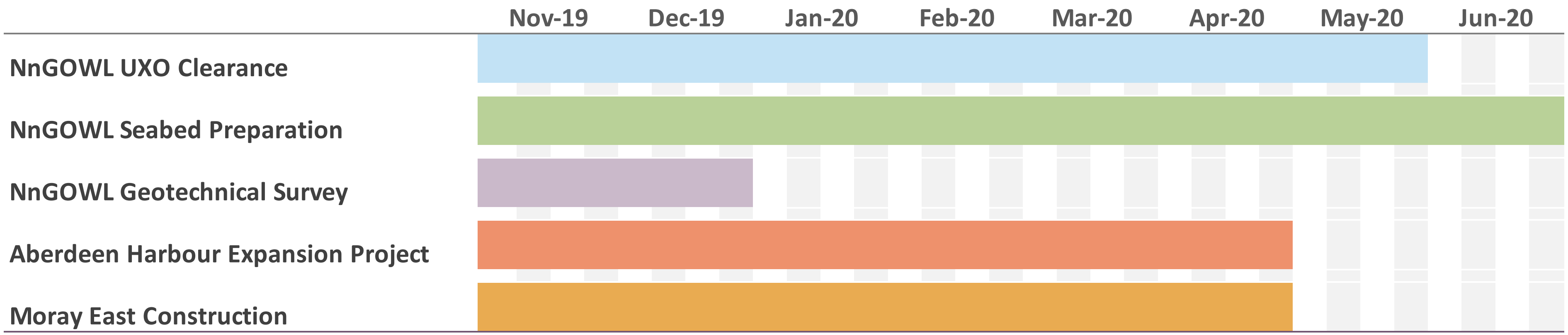

Figure 4-1: The schedules for projects with potential to cause cumulative impacts on marine mammals between November 2019 and March 2020.

5 Assessment of Likely Significant Effects and Adverse Effects on Integrity

5.1 Introduction

181. This section is intended to provide consideration of the potential for the UXO clearance works to lead to a Likely Significant Effect (LSE) on the conservation objectives of any relevant European designated (Natura 2000) or Ramsar site (referred to as a Stage 1 – screening assessment), and in the event of a LSE being identified, to provide information on the potential for the UXO activity to have an adverse effect on integrity (AEOI) of the relevant site/feature in relation to the stated conservation objectives (information to support Stage 2 – Appropriate Assessment).

182. Under the 2010 Habitats Regulations, the competent authority would be required to make an Appropriate Assessment of the implications of a proposed activity in view of any affected designated site's conservation objectives, should it be determined that the proposed activity represents an LSE. The information presented in this section, is intended to provide the competent authority with the relevant information to enable them to determine whether an Appropriate Assessment is required and where required, to support the completion of an Appropriate Assessment.

183. This section considers whether a qualifying feature is likely to be directly or indirectly affected. Where there is not a clear-cut case for there being no LSE on the interest feature or conservation objectives, a fuller consideration is then applied, using further analysis and information, to confirm and justify the presence or absence of AEOI.

184. An LSE is defined, in this context, as any effect (either alone or in-combination with other projects) that may be reasonably predicted as a consequence of a plan or project to have the potential to have a LSE on the favourable conservation status of the features for which the site was designated but excluding trivial or inconsequential effects (and with due regard to the conservation objectives for the site).

5.2 Designated Sites

185. The Natura 2000 and Ramsar sites identified as relevant to this assessment were selected due to their immediate proximity to the proposed UXO clearance works and existence of potential impact pathways relevant to the site features. The UXO clearance activities referred to within this report were not directly considered within the Consent Application documentation (ES or HRA). However, the associated effects of UXO clearance activities can be considered with reference to the worst case effects from the construction of the Project as detailed in the Application.

186. As the purpose of this Section is to identify the potential for any LSE (and where LSE is identified to provide information to support an Appropriate Assessment) and given the comparable footprint and shorter duration of the UXO clearance operations, effect pathways to more distant designated sites were considered unlikely.

5.3 Consideration of LSE and the Potential for AEOI

187. Potential sources of impacts from each aspect of the UXO clearance activities are considered below in Table 5-1 to Table 5-7, as applicable and/or relevant to each of the designated sites being considered:

- Moray Firth SAC;
- Firth of Tay and Eden Estuary SAC;
- Isle of May SAC;

- Berwickshire and North Northumberland coast SAC;
- Forth Islands SPA;
- St Abb's Head to Fast Castle SPA; and
- Outer Firth of Forth and St Andrews Bay Complex pSPA.

188. Where it is not possible to conclude no LSE on any site or features, Table 5-1 to Table 5-7 then go on to present further information to support an Appropriate Assessment in the form of an assessment of the potential for an AEOI of the site and feature(s) with due regard to the conservation objective for the relevant site.

5.3.1 Presence of vessels

189. A maximum of five vessels are proposed for the UXO clearance works. The potential for impact on the designated sites from the use of the above vessels will primarily relate to indirect disturbance, both in terms of noise and physical presence. This impact would be of a limited duration (a maximum of 7 months over the entire licence period).

5.3.2 Physical disturbance to the seabed

190. UXO clearance activities will likely result in both direct and indirect impacts such as the physical loss/removal and/or smothering of habitat; physical damage from siltation, abrasion or selected extraction; increase in turbidity; and release of contaminates from disturbed sediments.

5.3.3 Underwater noise

191. The detonation of UXO will cause noise that will have both direct and indirect impacts on marine life, including benthos, fish, seabirds and marine mammals.

5.4 Summary of Potential for LSE and AEOI

5.4.1 Moray Firth SAC

Table 5-1: Moray Firth SAC

Description of the site	The Moray Firth SAC lies approximately 170 km (in a direct line) to the north of Wind Farm Area and Offshore Export Cable Corridor. The site covers an area of 1,512 km^2 and is a marine site. Qualifying feature relevant to this assessment: • Bottlenose dolphin *Tursiops truncatus*	
Conservation objectives of the site	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and 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 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.	
Potential for LSE	**Presence of vessels**	The presence of vessels and underwater sounds created by large ships are unlikely to cause physical trauma to bottlenose dolphins but has the potential to make preferred habitats somewhat less attractive as a result of disturbance (habitat displacement, area avoidance). Although bottlenose dolphins are known to occur within the area, there were no sightings of bottlenose dolphin during the two years of boat-based surveys undertaken across the Wind Farm Area and Offshore Export Cable Corridor suggesting the area does not support key habitats for this species. The potential impacts from vessel noise and the presence of vessels on marine mammals were assessed in the Original ES (NnGOWL, 2012) as being not significant (and the issue was scoped out from further assessment in the EIA for the Project (Marine Scotland, 2017)); given this conclusion was in relation to the main construction works, the effect would be of even smaller scale for the UXO clearance works (noting also that vessel activity already occurs in the vicinity of the Wind Farm Area and Offshore Export Cable Corridor).

		Further, based on advice in the Scoping Opinion (Marine Scotland 2017) and the conclusions of the HRA Report (2018a) the only potential for LSE on bottlenose dolphin from the Moray Firth SAC were effects due to potential physical injury and disturbance arising from pile driving during construction with the Project on its own and in-combination with other offshore wind farms. As the UXO clearance works will be temporary and the operations localised and involving only a small number of vessels in the area over a relatively short duration, no LSE (alone or in-combination) are predicted on bottlenose dolphin as a feature of the Moray Firth SAC.
	Physical disturbance to seabed	Due to the local spatial extent and intermittent nature of the impacts on the seabed habitats and associated prey items and the highly mobile and wide ranging nature of bottlenose dolphins (coupled with empirical evidence indicating movement of animals back to the area of impact following cessation of offshore wind farm construction activity), no LSE are predicted on bottlenose dolphin as a feature of this site. The effects associated with physical disturbance to the seabed associated with the main construction works were not screened into the assessment presented within the HRA Report (NnGOWL, 2018a). As such, it can be concluded that there is no potential for LSE alone or in-combination.
	Underwater noise	**Potential for LSE** Based on the results from the noise modelling undertaken to support the UXO clearance (Appendix A and B) and the baseline information presented in Section 3.6, it is concluded that there will be a LSE on bottlenose dolphin from the Moray Firth SAC due to potential physical injury and disturbance arising from the detonation of UXO. **Potential for AEOI** The bottlenose dolphin population at the Moray Firth SAC is in a favourable and recovered condition (Cheney *et al*. 2018, SNH 2019). The estimated SAC population is 195 (95% HDPI 162 – 253) individuals. Results from the noise modelling undertaken indicates that effectively no bottlenose dolphins will receive sound levels at which traumatic injury could arise and less than one individual is predicted to be at risk of either PTS or TTS (Table 3-4 and Table 3-5) from all detonations for charge sizes up to 1,000 kg. Agreed mitigation measures in place, as presented in Section 5.7 and the MMMP (Appendix B), will ensure that there will be no bottlenose dolphins at risk of traumatic or permanent auditory injury. There may be some disturbance to bottlenose dolphins during the UXO clearance campaign. It is estimated that this will last for up to five months during which time up to 50 items of UXO may be cleared. Between detonations, and once UXO clearance has ceased, there will be no disturbance to bottlenose dolphins. Disturbance will therefore occur intermittently and over a relatively short period of time and the impacts will be temporary. There will be no disturbance to bottlenose dolphins within the site and their distribution within the site will not be affected. There will be no direct impacts on the distribution and extent of habitats supporting the species.

		Consequently, it is concluded that the impacts from UXO detonation noise on bottlenose dolphin will not adversely affect the integrity of the Moray Firth SAC, in light of the qualifying interest, its condition and the sites conservation objectives.

5.4.2 Firth of Tay and Eden Estuary SAC

Table 5-2: Firth of Tay and Eden Estuary SAC

Description of the site	The Firth of Tay and Eden Estuary SAC lies approximately 30 km to the west of the Wind Farm Area and Offshore Export Cable Corridor. The site covers an area of 154 km^2 and is a coastal site comprising mainly of estuaries, tidal rivers, mud flats and sand flats. Qualifying feature relevant to this assessment: • Harbour seal *Phoca vitulina*	
Conservation objectives of the site	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and 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 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.	
Potential for LSE	**Presence of vessels**	There is the potential for localised avoidance of vessels by seals. During three years of boat-based surveys harbour seals were infrequently recorded within the Wind Farm Area and buffer area (extending 8 km around the Wind Farm Area), the majority of sightings were outside of the Wind Farm Area with most observations to the south-east of the site. It is known that harbour seals are opportunistic feeders, feeding up to 40-50 km from their haul out sites, and taking a wide variety of prey. Given that the UXO clearance works will be temporary and the operations localised, occurring intermittently and over a relatively short duration, and involving only a small number of vessels, it is predicted that increased vessel traffic associated with UXO clearance works will not lead to a significant effect.

		The potential impacts from vessel noise and the presence of vessels on marine mammals were assessed in the Original ES (NnGOWL, 2012) as being not significant (and the issue was scoped out from further assessment in the 2018 ES); given this conclusion was in relation to the main construction works, the effect would be of even smaller scale for the UXO clearance works (noting also that vessel activity already occurs in the Wind Farm Area and Offshore Export Cable Corridor).
	Physical disturbance to seabed	Due to the local spatial extent and intermittent nature of the impacts on the seabed habitats and associated prey items and the highly mobile and wide-ranging nature of harbour seals (and their ability to forage on a wide range of prey species), no adverse effects are predicted on bottlenose dolphin as a feature of this site. The effects associated with physical disturbance to the seabed associated with the main construction works were not screened into the assessment presented within the HRA Report (NnGOWL, 2018a). As such, it can be concluded that there is no potential for LSE alone or in-combination.
	Underwater noise	**Potential for LSE** Based on the results from the noise modelling undertaken to support the UXO clearance and the baseline information presented in Section 3.6, it is concluded that there will be a LSE on harbour seal from the Firth of Tay and Eden Estuary SAC due to potential physical injury and disturbance arising from the detonation of UXO. **Potential for AEOI** The harbour seal population at the Firth of Tay and Eden Estuary SAC is in an unfavourable and declining condition (SNH 2019). The latest published counts recorded 29 harbour seals in 2017 (Duck *et al*. 2018). The latest estimated number of harbour seals within the East Scotland Management Area (ESMA) is 346 individuals (Duck *et al*. 2018). For the purposes of this assessment the ESMA is taken to be the SAC population. The results from the noise modelling indicate that there is a very low risk of any harbour seals at risk of traumatic injury from the detonation of UXO (Table 3-3). There is potential for the onset of PTS to occur within 3.1 km from the detonation of a 1,000 kg NEQ UXO and less than two harbour seal may be impacted. The onset of TTS is predicted to occur out to 5.8 km in the event a UXO with a charge weight of 1,000 kg is detonated and impact on less than five harbour seals, equivalent to 1.2% of the ESMA population. Agreed mitigation measures in place, as presented in Section 5.7 and the MMMP (Appendix B), will ensure that there will be no harbour seals at risk of traumatic or permanent auditory injury. There will be some disturbance to harbour seals during the clearance of UXO. It is estimated that this will occur intermittently over a period of five months and impact on approximately 1% of the Management Area population. Once UXO clearance has ceased there will be no disturbance to harbour seals and the impacts from disturbance are therefore temporary. There will be no direct impacts on the distribution and extent of habitats supporting the species, although there may be an impact on their prey (Section 3.5)

		Consequently, it is concluded that the impacts from UXO clearance on harbour seals will not adversely affect the integrity of the Firth of Tay and Eden Estuary SAC, in light of the qualifying interest, the condition and the site's conservation objectives.

5.4.3 Isle of May SAC

Table 5-3: Isle of May SAC Supporting Information

Description of the site	The Isle of May SAC lies approximately 16 km to the west of the Wind Farm Area and Offshore Export Cable Corridor. The site covers an area of 3.56 km^2 and is an island site comprising mainly of marine habitat. Site designation – qualifying species and features • Grey seal *Halichoerus grypus*	
Conservation objectives of the site	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained, and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and 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 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.	
Potential for LSE	**Presence of vessels**	There is the potential for localised avoidance of vessels by seals. Grey seals are known to occur regularly in the waters around the Wind Farm Area and Offshore Export Cable Corridor. Data from existing offshore wind farms suggesting a low sensitivity to disturbance and rapid returns to construction sites, together with the ability of grey seals to forage widely indicate that there would no effect on their foraging behaviour. As the UXO clearance works will be temporary and the operations localised and involving only a small number of vessels working intermittently over a relatively short duration, it is predicted that effects on grey seal from increased vessel traffic associated with seabed clearance works will not be significant.

		The potential impacts from vessel noise and the presence of vessels on marine mammals were assessed in the Original ES (NnGOWL, 2012) as being not significant (and the issue was scoped out from further assessment in the EIA Report (NnGOWL, 2018); given this conclusion was in relation to the main construction works, the effect would be of even smaller scale for the seabed clearance works (noting also that vessel activity already occurs in the Wind Farm Area and Offshore Export Cable Corridor). The most recent scoping opinion provided by Marine Scotland for the Project (Marine Scotland 2017) advised that the only impacts from the proposed Project alone and in-combination that could have a likely significant effect on seals are the impacts from noise arising from pile driving during. This being the case for the main construction works, a similar conclusion is drawn for the UXO clearance works. As such, it can be concluded that there is no potential for LSE alone or in-combination
	Physical disturbance to seabed	There will be no direct impacts on the distribution and extent of habitats supporting the species, but the potential for indirect impacts on habitats that support prey items. Due to the local spatial extent and intermittent nature of the impacts, the highly mobile and wide ranging nature of grey seals coupled with empirical evidence indicating movement of animals back to the area of impact following cessation of the activity, no significant effects are predicted on grey seals. The effects associated with physical disturbance to the seabed, from the main construction works, were screened out of the assessment presented within the HRA Report (NnGOWL, 2018a). As such, it can be concluded that there is no potential for LSE alone or in-combination
	Underwater noise	**Potential for LSE** Based on the results from the noise modelling undertaken to support the UXO clearance campaign (Appendix A and B) and the baseline information summarised in Section 3.6 it is concluded that there will be a likely significant effect on grey seals from the Isle of May SAC due to potential physical injury and disturbance arising from the detonation of UXO. **Potential for AEOI** The grey seal populations at the Isle of May SAC are in a favourable and maintained condition (SNH 2019). Based on the latest population estimates and a scalar multiplier of 2.39 (Russell *et al.* 2016), the latest population estimate of grey seals in the ECMA is 9,607 (95% CI 8,028 – 11,958). For the purposes of this assessment the ECMA is taken to be the population for both SACs. Agreed mitigation measures in place, as presented in Section 5.7 and the MMMP (Appendix B), will ensure that there will be no grey seals at risk of traumatic or permanent auditory injury. The results from the noise modelling indicate that there is a very low risk of any grey seals being within the range at which traumatic injury is predicted to occur. There is potential for the onset of PTS to occur within 3. km from the detonation of a 1,000 kg NEQ UXO. It is predicted that less than five

		grey seals could be impacted. This is equivalent to 0.04% of the Management Area population (Table 3-4) The onset of TTS could cover an area of 105 km^2 and impact on up to 15 grey seals, which would be 0.15% of the Management Area population (Table 3-5). There will be some disturbance to grey seals during the clearance of UXO. It is estimated that this will occur intermittently over a period of five months and impact on no more than 0.1% of the Management Area population. Once UXO clearance has ceased there will be no disturbance to grey seals and the impacts from disturbance are therefore temporary. There will be no direct impacts on the distribution and extent of habitats supporting the species, although there may be an impact on their prey (See Section 3.5). Consequently, it is concluded that the impacts from UXO clearance on harbour seals will not adversely affect the integrity of the Isle of May, in light of their qualifying interest, their condition and the sites' conservation objectives.

5.4.4 Berwickshire and North Northumberland Coast SAC

Table 5-4: Berwickshire and North Northumberland Coast SAC Supporting Information

Description of the site	The Berwickshire and North Northumberland Coast SAC lies approximately 33 km to the south of the Wind Farm Area and Offshore Export Cable Corridor. The site covers an area of 652 km^2 and is a coastal and marine site comprising mainly of marine areas, tidal rivers, estuaries, mud flats, sand flats and lagoons Qualifying Feature: • Grey seals *Halichoerus grypus*
Conservation objectives of the site	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and 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 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.

Potential for LSE	**Presence of vessels**	There is the potential for localised avoidance of vessels by seals. Grey seals are known to occur regularly in the waters around the Wind Farm Area and Offshore Export Cable Corridor. Data from existing offshore wind farms suggesting a low sensitivity to disturbance and rapid returns to construction sites, together with the ability of grey seals to forage widely indicate that there would no effect on their foraging behaviour. As the UXO clearance works will be temporary and the operations localised and involving only a small number of vessels working intermittently over a relatively short duration, it is predicted that effects on grey seal from increased vessel traffic associated with seabed clearance works will not be significant. The potential impacts from vessel noise and the presence of vessels on marine mammals were assessed in the Original ES (NnGOWL, 2012) as being not significant (and the issue was scoped out from further assessment in the 2018 ES); given this conclusion was in relation to the main construction works, the effect would be of even smaller scale for the UXO clearance works (noting also that vessel activity already occurs in the Wind Farm Area and Offshore Export Cable Corridor The most recent scoping opinion provided by Marine Scotland for the Project (Marine Scotland 2017) advised that the only impacts from the proposed Project alone and in-combination that could have a likely significant effect on seals are the impacts from noise arising from pile driving during. This being the case for the main construction works, a similar conclusion is drawn for the UXO clearance works. As such, it can be concluded that there is no potential for LSE alone or in-combination.
	Physical disturbance to seabed	There will be no direct impacts on the distribution and extent of habitats supporting the species, but the potential for indirect impacts on habitats that support prey items. Due to the local spatial extent and intermittent nature of the impacts, the highly mobile and wide-ranging nature of grey seals coupled with empirical evidence indicating movement of animals back to the area of impact following cessation of the activity, no significant effects are predicted on grey seals. The effects associated with physical disturbance to the seabed, from the main construction works, were screened out of the assessment presented within the HRA Report (NnGOWL, 2018a). As such, it can be concluded that there is no potential for LSE alone or in-combination
	Underwater noise	**Potential for LSE** Based on the results from the noise modelling undertaken to support the UXO clearance campaign and the baseline information summarised in Section 3.6 it is concluded that there will be a likely significant effect on grey seals from the Berwickshire and North Northumberland Coast SAC due to potential physical injury and disturbance arising from the detonation of UXO.

		Potential for AEOI The grey seal populations at the Berwickshire and North Northumberland Coast SAC are in a favourable and maintained condition (SNH 2019). Based on the latest population estimates and a scalar multiplier of 2.39 (Russell *et al*. 2016), the latest population estimate of grey seals in the ECMA is 9,607 (95% CI 8,028 – 11,958). For the purposes of this assessment the ECMA is taken to be the population for both SACs. The results from the noise modelling indicate that there is a very low risk of any grey seals being within the range at which traumatic injury is predicted to occur. There is potential for the onset of PTS to occur within 3. km from the detonation of a 1,000 kg NEQ UXO. It is predicted that less than five grey seals could be impacted. This is equivalent to 0.04% of the Management Area population (Table 3-4). The onset of TTS could cover an area of 105 km^2 and impact on up to 15 grey seals, which would be 0.15% of the Management Area population (Table 3-5). Agreed mitigation measures in place, as presented in Section 5.7 and the MMMP (Appendix B), will ensure that there will be no grey seals at risk of traumatic or permanent auditory injury. There will be some disturbance to grey seals during the clearance of UXO. It is estimated that this will occur intermittently over a period of five months and impact on no more than 0.1% of the Management Area population. Once UXO clearance has ceased there will be no disturbance to grey seals and the impacts from disturbance are therefore temporary. There will be no direct impacts on the distribution and extent of habitats supporting the species, although there may be an impact on their prey (See Section 3.5). Consequently, it is concluded that the impacts from UXO clearance on harbour seals will not adversely affect the integrity of the Berwickshire and North Northumberland Coast SAC, in light of their qualifying interest, their condition and the sites' conservation objectives.

5.4.5 The Forth Islands SPA

Table 5-5: Forth Islands SPA Supporting Information

Description of the site	The Forth Islands SPA lies approximately 16 km to the west of the Wind Farm Area and Offshore Export Cable Corridor. The site comprises a series of islands supporting the main seabird colonies in the Firth of Forth including the Isle of May, Bass Rock, Craigleith, Inchmickery, Fidra and The Lamb. Qualifying features relevant to this assessment (* indicates assemblage qualifier only) • Arctic tern *Sterna paradisaea*; common tern *Sterna hirundo*; cormorant *Phalacrocorax carbo**; fulmar *Fulmarus glacialis**; gannet *Morus bassanus*; guillemot *Uria aalge**; herring gull *Larus argentatus**; kittiwake *Rissa tridactyla**; lesser black-backed gull *Larus fuscus*; puffin *Fratercula arctica*; razorbill *Alca torda**; roseate tern *Sterna dougallii*; sandwich tern *Sterna sandvicensis*; shag *Phalacrocorax aristotelis*; and seabird assemblage.

Conservation objectives of the site	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and to ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site; • Distribution of the species within 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.	
Potential for LSE	**Presence of vessels**	Studies generally show that birds are disturbed by a sudden large noise but have the ability to habituate to regular noises, including those generated by vessels on site. When viewed in the wider context of the shipping and navigation in the area, the impacts associated with vessels present to complete the UXO clearance works will be localised, short term and intermittent over a relatively short duration. The duration, magnitude and extent of impacts resulting from vessel activity on the SPA qualifying species is, therefore, assessed as being unlikely to compromise the conservation objectives the SPA. Consequently, no potential for LSE is predicted (alone or in-combination).
	Physical disturbance to seabed	There is potential for a sediment plume to occur that could affect the ability of birds to forage in the water column. The Original ES (NnGOWL, 2012) concluded that there would be only short-term increases in SSC that may temporarily exceed background levels (from the main construction works); however, the resulting plumes would not be advected beyond the near field and rapidly dispersed by the tidal regime in the area and will settle out within a few hours of disturbance. The Original ES (NnGOWL, 2012) also concluded that the resulting deposition would be limited and would occur over the whole development area. Settled material will be the same as that occurring naturally and will be subject to the natural processes of erosion/deposition experienced at the site. The levels of sediment disturbance and SSC resulting from the detonations and any required excavation work are expected to be very substantially less that the worst case impacts assessed within the Original ES. The increase in sediment in the water column will, therefore, relatively low, localised, short term and occur intermittently over the duration of the works; this will not impact on the ability of seabirds to forage. As such, the duration, magnitude and extent of impacts resulting from increased suspended sediment concentrations and prey availability in the water column on SPA qualifying species are assessed as being unlikely to compromise the conservation objectives of the SPA. Consequently, no potential for LSE is predicted (alone or in-combination).
	Underwater noise	Whilst there is potential for the noise from the detonation to disturb diving birds, this will be for a short duration and of limited extent during each of the individual detonations. It is expected that the presence of vessels in the area will also minimise the number of individuals present in the immediate area.

		The potential for effect to birds due to noise disturbance during the UXO works will be limited and significantly less than that anticipated during the offshore construction phase. Consequently, no potential for LSE with respect to designated SPA interests is predicted (alone or in-combination).

5.4.6 St Abb's Head to Fast Castle SPA

Table 5-6: St Abb's Head to Fast Castle SPA Supporting Information

Description of the site	St Abb's Head to Fast Castle SPA lies approximately 31 km to the south of the Wind Farm Area and Offshore Export Cable Corridor. The site comprises an area of sea cliffs and coastal strip stretching over 10 km along the Berwickshire coast, north of St Abb's. Qualifying species and features (* indicates assemblage qualifier only) • Guillemot *Uria aalge**; herring gull *Larus argentatus**; kittiwake *Rissa tridactyla**; razorbill *Alca torda**; shag *Phalacrocorax aristotelis** and seabird assemblage	
Conservation objectives of the site	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and to ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site; • Distribution of the species within 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	
Potential for LSE	**Presence of vessels**	Studies generally show that birds are disturbed by a sudden large noise but have the ability to habituate to regular noises, including those generated by vessels on site. When viewed in the wider context of the shipping and navigation in the area, the impacts associated with vessels present to complete the UXO clearance works will be localised, short term and intermittent over a relatively short duration. The duration, magnitude and extent of impacts resulting from vessel activity on the SPA qualifying species is, therefore, assessed as being unlikely to compromise the conservation objectives the SPA. Consequently, no potential for LSE is predicted (alone or in-combination).

	Physical disturbance to seabed	There is potential for a sediment plume to occur that could affect the ability of birds to forage in the water column. The Original ES (NnGOWL, 2012) concluded that there would be only short-term increases in SSC that may temporarily exceed background levels (from the main construction works); however, the resulting plumes would not be advected beyond the near field and rapidly dispersed by the tidal regime in the area and will settle out within a few hours of disturbance. The Original ES (NnGOWL, 2012) also concluded that the resulting deposition would be limited and would occur over the whole development area. Settled material will be the same as that occurring naturally and will be subject to the natural processes of erosion/deposition experienced at the site. The levels of sediment disturbance and SSC resulting from the detonations and any required excavation work are expected to be very substantially less that the worst case impacts assessed within the ES. The increase in sediment in the water column will, therefore, relatively low, localised, short term and occur intermittently over the duration of the works; this will not impact on the ability of seabirds to forage. As such, the duration, magnitude and extent of impacts resulting from increased suspended sediment concentrations and prey availability in the water column on SPA qualifying species are assessed as being unlikely to compromise the conservation objectives of the SPA. Consequently, no potential for LSE is predicted (alone or in-combination).
	Underwater noise	Whilst there is potential for the noise from the detonation to disturb diving birds, this will be for a short duration and of limited extent during each of the individual detonations. It is expected that the presence of vessels in the area will also minimise the number of individuals present in the immediate area. The potential for effect to birds due to noise disturbance during the UXO works will be limited and significantly less than that anticipated during the offshore construction phase. Consequently, no potential for LSE with respect to designated SPA interests is predicted (alone or in-combination).

5.4.7 The Outer Firth of Forth and St Andrews Bay Complex SPA

Table 5-7: The Outer Firth of Forth and St Andrews Bay Complex SPA

Description of the site	The Outer Firth of Forth and St Andrews Bay Complex pSPA partially overlaps with Wind Farm Area and Offshore Export Cable Corridor. The site comprises of marine and coastal habitat. Qualifying species • Arctic tern *Sterna paradisaea*, black-headed gull *Chroicocephalus ridibundus*, common gull *Larus canus*, common scoter *Melanitta nigra*, common tern *Sterna hirundo*, eider *Somateria mollissima*, gannet *Morus bassanus*, goldeneye *Bucephala clangula*, guillemot *Uria aalge*, herring gull *Larus argentatus*, kittiwake *Rissa tridactyla*, little gull *Hydrocoloeus minutus*, long-tailed duck *Clangula hyemalis*, manx shearwater *Puffinus puffinus*,

	puffin *Fratercula arctica*; razorbill *Alca torda*, red-breasted merganser *Mergus serrator*, red-throated diver *Gavia stellata*, shag *Phalacrocorax aristotelis*, Slavonian grebe *Podiceps auratus* and velvet scoter *Melanitta fusca*.	
Conservation objectives of the site	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species; and To ensure for the qualifying species that, subject to natural change, the following attributes are maintained in the long term: • The species as a viable component of the site; • No significant disturbance of the species or significant reduction in ability of the species to utilise important parts of the site; • Distribution and extent of habitats and the structure, function and supporting processes of the habitats supporting the qualifying species and their prey are maintained	
Potential for LSE	**Presence of vessels**	Studies generally show that birds are disturbed by a sudden large noise but have the ability to habituate to regular noises, including those generated by vessels on site. When viewed in the wider context of the shipping and navigation in the area, the impacts associated with vessels present to complete the UXO clearance works will be localised, short term and intermittent over a relatively short duration. The duration, magnitude and extent of impacts resulting from vessel activity on the SPA qualifying species is, therefore, assessed as being unlikely to compromise the conservation objectives the SPA. Consequently, no potential for LSE is predicted (alone or in-combination).
	Physical disturbance to seabed	There is potential for a sediment plume to occur that could affect the ability of birds to forage in the water column. The Original ES (NnGOWL, 2012) concluded that there would be only short-term increases in SSC that may temporarily exceed background levels (from the main construction works); however, the resulting plumes would not be advected beyond the near field and rapidly dispersed by the tidal regime in the area and will settle out within a few hours of disturbance. The Original ES (NnGOWL, 2012) concluded that the resulting deposition would be limited and would occur over the whole development area. Settled material will be the same as that occurring naturally and will be subject to the natural processes of erosion/deposition experienced at the site. The levels of sediment disturbance and SSC resulting from the detonations and any required excavation work are expected to be very substantially less that the worst case impacts assessed within the Original ES. The increase in sediment in the water column will, therefore, relatively low, localised, short term and occur intermittently over the duration of the works; this will not impact on the ability of seabirds to forage. As such, the duration, magnitude and extent of impacts resulting from increased suspended sediment concentrations and prey availability in the water column on SPA qualifying species are assessed as being unlikely to compromise the conservation objectives of the SPA. Consequently, no potential for LSE is predicted (alone or in-combination).

	Underwater noise	Whilst there is potential for the noise from the detonation to disturb diving birds, this will be for a short duration and of limited extent during each of the individual detonations. It is expected that the presence of vessels in the area will also minimise the number of individuals present in the immediate area. The potential for effect to birds due to noise disturbance during the UXO works will be limited and significantly less than that anticipated during the offshore construction phase. Consequently, no potential for LSE with respect to designated SPA interests is predicted (alone or in-combination).

5.5 Implications of the Nature Conservation Advice

192. For the relevant designated sites detailed in this section, it can be concluded with confidence that the UXO clearance works will not affect the population or distribution of the qualifying features of the Natura 2000 sites. This is due to the limited duration, magnitude and extent of the impact related to the physical presence of the vessels, and the physical disturbance of the seabed as a result of the seabed clearance works. Therefore, it can be concluded that there will be no LSE as a result of the proposed UXO clearance works on these designated sites.

5.6 In-Combination Effects

5.6.1 SPAs

193. In relation to the features of the SPAs considered above, Table 5-5 to Table 5-7 have concluded on both alone and in-combination potential for LSE. Given the small scale nature of the disturbance arising from the UXO clearance works, both spatially and temporally, it has been concluded that there is no potential for an in-combination LSE for any of the SPA sites considered.

5.6.2 SACs

194. The projects listed in Table 4-1 have been identified as having the potential to cause an in-combination impact on marine mammals from noise arising from the detonation of UXO.

195. The NnGOWL Seabed Preparation survey will be ongoing throughout the UXO clearance campaign. However, the only equipment being used during this survey is Ultra Short Baseline (USBL) which is operated at levels below which the onset of PTS is predicted to occur and predicted to have a very localised area of disturbance (NOAA, 2018; Natural Power, 2018).

196. There is potential for in combination impacts to arise from the construction of Aberdeen Harbour (The Aberdeen Harbour Expansion Project (AHEP)). Activities capable of causing in combination impact include dredging, drilling and rock blasting. The potential impacts from dredging and drilling are predicted to be very localised and be largely within the area of works. The impacts from rock-blasting will have a wider area of impact. Mitigation measures in place include the use of a double bubble curtains and an ADD which ensure that there is a very low risk of any cetaceans being at risk of the onset of PTS. Furthermore, blasting will only occur in sea state of three or less and when wave heights are less than 0.5 m (Dragados 2018). It is therefore less likely that blasting will occur during the winter period during which the NNG UXO clearance works will be undertaken. In the event that it does, any disturbance impacts will be temporary and due to the presence of a double bubble curtain predicted to be localised.

197. There is potential for in combination impacts to arise with the construction pile-driving being undertaken at the Moray East Offshore Wind Farm which may be occurring concurrently with the planned NNG UXO clearance. The estimated number of bottlenose dolphin impacted by pile-driving at the Moray East Offshore Wind Farm and the proposed UXO clearance are presented in Table 5-8.

198. For all UXO charge weights the number of bottlenose dolphin predicted to be at risk of permanent auditory injury is less than one and in-combination with pile-driving impacts it is predicted that less than two bottlenose dolphins are at risk of the onset of PTS. The proportion of individuals at risk of disturbance is higher with an estimated 9.2% of the regional bottlenose dolphin population predicted to be disturbed when considering both activities; with the overwhelming majority affected by the pile-driving at the Moray East Wind Farm rather than the NNG UXO clearance. The Moray East Wind Farm is located over 200 km from the planned UXO clearance for the Project and therefore there will be no overlapping noise. Based on their wide-ranging distributions, displaced bottlenose dolphin will be able

to relocate elsewhere for the duration of the UXO clearance. UXO clearance is predicted to take up to five months during which time up to 50 detonations may be undertaken. Consequently, the noise from the UXO clearance will be intermittent with no noise impacts over the majority of this period. The impacts will be temporary with bottlenose dolphin predicted to return to the area shortly after the activities have ceased.

Table 5-8: Estimated cumulative impacts arising from pile-driving at Moray East offshore wind farm and UXO clearance at NnG.

SPECIES	MORAY EAST OWF CONSTRUCTION	NNGOWL UXO	CUMULATIVE TOTAL	PROPORTION OF MANAGEMENT UNIT
Bottlenose dolphin - PTS	1	1	2	1.0
Bottlenose dolphin - TTS	17	1	18	9.23

199. There is potential for in-combination disturbance impacts. However, the impacts are spatially separate and any displaced bottlenose dolphin will be able to relocate to areas where there are no impacts. The duration of the in-combination impacts are temporary and any displaced bottlenose dolphin are predicted to return to the area once activities have ceased. Consequently, it is concluded that although there may be disturbance to bottlenose dolphin during the period of UXO clearance and pile-driving at the Moray East Offshore Wind Farm, the impacts will be temporary and will not adversely affect the integrity of the Moray Firth SAC, in light of its qualifying interest, condition and the site's conservation objectives.

200. It is recognised that both the pile-driving being undertaken in the Moray Firth and the planned UXO clearance for the Project will also potentially impact on both grey and harbour seals. However, the seals affected by the Moray East Offshore Wind Farm are those from the Moray Firth Management Area as opposed to those from East Scotland Management Area affected by the Project. Although, there is potential for seals from both Management Areas to occur, those from the Moray Firth Management Area are not predicted to be strongly associated with the relevant SACs subject to this assessment. The potential impacts on seals from the Aberdeen Harbour Expansion Project and the use of USBL equipment within the Wind Farm Area may cause localised disturbance to seals. However, the effects from disturbance, should it occur, will be temporary with any changes in behaviour returning to normal shortly after the noise causing the disturbance ceases.

201. Consequently, it is concluded that there will not be an in-combination adverse effect on the Firth of Tay and Eden Estuary SAC with respect to harbour seals nor on the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC with respect to grey seals.

5.7 Mitigation

202. Mitigation is proposed for marine mammals to reduce the risk of any marine mammals being present in an area within which traumatic injury or permanent threshold shift are predicted to occur and therefore reduces the risk of any impacts that could affect the integrity of the sites. Details of the proposed mitigation that will be used throughout the UXO clearance campaign are presented in the MMMP. A brief summary of the proposed mitigation is presented below.

203. The proposed mitigation is:

- Leave *in situ* or avoid the UXO,
- Remove or relocate UXO, including relocating smaller items of UXO into a cluster for a single detonation,
- The use of MMOs and PAM,
- The use of a Lofitech ADD,
- The use of a 'soft start' using a series of smaller charges increasing in weight over a period of time.

204. In the event that UXO is required to be detonated the proposed mitigation is predicted to be effective at ensuring that there is minimal risk of any marine mammal occurring in the area at which permanent auditory injury is predicted to occur for any UXO. This is on the basis that:

- The use of MMOs and PAM will ensure that no marine mammals are at risk of traumatic injury.
- The use of ADD will ensure that there is a very low risk of any marine mammals being within the range at which the onset of PTS will occur for charge sizes of 50 kg or less.
- The use of a 'soft start' prior to any detonations of UXO with a charge weight of greater than 50 kg will further reduce the risk of any marine mammals being within the range at which the onset of PTS will occur for all charge sizes up to 1,000 kg.
- In the event that UXO with a significant charge weight of greater than 750 kg is required to be detonated the appropriate soft-start procedures will be discussed with MSS and SNH prior to clearance.

5.8 Conclusion

205. The purpose of Section 5 of this document is to determine if the proposed UXO clearance works constitute an LSE on the relevant designated sites, and subsequently where the proposed works have the potential to lead to an LSE, provide information on the potential for AEOI on the relevant designated site.

206. The proposed UXO clearance works either fall with, or are in close proximity to the following relevant designated sites, which are identified as follows:

- Forth Islands SPA,
- St Abb's Head to Fast Castle SPA,
- Outer Firth of Forth and St Andrews Bay Complex pSPA,
- Moray Firth SAC,
- Firth of Tay and Eden Estuary SAC,
- Isle of May SAC,
- Berwickshire and North Northumberland coast SAC.

207. The assessment undertaken in this section has established that given the nature of the effects predicted (both in magnitude and duration), the scale of the features present and the existing activity levels taking place in the area, there is either no potential for LSE on these features, or for those sites where LSE has been identified, the information to support stage 2 assessment has concluded that the proposed activities will not have an adverse effect upon the integrity of any of the sites considered.

6 Conclusion

208. This Supporting Environmental Information report has been prepared in advance of proposed UXO clearance works associated with the Wind Farm Area and the Offshore Export Cable Corridor. This document is intended to provide the regulatory authorities (and their statutory advisers, where relevant) with the necessary supporting information to inform the Marine Licensing process for the proposed works.

209. This report has provided a consideration of the potential environmental effects resulting from proposed UXO clearance works. The UXO clearance works will commence in November 2019 and are expected to be completed by May 2020.

210. Receptors that may be affected by the UXO clearance works have been identified and assessed. No significant effects (alone or cumulatively) are predicted to occur given the small scale and temporary duration of the works, and when considering the mitigation proposed and that already in place for the Project.

211. The LSE assessment, and where necessary consideration of potential adverse effects on integrity, presented within this document has been established through a review of the following:

- The nature of the effects predicted (both in magnitude and duration);
- The scale of the features present; and
- The existing activity levels taking place in the area.

212. No LSE is concluded for the SPA sites considered. For the SAC sites with marine mammal features, LSE is identified but when considering the mitigation proposed it has been concluded that there will be no adverse effects on site integrity.

213. Mitigation measures are proposed for a number of receptors, namely marine mammal, commercial fisheries and archaeology.

214. The following mitigation will be adopted to in relation to the UXO clearance works:

- Advanced warning of activities through the promulgation of Notice to Mariners, advertisement on Kingfisher charts and VHF radio transmissions;
- Vessels will be lit appropriately (i.e., they will display lights and signals in accordance with the UK Standard Marking Schedule for Offshore Installations, and in accordance with the requirements of the International Regulations for the Prevention of Collisions at Sea);
- Compliance with agreed archaeological AEZs and adherence to the WSI at all times during the seabed preparation works;
- The use of a FLO to communicate with local commercial fisheries interests;
- Leave *in situ* or avoid the UXO;
- Remove or relocate UXO, including relocating smaller items of UXO into a cluster for a single detonation;
- The use of MMOs and PAM;
- The use of a Lofitech ADD; and
- The use of a 'soft start' using a series of smaller charges increasing in weight over a period of time.

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Appendix A Summary of Noise Modelling for UXO Clearance

215. The results from the noise modelling relevant to this Marine Licence application are presented in Table A- 1 to Table A- 3.

Table A- 1: Predicted distances from UXO detonations where the adopted potential mortality threshold for marine mammals is exceeded (220 dB re. 1 µPa).

Species	Explosive weight (kg)	Distance to potential mortality threshold (m)
All Marine Mammals	10	80
	25	100
	50	130
	100	160
	250	210
	500	270
	1,000	340

Predicted distances have been rounded up to the nearest 10 m.

Table A- 2: Predicted distances from UXO detonations where marine mammal zero-to-peak SPL thresholds for PTS and TTS onset are exceeded

Species	Explosive weight (kg)	Distance to PTS threshold (km) [1]	Distance to TTS threshold (km) [1]
Harbour porpoise	10	3.4	6.3
	25	4.7	8.6
	50	5.9	10.8
	100	7.4	13.6
	250	10.1	18.5
	500	12.7	23.3
	1,000	16.0	29.4

Species	Explosive weight (kg)	Distance to PTS threshold (km) [1]	Distance to TTS threshold (km) [1]
Bottlenose dolphin and white-beaked dolphin	10	0.2	0.4
	25	0.3	0.5
	50	0.3	0.6
	100	0.4	0.8
	250	0.6	1.1
	500	0.7	1.3
	1,000	0.9	1.7
Minke whale	10	0.6	1.1
	25	0.8	1.5
	50	1.0	1.9
	100	1.3	2.4
	250	1.8	3.3
	500	2.2	4.1
	1,000	2.8	5.2
Grey seal Harbour seal	10	0.7	1.2
	25	0.9	1.7
	50	1.2	2.1
	100	1.4	2.7
	250	2.0	3.6
	500	2.5	4.6
	1,000	3.1	5.8

[1] Predicted distances have been rounded up to the nearest 0.1 km.

Table A- 3: Predicted distances from UXO detonations where marine mammal weighted SEL thresholds for PTS and TTS onset are exceeded

Species	Explosive weight (kg)	Distance to PTS threshold (km) 1	Distance to TTS threshold (km) 1
Harbour porpoise	10	1.8	7.4
	25	2.1	8.4
	50	2.3	9.2
	100	2.6	10.1
	250	3.0	11.4
	500	3.3	12.4
	1,000	3.7	13.5
Bottlenose dolphin and white-beaked dolphin	10	0.1	0.5
	25	0.1	0.6
	50	0.1	0.7
	100	0.1	0.7
	250	0.2	0.9
	500	0.2	1.0
	1,000	0.2	1.1
Minke whale	10	0.9	8.5
	25	1.1	11.0
	50	1.4	13.2
	100	1.7	15.8
	250	2.2	19.7
	500	2.6	23.2
	1,000	3.1	27.0

Species	Explosive weight (kg)	Distance to PTS threshold (km) [1]	Distance to TTS threshold (km) [1]
Grey seal Harbour seal	10	0.2	1.8
	25	0.3	2.3
	50	0.3	2.6
	100	0.4	3.1
	250	0.5	3.8
	500	0.6	4.4
	1,000	0.7	5.0

[1] Predicted distances have been rounded up to the nearest 0.1 km.

Appendix B - Genesis Underwater Noise Modelling Report

TECHNICAL NOTE

Neart na Gaoithe Offshore Wind Farm UXO Noise Modelling

Prepared for: **Neart na Gaoithe Offshore Wind Limited**

Prepared by: **Genesis**
Pavilion 3, Aspect 32, Prospect Road, Arnhall Business Park, Westhill, AB32 6FE, UK
Tel: +44 (0)1224 615100
Fax: +44 (0)1224 615111
www.genesisoilandgas.com

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B1	13/06/2019	Issued for client comment	AMi	MLa	MLa	

deeper understanding

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ACRONYMS AND UNITS

Acronyms

HF	High Frequency
LF	Low Frequency
MF	Mid Frequency
NMFS	National Marine Fisheries Service
NnG	Neart na Gaoithe
NnGOWL	Neart na Gaoithe Offshore Wind Limited
NOAA	National Oceanic and Atmospheric Administration
PTS	Permanent Threshold Shift
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SSE	Scottish and Southern Energy
TNT	Trinitrotoluene
TTS	Temporary Threshold Shift
UK	United Kingdom
UXO	Unexploded ordnance

Units

dB	decibel
dB re 1 µPa	decibels relative to one micropascal (unit of zero-to-peak sound pressure level, peak-to-peak sound pressure level, and root-mean-square sound pressure level)
dB re 1 µPa^{2}s	decibels relative to one micropascal square second (unit of sound exposure level)
dB re 1 µPa^{2}s/Hz	decibels relative to one micropascal square second per Hertz (unit of sound exposure level spectral density)
Hz	Hertz (unit of frequency)
kg	kilograms (unit of mass)
kHz	kilohertz (unit of frequency)
km	kilometre (unit of distance)
km^2	square kilometre (unit of area)
m	metre (unit of distance)
Pa	Pascals (unit of pressure)
Pa^{2}s	Pascal square seconds (unit of sound exposure)
Pa^{2}s/Hz	Pascal square seconds per Hertz (unit of sound exposure spectral density)
s	seconds (unit of time)
µPa	micropascal (unit of pressure)
µPa^{2}s	micropascal square second (unit of sound exposure)

1.0 INTRODUCTION

This document has been prepared by Genesis Oil and Gas Consultant Limited (hereafter referred to as Genesis) and presents underwater noise modelling results for unexploded ordnance (UXO) removal operations that could potentially be required at the Neart na Gaoithe Wind Farm.

1.1 Project Background

The Neart na Gaoithe Offshore Wind Farm project is being developed by Neart na Gaoithe Offshore Wind Limited (NnGOWL), a wholly owned subsidiary of Mainstream Renewable Power (hereafter, Mainstream). NnGOWL is promoting the Neart na Gaoithe project as part of the Forth and Tay Offshore Wind Energy Developers Group.

The Neart na Gaoithe wind farm development is located approximately 15.5 km from Fife Ness and 16 km from the Isle of May (see Figure 1-1). The development site lies in the outer Firth of Forth in water depths of approximately 50 m and covers an area of approximately 105 km^2. The wind farm will comprise up to 54 turbines and will have a maximum permissible site capacity of 450 MW. In addition to Neart na Gaoithe, a number of other wind farm projects are being developed in the Forth and Tay area; Inch Cape and the Seagreen project. The Inch Cape Offshore Wind Farm is being developed by Inch Cape Offshore Limited, which is owned by Red Rock Power. The Seagreen project comprises the Seagreen Phase 1, incorporating the Alpha and Bravo offshore wind farms, and is a joint venture between SSE Renewables Developments (UK) Limited and Flour Limited.

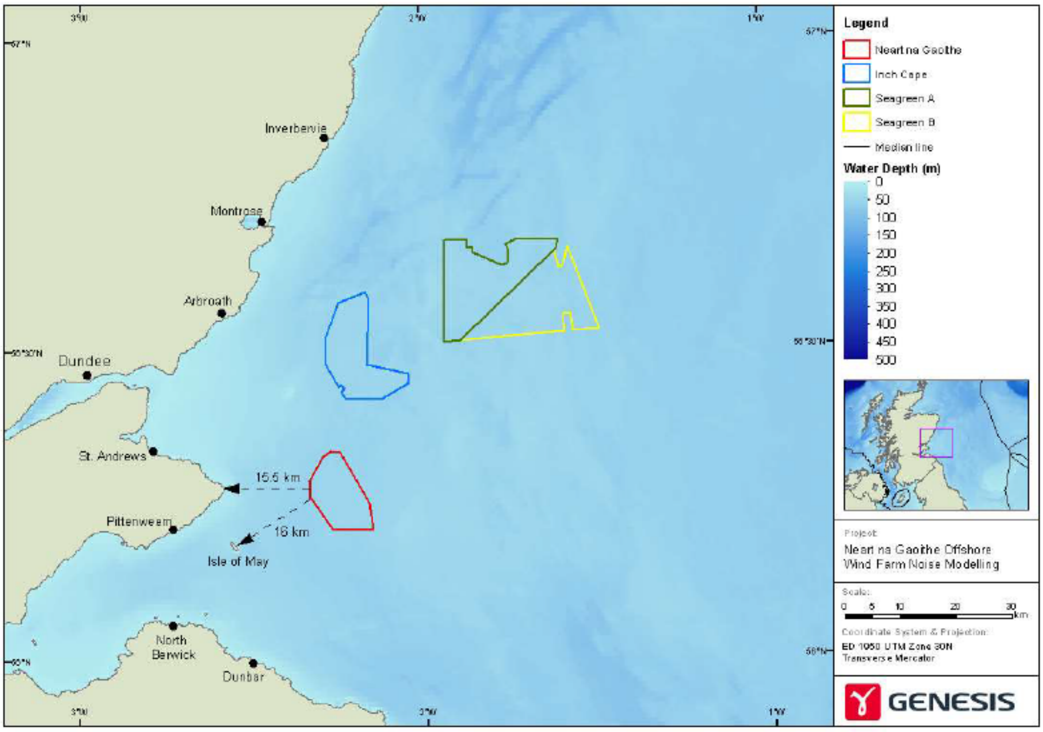

Figure 1-1: Neart na Gaoithe Offshore Wind Farm location.

1.2 Assessment Overview

This Technical Note presents noise modelling results obtained for UXO detonations that could potentially be carried out at the Neart na Gaoithe wind farm. Since it is currently unknown if there is UXO in the area, the noise modelling has been conducted considering a wide range of explosive weights in order to present a range of results that should cover the worst-case detonations that may take place at Neart na Gaoithe. Specifically, the noise modelling has been conducted for explosive weights ranging from 10 kg to 1,000 kg.

The modelling has been conducted to estimate the zero-to-peak Sound Pressure Level (SPL) and Sound Exposure Level (SEL) with distance from the explosive. Semi-empirical formulas that have been established based on measurements of sound from underwater explosives have been used to predict the zero-to-peak SPL and SEL with distance. These formulas are relatively simplistic and do not account for site-specific propagation effects resulting from, for example, varying bathymetry, water column profiles and seabed sediments in the area. The formulas that have been used in this assessment to predict sound levels from UXO detonations at Neart na Gaoithe account for the weight of explosive material in terms of trinitrotoluene (TNT) equivalent weight and have been derived based on measurements from explosives detonated in the water column. Sound from an explosive detonated in the water column is likely to propagate further than that from a similar explosive detonated on the seabed since the seabed will absorb some of the sound energy. Therefore, the formulas that have been used are likely to be conservative and will likely over-estimate sound levels (particularly at large distances).

The modelling results have been compared to the Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) thresholds established by the National Oceanographic and Atmospheric Administration (NOAA) for estimating potential distances where PTS and TTS may occur to marine mammals. A mortality threshold has been used to indicate distances where marine mammal mortality may occur. The sound propagation modelling results have also been compared to the Popper underwater explosion thresholds for estimating distances where potential mortality to fish species may occur.

2.0 SOUND PROPAGATION MODELLING METHODOLOGY

This section discusses the underwater sound propagation methodology that has been used to estimate received sound levels from potential UXO detonations at Neart na Gaoithe.

2.1 UXO Modelling Scenarios

It is currently unknown if there are any UXO in the Neart na Gaoithe development area and therefore it is not possible to estimate any explosive weights that may need to be detonated. However, a review of UXO risk to the Neart na Gaoithe wind farm site (NnG, 2019) concluded that the following types of UXO could potentially be present in the development area or in the vicinity of the development area:

- Projectiles;
- Aerial delivered bombs;
- Sea mines;
- Depth charges;
- Torpedoes; and
- Dumped munitions.

Since there has been no confirmed UXO in the development area, the modelling has been conducted for a broad range of explosive weights, ranging from 10 kg to 1,000 kg.

2.2 Underwater Explosions

The pressure levels generated from underwater explosions, particularly open water explosions such as UXO detonations, can be significantly higher than any other underwater sound sources. The pressure wave from an open water explosive event can travel very large distances (thousands of kilometres) before attenuating to ambient levels. As an example of this, Prior *et al.* (2010) reported that the accidental explosion of a power supply for seabed moored oceanographic equipment was detected approximately 8,000 km from where the explosion occurred. Prior *et al.* (2011) also reported that underwater explosions of less than 40 kg equivalent TNT weight were detected by hydrophones at distances of up to 16,000 km from the explosions.

When an explosive is detonated underwater, the initial mass of explosive material rapidly expands to produce a large volume of gas at high temperatures and pressures. Initially the gas sphere has a much greater pressure than the surrounding ambient hydrostatic pressure in the water, which is partially alleviated by the creation of a shockwave, and then fully alleviated by the outward flow of water (Cole, 1948). The pressure wave that is generated from underwater explosions does not propagate in the same manner as acoustic waves. As such, well established acoustic propagation models such as those based on e.g. ray tracing theory (Porter and Liu, 1994) and parabolic equation methods (Collins, 1993) cannot be easily applied in estimating sound levels at distance from underwater explosions. Received sound levels from underwater explosions are therefore generally estimated using semi-empirical equations established from measurements.

There is a considerable amount of literature on the characteristics of underwater explosions in open water (see e.g. Richardson *et al*., 1995; Barrett, 1996; Urick, 1983; Nedwell & Edwards, 2004; Chapman, 1985, 1988; Gaspin *et al*., 1979; Cole, 1948; Slifko, 1967; Swisdack, 1978; Soloway and Dahl, 2014). The pressure wave of an underwater explosive detonation in open water is composed of a primary shock wave followed by a series of bubble pulses (see Figure 2-1). The shock pulse has an almost instantaneous rise time and exponential decay. The high pressure associated with the shock pulse results from the rapid conversion of solid explosive material to gaseous form. The gas bubble that forms expands and contracts in an oscillatory fashion, which generates a series of bubble pulses with diminishing amplitudes but increasing durations as shown in Figure 2-1.

Numerous authors have reported measurements that describe different characteristics of the pressure wave that results from underwater explosions (including Chapman, 1985, 1988; Cole, 1948; Slifko, 1967; Swisdack, 1978; Soloway and Dahl, 2014). For assessing potential impacts to marine mammals and fish, the zero-to-peak SPL and SEL of the shock wave are important metrics since impact thresholds are expressed in terms of these quantities (see Section 3.0).

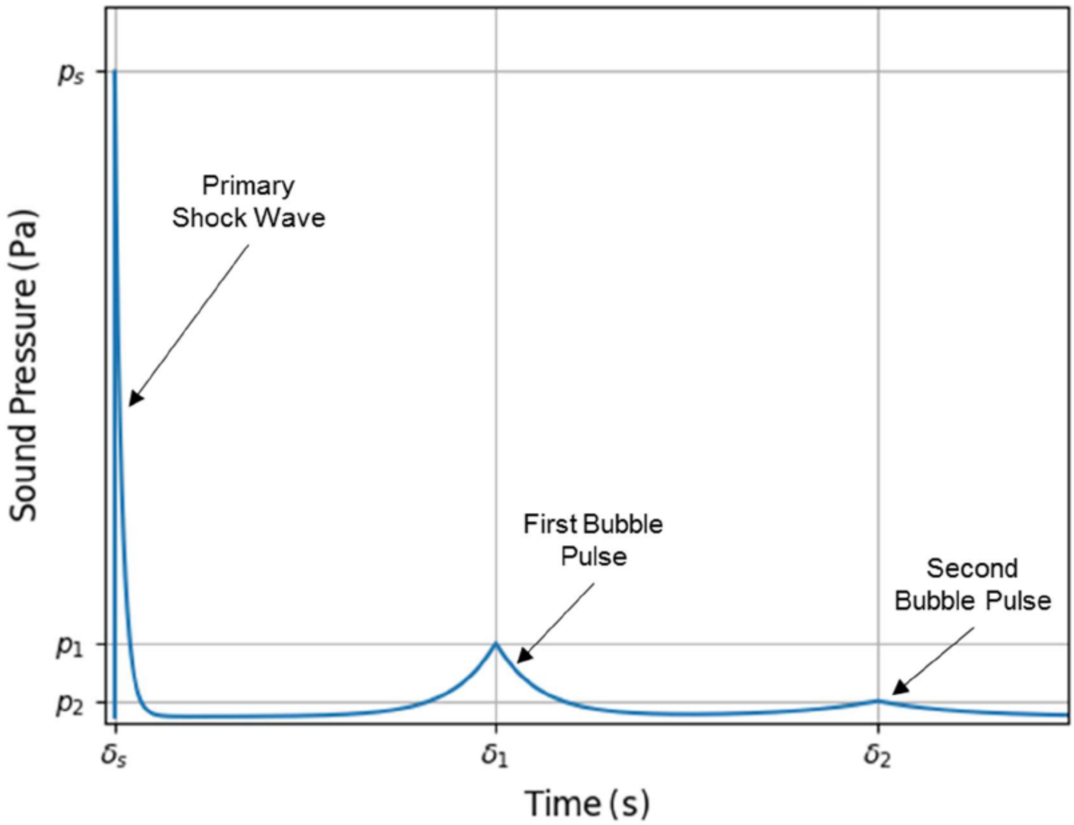

Figure 2-1: Idealised pressure waveform from an open water explosion.

2.3 Estimation of Zero-to-Peak SPL

Similitude equations for the zero-to-peak sound pressure have been developed for explosives in open water based on the principle of similarity (Cole, 1948; Slifko, 1967; Swisdack, 1978). Despite not being physical laws, similitude equations have been demonstrated to accurately describe pressure wave characteristics from underwater explosions through experimental validation. However, it should be noted that such similitude equations have generally been derived based on measurements over short ranges (typically less than 1 km), and for limited explosive weights. The extrapolation of results to longer ranges and larger explosive weights should therefore be treated with a degree of caution.

The similitude equation that has been used in this assessment for describing the zero-to-peak pressure shock waves from UXO detonations is given by (Cole, 1948; Slifko, 1967; Swisdack, 1978; Soloway and Dahl, 2014)

$$p_s = 52.4e6\left(\frac{w^{1/3}}{r}\right)^{1.13} , \quad (1)$$

where p_s is the shock wave zero-to-peak pressure in Pascals (Pa), w is the weight of explosive material in kilograms (kg) and r is the distance from the explosive in meters (m). With the zero-to-peak sound pressure given in (1), the corresponding zero-to-peak SPL is

$$L_{pk} = 20\log_{10}\left(\frac{p_s}{p_0}\right) , \quad (2)$$

where L_{pk} is the zero-to-peak SPL in units of dB re 1 μPa and p_0 is a reference sound pressure of 1 μPa. For a given explosive weight, equations (1) and (2) can be used to calculate the zero-to-peak SPL with range/distance from the explosive.

2.4 Estimation of SEL

The SEL from underwater explosives has been measured by Soloway and Dahl, (2014), who made measurements from explosives at measurement ranges of 165 m, 430 m and 950 m. The explosive weights that were used during these measurements ranged from 0.07 kg to 4.5 kg (with equivalent TNT weights ranging from 0.1 kg to 6 kg). Soloway and Dahl derived the following equation for estimating the SEL from underwater explosives

$$SEL = 219 + 6.14\log\left(w^{1/3}\left(\frac{w^{1/3}}{r}\right)^{2.12}\right) , \quad (3)$$

where SEL is the broadband SEL measured in units of decibels relative to one micro-Pascal square second (dB re 1μPa^{2}s), w is the explosive weight in kilograms, and r is the measurement distance in metres. This equation can be used to estimate the broadband SEL from an underwater detonation. The broadband SEL of a signal can be equivalently obtained in either the time domain or the frequency domain (Ambardar, 1999). It is convenient to calculate the SEL in the frequency domain since this more easily allows the application of the NOAA auditory weighting functions (see Figure 3-1). Calculation of the SEL in the frequency domain requires the frequency spectrum of the explosive signal to be known. Whilst some works have presented measured frequency spectra of open water explosions (e.g. frequency spectra are shown in Soloway and Dahl, (2014)), they are typically only presented graphically, and the actual data is unavailable. In the absence of a useable measured frequency spectrum, a theoretical spectrum for explosives has been used in this assessment. The theoretical frequency spectrum derived in Weston, (1960) is used, which is derived based on the assumption that the shock pulse can be adequately described by a right-sided decaying exponential function, whilst the bubble pulses can be described by two-sided decaying exponential functions. The theoretical spectrum is given by (Weston, 1960)

$$E(f) = \frac{2p_s^2\tau_s^2}{1+4\pi^2 f^2\tau_s^2} + 8\sum_{i=1}^{N}\left(\frac{p_i^2\tau_i^2}{1+4\pi^2 f^2\tau_i^2}\right)^2, \quad (4)$$

where $E(f)$ is the one-sided energy spectral density (or sound exposure spectral density) in units of Pascal squared seconds per Hertz (Pa^{2}s/Hz), f is frequency in Hertz (Hz), p_s and p_i are the peak pressures of the shock wave and bubble pulses, respectively, τ_s and τ_i are the rise/decay time constants of the shock pulse and bubble pulses, respectively, and N is the number of bubble pulses. The shock wave peak pressure is given by equation (1) and the bubble pulse peak pressures can be calculated according to the expressions given in Chapman, (1985). The rise/decay time constants are computed as discussed in Weston, (1960) and are related to the shock wave and bubble pulse impulses. These impulses are computed according to expressions derived by Chapman, (1985). It is noted that the expression in equation (4) differs to that presented in Weston, (1960) by a factor of ρc (see equations (5) and (9) in Weston, (1960)). This is because the energy spectrum in Weston, (1960) is formulated as an energy flux spectral density, whereas here it is more convenient to express it as a sound exposure spectral density.

The energy spectral density in (4) can alternatively be expressed as an unweighted SEL spectral density in units of decibels relative to one micro-Pascal square second per Hertz (dB re 1 μPa^{2}s/Hz). The unweighted SEL spectral density is given by

$$SEL_u(f) = 10\log\left[\frac{1}{e_0}\left(\frac{2p_s^2\tau_s^2}{1+4\pi^2 f^2\tau_s^2} + 8\sum_{i=1}^{N}\left(\frac{p_i^2\tau_i^2}{1+4\pi^2 f^2\tau_i^2}\right)^2\right)\right]. \quad (5)$$

where $SEL_u(f)$ is the unweighted SEL at frequency f and e_0 is the reference sound exposure of 1 μPa^{2}s.

The broadband unweighted SEL can easily be obtained from equation (4) by integrating over all frequencies and expressing the result in dB re 1 μPa^{2}s. Thus, the unweighted broadband unweighted SEL can be obtained as

$$SEL_u = 10\log\left[\frac{1}{e_0}\left(\int_{f_1}^{f_2}\frac{2p_s^2\tau_s^2}{1+4\pi^2 f^2\tau_s^2}df + 8\sum_{i=1}^{N}\int_{f_1}^{f_2}\left(\frac{p_i^2\tau_i^2}{1+4\pi^2 f^2\tau_i^2}\right)^2 df\right)\right]. \quad (6)$$

For estimating the SEL from UXO detonations at Neart na Gaoithe, the sound exposure energy spectral density in (4) has been scaled such that it matches the measurements made by Soloway and Dahl (2014). In other words, equations (4) and (5) determine the shape of the explosive energy spectrum, whilst the overall unweighted SEL level is determined by the measurements made by Soloway and Dahl (2014) i.e. such that broadband unweighted SEL in (6) matches that in (3). Figure 2-2 shows the resulting source level (computed at 1 m range) SEL spectral densities for the range of explosive weights considered in this assessment.

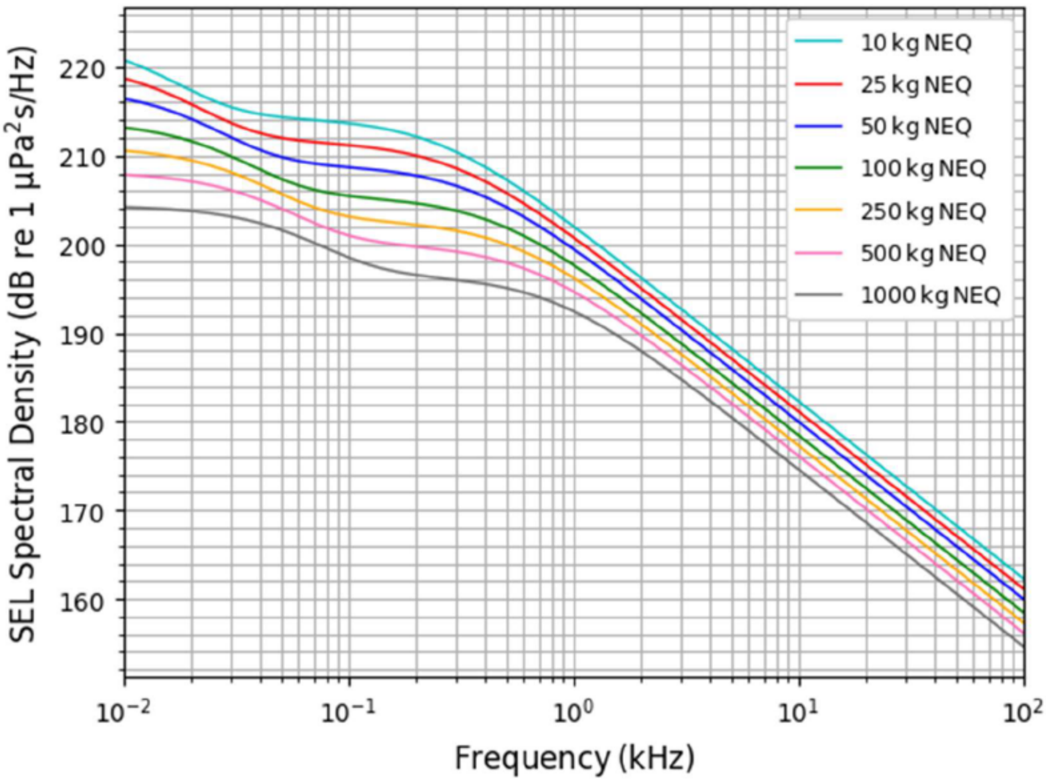

Figure 2-2: SEL source level spectral density for underwater explosives.

For estimating the unweighted SEL at further distances from the explosion, an additional frequency dependent attenuation term has been included in the calculations. This is important since the measurements made by Soloway and Dahl (2014) were limited to 1 km where frequency dependent attenuation (Jensen, 2011; Thorpe, 1967) would be negligible. However, at larger distances from the explosives such frequency dependent attenuation would begin to be significant (particularly for higher frequencies). Thus, an additional frequency dependent attenuation term has been included according the following equation (Thorpe, 1967)

$$\propto (f) = 3.3 \times 10^{-3} + 3.0 \times 10^{-4} f^2 + \frac{0.11 f^2}{1 + f^2} + \frac{44 f^2}{1 + f^2}\,, \qquad (7)$$

where $\alpha(f)$ is the frequency dependent attenuation rate in units of decibels per kilometre (dB/km) and f is frequency in kilohertz (kHz). Incorporation of this frequency dependent term, as well as any auditory weighting function, leads to the following expression for the weighted SEL spectral density

$$SEL_w(f) = \underbrace{10\log\left[\frac{1}{e_0}\left(\frac{p_s^2\tau_s^2}{1+4\pi^2f^2\tau_s^2} + 4\sum_{i=1}^{N}\left(\frac{p_i^2\tau_i^2}{1+4\pi^2f^2\tau_i^2}\right)^2\right)\right]}_{SEL_u(f)} - \propto(f) + W(f), \quad (8)$$

where $W(f)$ is the applied auditory weighting function e.g. the NOAA auditory weighting functions (see Figure 3-1). The corresponding broadband weighted SEL is then given by

$$SEL_w = \ 10\log\left[\int_{f_1}^{f_2} 10^{SEL_w(f)/10}\, df\right]. \quad (9)$$

In summary, for a given explosive weight and distance from the explosive, the following steps are used to calculate the weighted SEL:

- Calculate the sound exposure and SEL spectral densities in (4) and (5).
- Scale the spectral densities such that the broadband unweighted SEL given by equation (6) matches the broadband SEL predicted by equation (3).
- Select appropriate NOAA auditory weighting function $W(f)$.
- Calculate the weighted SEL spectral density with frequency dependent attenuation included using equation (8), where the frequency dependent attenuation is given by equation (7).
- Calculate the broadband weighted SEL using equation (9).

3.0 IMPACT ASSESSMENT CRITERIA

Noise from underwater explosives has the potential to adversely impact marine fauna (OSPAR, 2009; Richardson, *et al.*, 1995; Southall *et al.*, 2007; NMFS, 2016; Popper *et al.*, 2014). This section discusses the adopted impact assessment criteria used to predict potential impacts that noise generated from UXO removal operations at Neart na Gaoithe may have on marine mammals and fish.

3.1 Impact Thresholds for Marine Mammals

Numerous studies have established thresholds where underwater sound (or underwater pressure signals) could potentially cause mortality to marine mammals, or to cause lesser injuries such as a PTS i.e. a permanent change in hearing, or TTS i.e. a temporary/recoverable change in hearing.

3.1.1 Threshold for Potential Mortality

Underwater explosions can potentially cause physical injury or trauma that may result in mortality to marine mammals (Wright, 1971), although there are limited observations of marine mammal mortality that can be directly attributed to the use of underwater explosives. Mortality to marine mammals is most likely to occur at close distances to an underwater explosion with the risk of mortality diminishing with distance from the explosive event.

Parvin *et al.,* (2007) published a review of the impact of high level underwater sound on marine mammals and fish. The impact criteria proposed by Parvin *et al.,* (2007) were based on a review of numerous studies (including Yelverton *et al.,* 1973, 1975 and 1981; Bebb and Wright, 1953; Rawlins, 1974; Goertner, 1982; Richardson, 1995). The report concluded that there would be an increasing likelihood of mortality to marine mammals at incident zero-to-peak SPLs exceeding 240 dB re 1 μPa, and zero-to-peak SPLs exceeding 260 dB re 1 μPa would almost always be lethal. As a conservative measure, the lower zero-to-peak SPL threshold of 240 dB re 1 μPa has been adopted in this assessment to assess potential mortality to marine mammals from UXO detonations.

3.1.2 Thresholds for Potential PTS and TTS

A common approach for estimating the potential onset of PTS and TTS to marine mammals is by comparing received sound levels to thresholds proposed by the NOAA (NMFS, 2016). NOAA have proposed thresholds for marine mammals grouped marine mammals into different functional hearing groups. The functional hearing groups that have been considered in this assessment are:

- Low-frequency (LF) cetaceans;
- Mid-frequency (MF) cetaceans;
- High-frequency (HF) cetaceans; and
- Phocid pinnipeds (earless/true seals).

Table 3-1 shows various marine mammal species that have been observed in the North Sea (Hammond *et al.*, 2017) categorised according to these different functional hearing groups. NOAA also proposed another functional hearing group, Otariid pinnipeds (eared seals). However, no otariid pinnipeds are known to occur in the North Sea and this functional hearing group has therefore been omitted from this assessment.

Table 3-1: Marine mammals in the North Sea categorised according to the NOAA functional hearing groups.

Marine Mammal Hearing Group	Species
LF cetaceans	Minke whale, Fin whale
MF cetaceans	Bottlenose dolphin, White-beaked dolphin, White-sided dolphin, Risso's dolphin, Common dolphin, Striped dolphin, Pilot whale, Sperm whale, Orca
HF cetaceans	Harbour porpoise
Phocid Pinnipeds	Harbour seal, Grey seal

The thresholds proposed by NOAA that have been adopted in this assessment are summarised in Table 3-2. The NOAA criteria is dual metric with thresholds expressed in terms of both zero-to-peak SPL and cumulative SEL metrics. The onset of PTS or TTS is considered to have occurred when either one of these thresholds are exceeded (NMFS, 2016).

Table 3-2: NOAA thresholds for potential onset of PTS and TTS to marine mammals.

Marine Mammal Hearing Group	Sound Metric	PTS Threshold	TTS Threshold
LF cetaceans	Zero-to-peak SPL (dB re 1 µPa)	219	213
	Cumulative SEL (dB re 1 µPa^{2}s)	183	168
MF cetaceans	Zero-to-peak SPL (dB re 1 µPa)	230	224
	Cumulative SEL (dB re 1 µPa^{2}s)	185	170
HF cetaceans	Zero-to-peak SPL (dB re 1 µPa)	202	196
	Cumulative SEL (dB re 1 µPa^{2}s)	155	140
Phocid Pinnipeds	Zero-to-peak SPL (dB re 1 µPa)	218	212
	Cumulative SEL (dB re 1 µPa^{2}s)	185	170

The zero-to-peak SPL thresholds are used to assess the potential for PTS or TTS to occur in marine mammals due to instantaneous sound pressures and do not take into consideration the hearing sensitivity marine mammals. In contrast, the cumulative SEL metric accounts for hearing capability by weighting the received SEL using auditory weighting filters. The auditory weighting functions proposed by NOAA for the different marine mammal hearing groups are shown in Figure 3-1. The application of the auditory weighting functions is such that sound energy is reduced at frequencies that a marine mammal hearing group is less sensitive to i.e. do not hear as well.

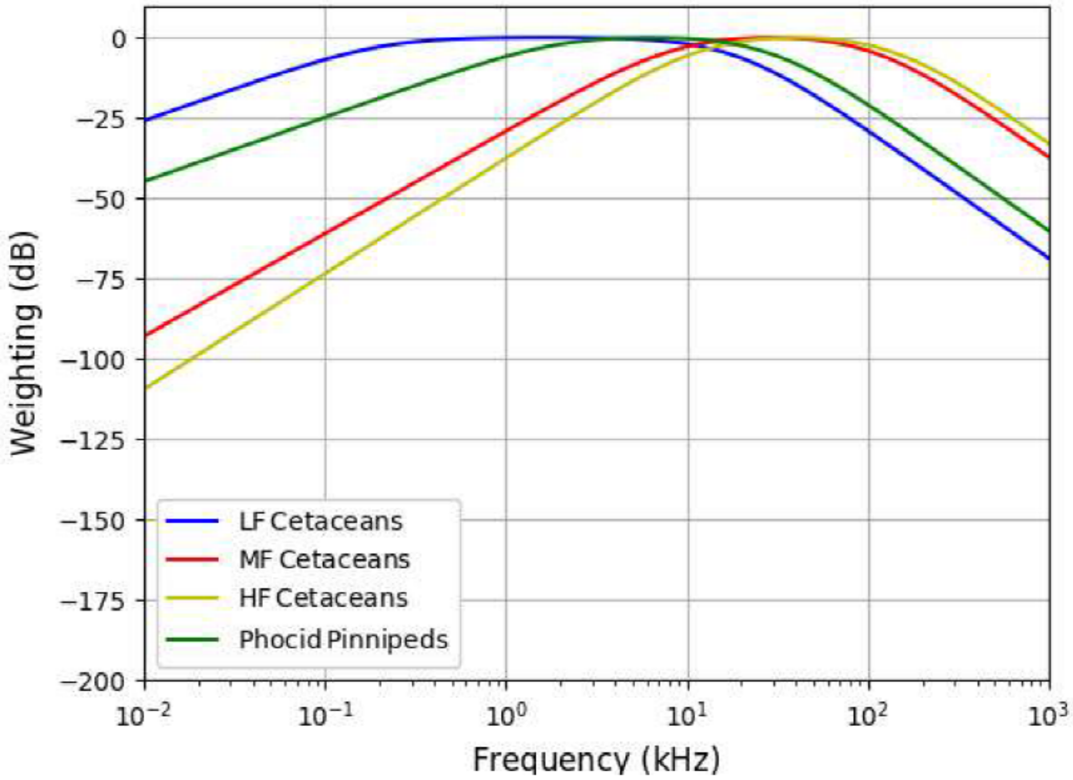

Figure 3-1: NOAA auditory weighting functions.

3.2 Impact Thresholds for Fish

Effects of underwater explosives on fish have been well documented (see reviews by Christian, 1973; Hill, 1978; Baxter *et al.* 1982; Lewis, 1996; and Keevin and Hempen, 1997; Popper *et al.*, 2014). Empirical studies indicate that at very close range, underwater explosions are lethal to most fish species regardless of size, shape, or internal anatomy. At greater distances from the explosive source, fish species with gas-filled swim bladders (which act as a pressure receiver) suffer higher mortality rates than those without swim bladders. Studies also suggest that larger fish are generally less susceptible to death or injury than small fish at the same distance from the explosive.

Popper *et al*. (2014) defined criteria for potential injury to fish based on a review of publications related to impacts to from various high-energy sources including underwater explosives. Different injury thresholds are derived in Popper *et al*. (2014) for the following categories:

- Fishes with no swim bladder or other gas chamber;
- Fishes with swim bladders in which hearing *does not* involve the swim bladder or other gas volume; and
- Fishes with swim bladders in which hearing *does* involve a swim bladder or other gas volume.

The thresholds proposed by Popper *et al*. (2014) for potential mortality to fish from underwater explosives are based on results presented by Hubbs and Rechnitzer (1952), who showed that zero-to-peak SPLs of 229 dB re 1 μPa to 234 dB re 1 μPa from underwater explosives consistently resulted in mortality to fish. As a conservative measure, only the lower threshold of 229 dB re 1 μPa has been adopted in this assessment for evaluating potential mortality to fish from UXO detonations at Neart na Gaoithe.

4.0 RESULTS

This section presents the sound propagation modelling results for a range of explosive weights and assesses any potential impacts to marine mammals and fish species using the impact thresholds presented in the previous section.

4.1 Assessment of Impacts to Marine Mammals

The zero-to-peak SPL from UXO detonations has been predicted using equations (1) and (2). Figure 4-1 shows the predicted zero-to-peak SPL for different explosive weights over a distance of 500 m with the adopted marine mammal potential mortality threshold highlighted. The predicted distances to the marine mammal potential mortality threshold for different explosive weights are summarised in Table 4-1.

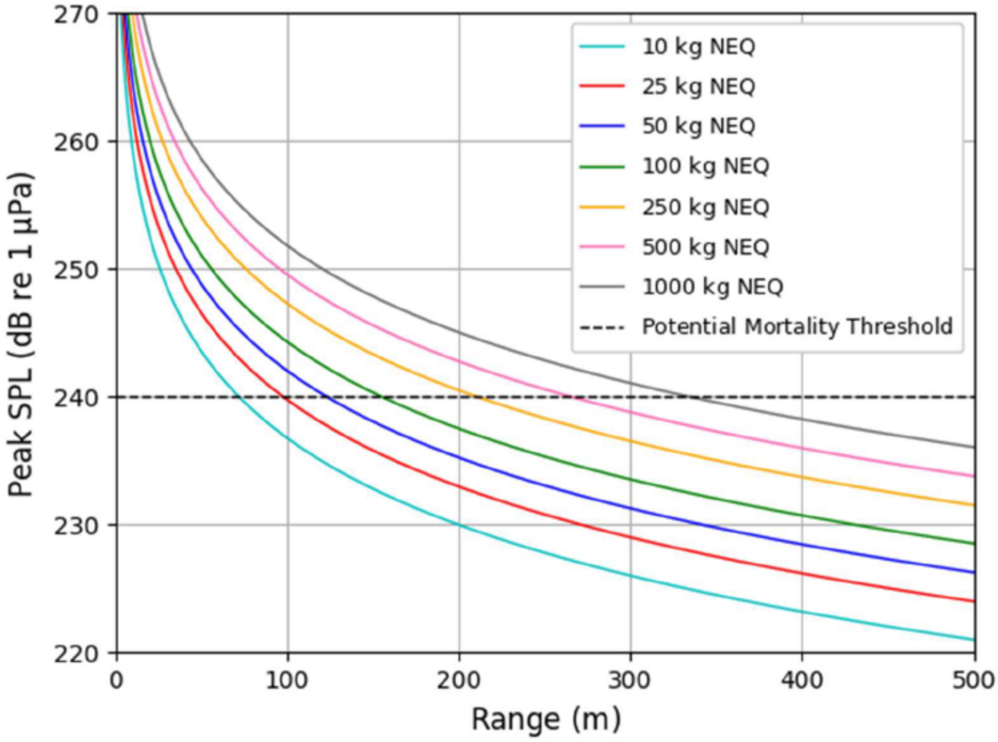

Figure 4-1: Predicted zero-to-peak SPL from UXO detonations with the adopted threshold for potential mortality to marine mammals highlighted.

Table 4-1: Predicted distances from UXO detonations where the adopted potential mortality threshold for marine mammals is exceeded.

Marine Mammal Hearing Group	Explosive Weight (kg)	Distance to Potential Mortality Threshold (m) [1]
All Marine Mammals	10	80
	25	100
	50	130
	100	160
	250	210
	500	270
	1,000	340

[1] Predicted distances have been rounded up to the nearest 10 m.

The predicted zero-to-peak SPL has also been compared to the NOAA thresholds to estimate distances at which marine mammals may experience the onset of PTS and TTS. Figure 4-2 shows the predicted zero-to-peak SPL for different explosive weights over a distance of 50 km with the NOAA PTS and TTS thresholds highlighted. The predicted distances where the NOAA zero-to-peak SPL thresholds are exceeded for PTS and TTS onset to marine mammals are summarised in Table 4-2.

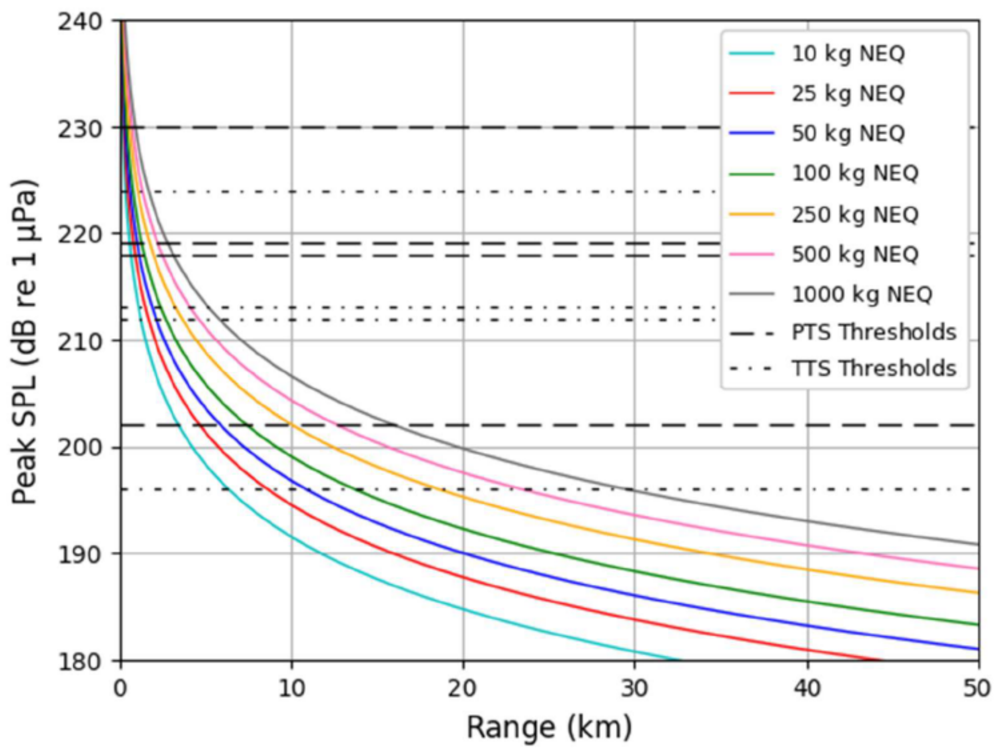

Figure 4-2: Predicted zero-to-peak SPL from UXO detonations with the NOAA marine mammal PTS and TTS thresholds highlighted.

Table 4-2: Predicted distances from UXO detonations where the NOAA marine mammal zero-to-peak SPL thresholds for PTS and TTS onset are exceeded.

Marine Mammal Hearing Group	Explosive Weight (kg)	Distance to PTS Threshold (km) [1]	Distance to TTS Threshold (km) [1]
LF cetaceans	10	0.6	1.1
	25	0.8	1.5
	50	1.0	1.9
	100	1.3	2.4
	250	1.8	3.3
	500	2.2	4.1
	1,000	2.8	5.2
MF cetaceans	10	0.2	0.4
	25	0.3	0.5
	50	0.3	0.6
	100	0.4	0.8
	250	0.6	1.1
	500	0.7	1.3
	1,000	0.9	1.7
HF cetaceans	10	3.4	6.3
	25	4.7	8.6
	50	5.9	10.8
	100	7.4	13.6
	250	10.1	18.5
	500	12.7	23.3
	1,000	16.0	29.4
Phocid Pinnipeds	10	0.7	1.2
	25	0.9	1.7
	50	1.2	2.1
	100	1.4	2.7
	250	2.0	3.6
	500	2.5	4.6
	1,000	3.1	5.8

[1] Predicted distances have been rounded up to the nearest 0.1 km.

The weighted SEL for underwater explosives of varying weights has been predicted using the methodology discussed in Section 2.4. The predicted weighted SEL for LF cetaceans, MF cetaceans, HF cetaceans and phocid pinnipeds are shown in Figure 4-3, Figure 4-4, Figure 4-5 and Figure 4-6, respectively. The predicted distances where the NOAA SEL thresholds for PTS and TTS onset to marine mammals are exceeded are summarised in Table 4-3.

The larger predicted distances to PTS and TTS threshold exceedance should be treated with a degree of caution. Whilst the distances have been predicted based on formulas derived from measurements of sound from underwater explosions, the measurements are typically limited to distances of only a few kilometres and are typically limited to smaller explosive weights (Cole, 1948; Slifko, 1967; Swisdack, 1978; Soloway and Dahl, 2014). There is inherent uncertainty in the use of these formulas for predicting sound levels at distances beyond a few kilometres and for estimating the sound levels for large charge sizes. Therefore, the predicted impacts within a few kilometres are considered to be more accurate than predicted impacts at larger distances (e.g. in the order of tens of kilometres), which are considered to be subject to uncertainty with the uncertainty increasing with distance.

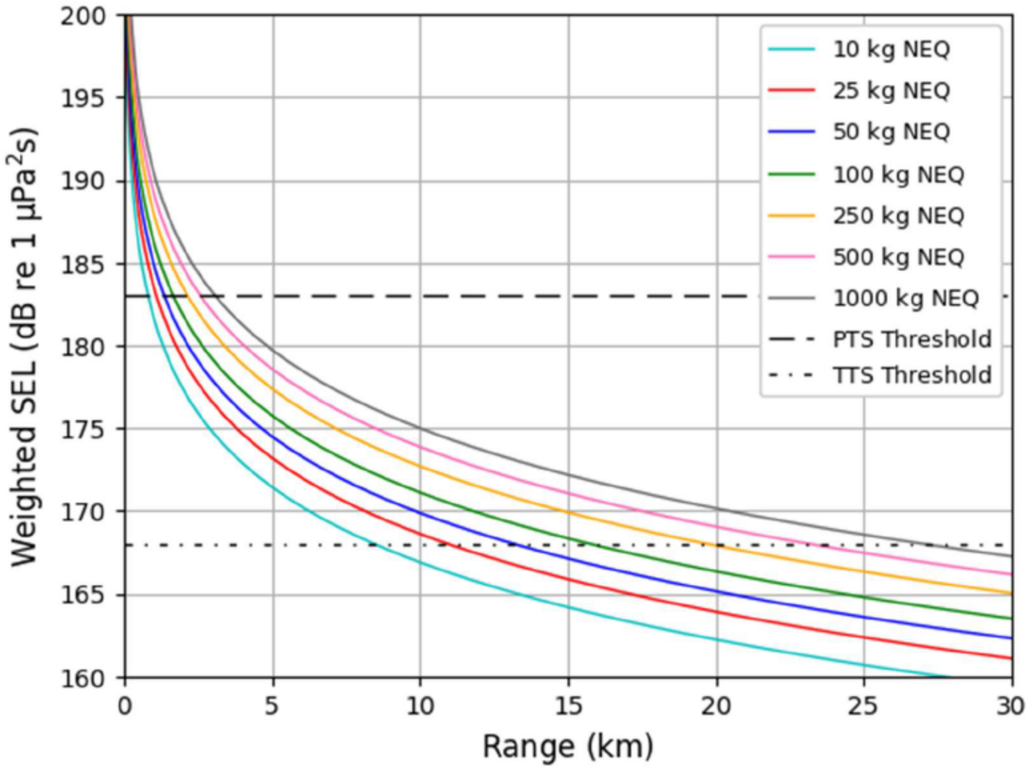

Figure 4-3: Predicted weighted SEL from UXO detonations for LF cetaceans.

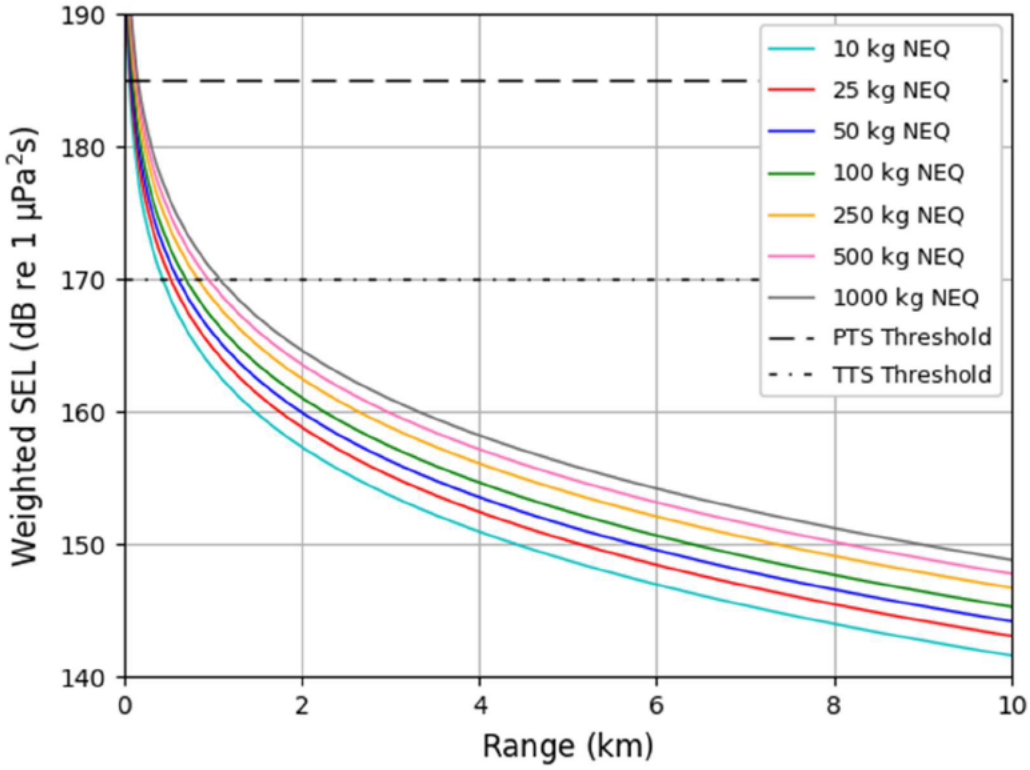

Figure 4-4: Predicted weighted SEL from UXO detonations for MF cetaceans.

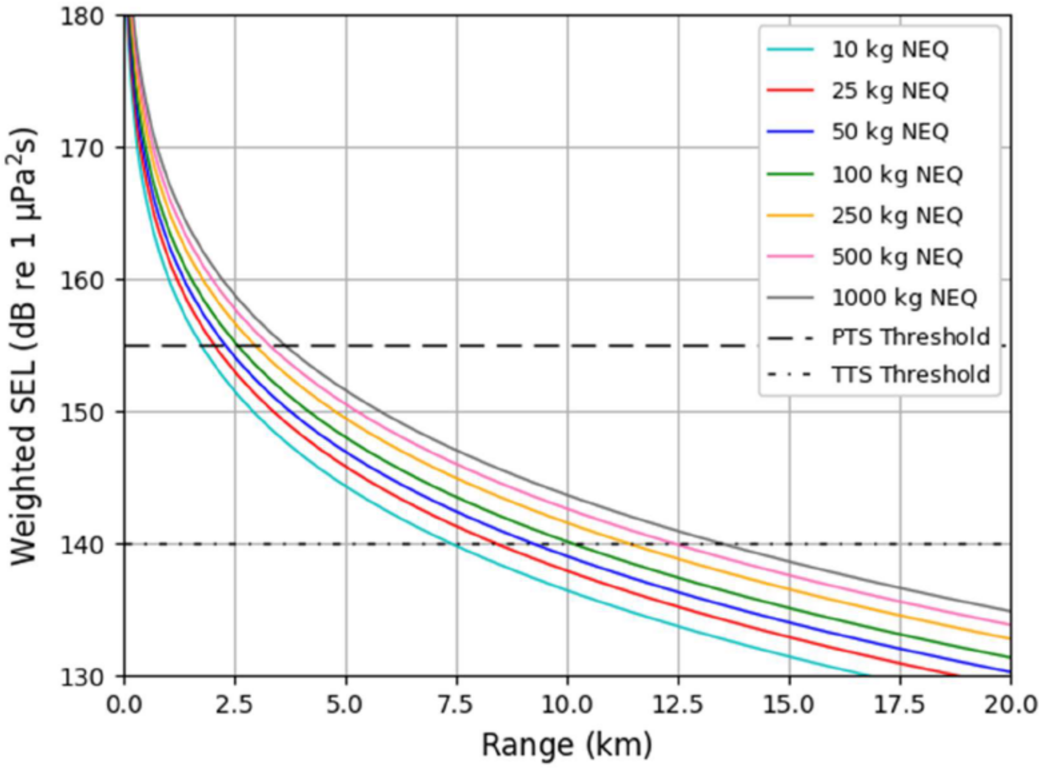

Figure 4-5: Predicted weighted SEL from UXO detonations for HF cetaceans.

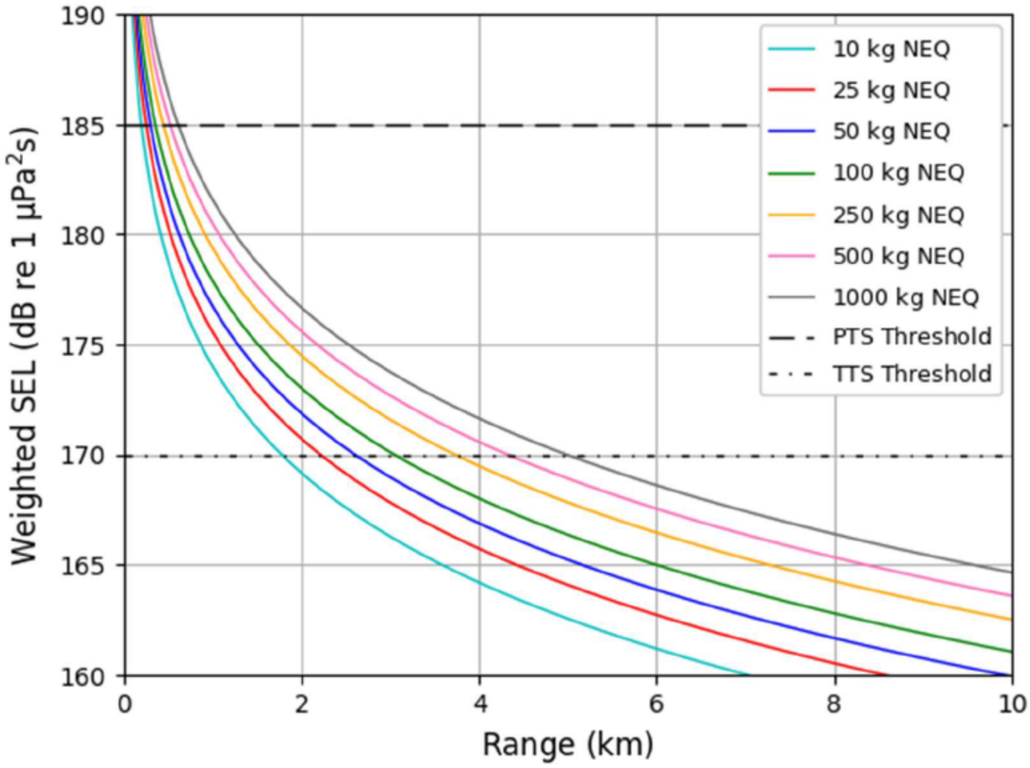

Figure 4-6: Predicted weighted SEL from UXO detonations for phocid pinnipeds.

Table 4-3: Predicted distances from UXO detonations where the NOAA marine mammal weighted SEL thresholds for PTS and TTS onset are exceeded.

Marine Mammal Hearing Group	Explosive Weight (kg)	Distance to PTS Threshold (km) [1]	Distance to TTS Threshold (km) [1]
LF cetaceans	10	0.9	8.5
	25	1.1	11.0
	50	1.4	13.2
	100	1.7	15.8
	250	2.2	19.7
	500	2.6	23.2
	1,000	3.1	27.0
MF cetaceans	10	0.1	0.5
	25	0.1	0.6
	50	0.1	0.7
	100	0.1	0.7
	250	0.2	0.9
	500	0.2	1.0
	1,000	0.2	1.1
HF cetaceans	10	1.8	7.4
	25	2.1	8.4
	50	2.3	9.2
	100	2.6	10.1
	250	3.0	11.4
	500	3.3	12.4
	1,000	3.7	13.5
Phocid Pinnipeds	10	0.2	1.8
	25	0.3	2.3
	50	0.3	2.6
	100	0.4	3.1
	250	0.5	3.8
	500	0.6	4.4
	1,000	0.7	5.0

[1] Predicted distances have been rounded up to the nearest 0.1 km.

4.2 Assessment of Impacts to Fish

The predicted zero-to-peak SPL has been compared to the Popper threshold for potential mortality to fish species. Figure 4-7 shows the predicted zero-to-peak SPL for different explosive weights with the adopted threshold for potential fish mortality highlighted. The predicted distances where the threshold for potential fish mortality are exceeded are summarised in Table 4-4.

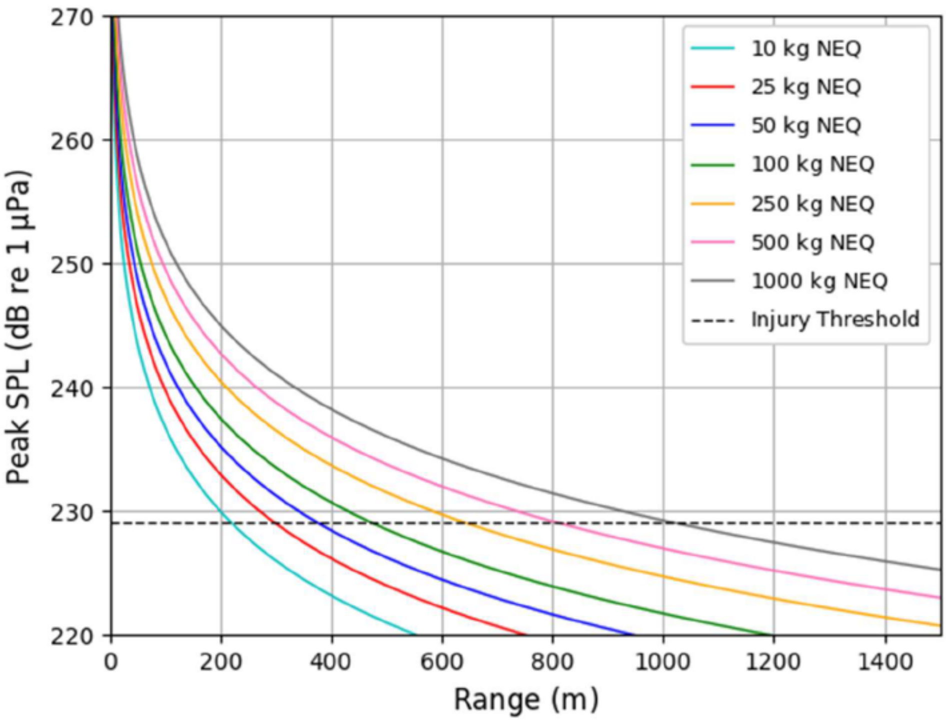

Figure 4-7: Predicted zero-to-peak SPL from UXO detonations with the threshold for potential mortality to fish highlighted.

Table 4-4: Predicted distances from UXO detonations where the threshold for potential mortality to fish is exceeded.

Fish Group	Explosive Weight (kg)	Distance to Potential Mortality Threshold (m) [1]
All Fish Species	10	220
	25	300
	50	380
	100	480
	250	650
	500	810
	1,000	1,020

[1] Predicted distances have been rounded up to the nearest 10 m.

5.0 DISCUSSION AND CONCLUSIONS

This report has presented noise modelling results for assessing the potential impacts that possible UXO detonations at the Neart na Gaoithe wind farm may have on marine mammals and fish. The sound modelling was conducted for explosive weights ranging from 10 kg to 1,000 kg to cover any potential UXO detonations that may be required at Neart na Gaoithe. The modelling predicted the zero-to-peak SPL and SEL from potential UXO detonation at Neart na Gaoithe using semi-empirical formulas derived from measurements of sound from underwater explosives (Cole, 1948; Slifko, 1967; Swisdack, 1978; Soloway and Dahl, 2014).

Potential impacts to marine mammals were predicted by comparing the estimate zero-to-peak SPL and SEL to the NOAA thresholds for potential PTS and TTS onset. The modelling predicted that PTS could potentially occur to LF cetaceans, MF cetaceans, HF cetaceans and phocid pinnipeds at maximum distances of 3.1 km, 0.9 km, 16.0 km and 3.1 km, respectively, for an explosive weight of 1,000 kg. TTS to LF cetaceans, MF cetaceans, HF cetaceans and phocid pinnipeds was predicted to occur at maximum distances of 27.0 km, 1.1 km, 13.5 km and 5.0 km, respectively, for an explosive weight of 1,000 kg.

The formulas utilised in this assessment for predicting sound levels from potential UXO detonations have been derived for underwater explosives in the water column. If UXO removal detonations are required at Neart na Gaoithe, the detonations will occur on the seabed. Detonations of underwater explosives on the seabed are likely to result in lower sound levels than equivalent detonations in the water column since the seabed sediment will absorb some of the sound energy. Therefore, the predicted sound levels presented in this report are likely to overestimate sound levels from potential UXO detonations at Neart na Gaoithe.

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Appendix C – Marine Mammal Mitigation Plan (MMMP)

Marine Mammal Mitigation Plan (MMMP)

1 Introduction

1. The purpose of the Marine Mammal Mitigation Plan (MMMP) is to ensure that no marine mammals are at risk of traumatic or permanent auditory injury, in the form of PTS, by the proposed UXO clearance to be undertaken by Neart na Gaoithe Offshore Wind Limited (NnGOWL). This MMMP has been prepared by Pelagica Environmental Consultancy Ltd (Pelagica).

2. The Plan supports the assessment undertaken for an EPS licence application and presents the measures that will be in place to ensure, as far as practicable, that no marine mammals are present within the area where either traumatic or permanent auditory injury could arise from the planned clearance of UXO. Mitigation measures presented within the MMMP also aim to reduce the duration of any disturbance.

3. NnGOWL plan to undertake UXO clearance between November 2019 and May 2020 within the area displayed in Figure 1-1.. It is estimated that up to 50 items of UXO may be required to be cleared, although the precise number is currently unknown. A UXO detection and target inspection survey will determine the precise number and type of UXO items present within the NnG Project Area.

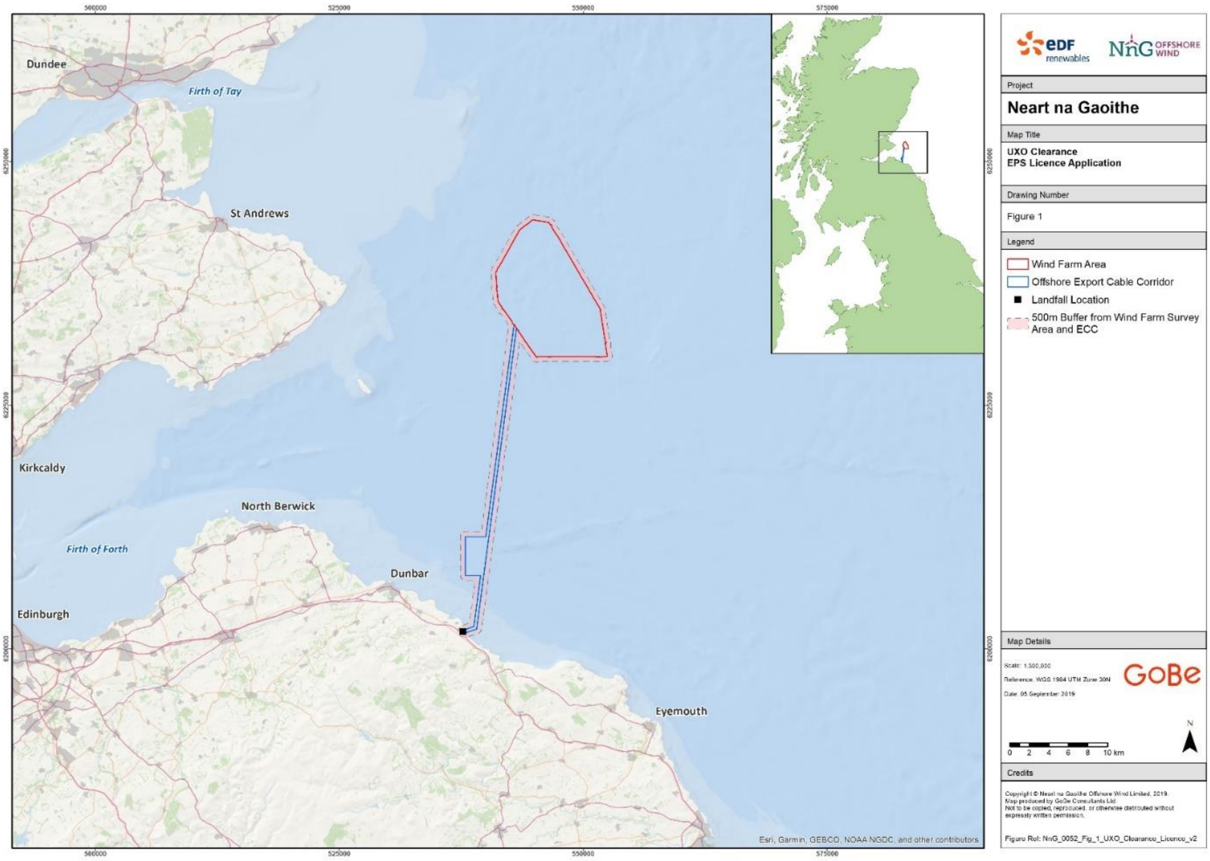

Figure 1-1: Neart na Gaoithe Wind Farm UXO clearance Project Area.

2 Marine Mammal Species Present

4. Details of marine mammals that may be present within the area of potential effect from UXO clearance and the potential impacts on them are presented in Section 3.6 of the Environmental Report to support a Marine Licence application: UXO Clearance. Bottlenose dolphin is a qualifying feature for the Moray Firth SAC, harbour seals are listed as qualifying features of the Forth and Tay and Eden Estuary SAC and grey seals are qualifying features of the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC. An assessment of the effect of UXO clearance on designated sites is presented in Section 5 of the Environmental Report to support a Marine Licence application: UXO Clearance.

3 Mitigation Identification

5. This section identifies the potential mitigation measures and their likely effectiveness in achieving the aim of ensuring no traumatic or permanent auditory injury to any marine mammals from UXO detonation and minimising disturbance.

3.1 Leaving *in situ* or avoidance of UXO

6. The primary mitigation measure to reduce the risk of any injury or disturbance is to leave *in situ* any UXO located and, if necessary, re-route or relocate activities around the UXO. In order for this to arise certainty is required that any UXO left *in situ* will not cause any safety risk.

7. Based on the UXO detection survey results, NnGOWL will determine whether it is possible to safely avoid any confirmed UXO identified within the NnG Project Area. A report commissioned by NnG provides estimates of the safe distances UXO can be left *in situ*. from construction activities (Table 3-1) (RPS 2019). This provides an indication of the likely separation distance required before any consideration can be made by NnG on whether UXO can be left.

8. By avoiding or leaving *in* situ any identified UXO there is no risk of any injury to marine mammals and minimal disturbance caused only by the presence of the vessels required to undertake the necessary surveys; it is therefore very effective mitigation. Following the identification of confirmed UXO NnG will determine whether it is safe to leave the UXO *in situ* or whether it is possible for the project to avoid the item either by re-routing or relocating. This will be done on a case-by-case basis with human safety being the paramount consideration.

Table 3-1: Approximate safe distances for avoiding UXO during wind farm construction (Source RPS 2019).

ACTIVITY	APPROXIMATE SAFE DISTANCE FROM UXO (M)
Pile-driving	150
Drilling	30 - 50
Cable laying	>50 (depending on cable laying methods)
Anchoring of installation vessels	18
Jack-up vessel	>9 (depending on selected jack-up vessel)

3.2 Removal or Relocation of UXO

9. If possible, any confirmed items of UXO that cannot be avoided will be removed from the sea and brought ashore for safe disposal or relocated to a safe site away from the proposed works. The removal or relocation of UXO is inherently risky and will only be undertaken when, following inspection, it is determined that it is safe to do so. If brought ashore the UXO will be disposed of at specialised facilities. By not detonating UXO there is no risk of any injury to marine mammals and minimal disturbance caused only by the presence of the survey vessels. It is therefore considered to be effective mitigation, where circumstances allow. However, the safe removal or relocation of UXO is not likely to be possible in all situations.

10. It is possible that multiple small items of UXO each less than 50 kg will be relocated to a single area and detonated together. This can reduce both the overall number of detonations required and the extent of impacts across the wider area. Focussing the detonation of UXO into a fewer areas reduces the risk of injury and the extent of disturbance to marine mammals as there is a reduction in both the number of locations across which impacts will occur and the geographical extent.

3.3 Low Order Defraglation

11. Low order defraglation as an alternative to high order detonation is not proposed to be used for the clearance of UXO for the Project for reasons provided in Section 2.3.

3.4 Marine Mammal Observers and Passive Acoustic Monitoring

12. The use of Marine Mammal Observers (MMO) and Passive Acoustic Monitoring (PAM) are widely used methods of mitigation for many differing activities where the level of noise has potential to cause hearing injury to marine mammals. The aim of using MMO and PAM is to reduce the risk of any marine mammal being within the range at which permanent auditory injury may occur. The effectiveness of MMOs in being able to detect marine mammals is dependent on the viewing conditions and the species of marine mammal likely to be present, with smaller less obvious species being harder to detect and therefore at greater risk of being present and not being observed. PAM is able to be operated in conditions unsuitable for MMO but does rely on being able to detect the vocalisation of marine mammals present in the area. If they are largely silent then there is an increased risk of them not being detected. As effective mitigation the use of MMO and PAM is limited to within the 'mitigation zone', an area within 1,000 m of the detonation. Published guidance provide clear advice on the use of MMOs and PAM when undertaking UXO clearance (JNCC 2010).

13. Under good viewing conditions the use of MMOs, supported by PAM, is considered to be effective mitigation for reducing the risk of traumatic injury to all marine mammal species likely to be present within 1,000 m area of UXO clearance. It will also reduce the risk of any dolphin species from being within the range at which the onset of PTS is predicted to occur. It is also effective for minke whales where the UXO detonation is less than 50 kg NEQ. However, due to the limited range across which it may be effective it is not suitable on its own at ensuring there is minimal risk of harbour porpoise being impacted by PTS. It is also recognised that there is increasing risk of not detecting marine mammals with increasing distance and when viewing conditions are not ideal.

3.5 Acoustic Deterrent Devices (ADD)

14. It is proposed to use an ADD during the UXO clearance operations. Although the precise model of ADD to be used has still to be determined it is likely to be Lofitech seal scarer (or one with a similar specification). The Lofitech ADD operates at a frequency of between 13.5 and 15 kHz with a signal

duration of 0.5 seconds repeated randomly between <1 and 40 seconds. The sound source level is between 191 and 204 dB re 1m Pa @ 1 m.

15. The use of ADD has the potential to reduce the likelihood of European Protected Species and other marine mammals being in the area within which traumatic or permanent auditory injury could occur at the time of UXO detonation and may be considered as additional mitigation supporting the use of MMO and PAM. They have been used regularly during UXO clearance at offshore wind farms in Scottish waters as a form of mitigation to reduce impacts on marine mammals (e.g. Aberdeen, Beatrice and Moray East Offshore Wind Farms).

16. There are a number of different ADDs available. However, most studies have been based on the use of a Lofitech ADD that is considered to be one of the more effective available ADDs (Sparling *et al.* 2017, McGarry *et al*. 2018). ADDs produce relatively high levels of sound in the water column with the aim of causing an avoidance behaviour in marine mammals and discouraging them from a particular area. The extent and duration of any displacement varies across devices and the behaviour of the individual species, with ADDs having less of an effect where marine mammals may be attracted to a site, e.g. seals and fish farms (Coram *et al.* 2014). However, in areas where there is less of an attraction, the use of ADDs have been found to be effective at temporarily displacing marine mammals from an area (Table 3-2).

17. Published studies have been undertaken on the effectiveness of using an ADD to displace harbour porpoise (Brandt *et al.* 2012, 2013, Dähne *et al.* 2017). The studies have reported differing levels of effectiveness with one recording a harbour porpoise within 798 m of an active ADD and another showing that all harbour porpoise avoided the area within 1.9 km and for half the time between 2.1 and 2.4 km (Brandt *et al.* 2012, 2013). Both these studies reported a strong avoidance behaviour by harbour porpoise to the ADDs with one study recording a 96% reduction in the number of detections out to 7.5 km (Brandt *et al*. 2013, Coram *et al*. 2014). The studies concluded that there appeared to be effective deterrence at levels of 132 dB re 1 µPa (rms SPL) and no clear avoidance at levels below 119 dB re 1 µPa (rms SPL) (Brandt *et al*. 2012). Avoidance from the area lasted approximately six hours.

18. A study undertaken looking at the effects of pile-driving at the DanTysk wind farm in the German Bight reported a significant reduction in the number of harbour porpoise detected out to at least 12 km from the ADD with near total avoidance of the area within 3 km by (Dähne *et al.* 2017).

19. There are limited studies undertaken on the effectiveness of ADDs on dolphins (Sparling *et al*. 2015). However, they are recognised to be less sensitive to noise than other cetaceans and the deterrent radius from an ADD is likely to be smaller than that for other cetaceans. However, the area within which the onset of PTS is predicted to occur extends less than 1 km from the source and therefore an ADD is predicted to be an effective deterrence for dolphins.

20. Studies undertaken for minke whale indicate that a Lofitech ADD caused a change to a direct swimming direction away from the sound source and significant increase in the net speed of minke whales, minke whales were reported to respond within 4 km of the ADD (McGarry *et al*. 2017).

21. Studies undertaken on harbour seals indicate a strong response to ADD’s out to 1 km with weaker responses beyond that range out to 3.1 km (Gordon *et al.* 2015).

Table 3-2: Predicted range of effective deterrence by Acoustic Deterrent Devices.

SPECIES	DETERRENT RANGE	SOURCE
Harbour porpoise	Up to 7.5 km	Brandt *et al.* (2013)
Dolphin Spp.	unknown	Sparling *et al.* (2015)
Minke whale	>1,000 m	McGarry *et al.* (2017)
Seal species	>1,000 m	Gordon *et al.* (2015)

3.6 Soft start detonations

22. Undertaking soft start detonations using small explosive charges immediately prior to the detonation of the UXO reduces the risk of marine mammals being within the area of potential traumatic or permanent auditory injury. The principles for the soft-start are the same as those routinely used as mitigation during pile-driving and seismic surveys; the aim of which is to deter marine mammals from being within the area of impact by producing increasing levels of noise over a period of time (JNCC 2010). This mitigation has been used during UXO clearance at Scottish offshore wind farm sites, e.g. Beatrice and Moray East offshore wind farms. At Beatrice Offshore Wind Farm three charges of 50 g, 100 g and 150 g were detonated at five minute intervals with the aim of allowing any marine mammals present to swim away from the site (BOWL 2016, Marine Scotland 2016). The size of the soft-start charges required to effectively deter marine mammals from an area is dependent on the size of the UXO to be detonated, with larger items of UXO potentially requiring additional larger soft-start detonations undertaken over a longer period of time to allow suitable time for the marine mammal(s) to swim away from the area.

23. Noise modelling undertaken indicates that the detonation of an initial 10 g charge will produce noise above the threshold at which the onset of PTS is predicted to occur in all marine mammal species within 500 m of the detonation and the potential for TTS occurs within 1 km (Figure 3-1) (Genesis *pers. com.*). The use of MMO, PAM and ADD will effectively mitigate against any permanent auditory impacts to marine mammals from the use of soft-start detonations. For harbour porpoise the onset of PTS is predicted occur up to 16 km in the event a 1,000 kg NEQ UXO is detonated (Appendix B - Genesis Underwater Noise Modelling Report). At this range the sound levels from soft start detonations of a 10 g charge size are predicted to be 164.3 dB re 1 µPa $_{(0\text{-}p)}$, for a 250 g charge size it is predicted to be 174.8 dB re 1 µPa $_{(0\text{-}p)}$ and a 1 kg charge 179.4 dB re 1 µPa $_{(0\text{-}p)}$. At these levels evidence from existing studies have indicated that there is significant displacement of harbour porpoise from the area and therefore given enough time and with increasing sizes of charge all marine mammal species will be beyond the range at which the onset of PTS is predicted to occur (Bailey 2010, Rumes *et al.* 2017, Tougaard *et al*. 2015).

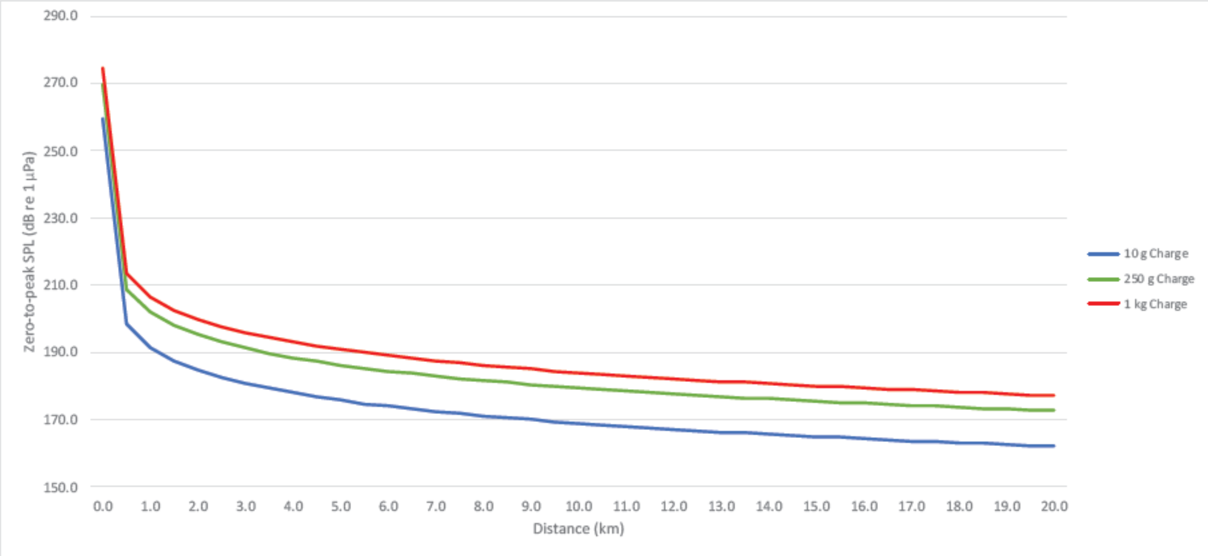

Figure 3-1: Sound levels (zero-peak SPL) arising from the detonation of 10 g, 250 g and 1 kg charges over distance (Source: Genesis pers. com).

24. At Moray East between four and five charges were detonated ranging in size from between 50 g and 250 g depending on the size of the UXO (MOWL 2018).

25. To ensure that no marine mammals are present within the area of permanent auditory injury charges ranging in size from between 10 g and 1,000 g will be detonated over an agreed period prior to the detonation of UXO. The number and size of charge used will depend on the size of the UXO. In the event that a UXO with a charge size of greater that 750 kg is detected further consultation will be undertaken.

26. Table 3-3 presents the possible soft-start detonation procedure that could be undertaken depending on the charge weight of the UXO. The duration of the procedure is based on the distance at which the onset of PTS is predicted to arise in harbour porpoise and the time it may take to swim away from the sound source with a swimming speed of 1.5 m/s (5.4 km/h). For charge weights of 50 kg or less the use of the ADD prior to the soft start will reduce the risk of marine mammals, particularly harbour porpoise, being present in the area and therefore no soft-start is required.

27. Gradually increasing the soft-start charge size over time will allow the marine mammal to swim away from the area. The exact soft-start procedure will be agreed with MS-LOT and SNH prior to UXO clearance.

Table 3-3: Potential soft-start detonation procedure for differing UXO charge weights.

UXO CHARGE WEIGHT (KG)	PREDICTED DISTANCE OF PTS (KM)	TIME TO AVOID AREA (MINS)	TIME (MINS) AND SOFT START CHARGE WEIGHTS (G)								
			0	10	30	50	60	90	120	150	180
50 - 100	7.4	80	10g	25g	50g	100g	250g	250g			
100 - 250	10.1	114	10g	25g	50g	100g	250g	250g	500g		
250 - 500	12.7	140	10g	25g	50g	100g	250g	250g	500g	1,000g	
500 - 1,000	16.0	174	10g	25g	50g	100g	250g	250g	500g	1,000g	1,000g

3.7 Bubble Curtains

28. Bubble curtains are designed to provide an acoustic barrier around the sound source to absorb noise. The use of bubble curtains to reduce the risk of injury to marine mammals from UXO clearance has not been used as mitigation at any offshore wind farm in UK waters.

29. There is limited published information on the effectiveness of bubble curtains in reducing impacts from explosives. Reductions in the peak pressure by the use of bubble curtains have been reported to be between 10 dB and 19 dB for small charge sizes of 1 kg, although lower reductions have been recorded for larger charge sizes with one study reporting reductions of only 4 dB for a 300 kg detonation in 20 m of water (Schmidtke et al. 2009, Meriläinen et al. 2018, Verfuss et al. 2019).

30. Bubble curtains have been used during pile-driving at offshore wind farms in Germany to meet a maximum noise threshold defined by the regulator. Monitoring undertaken during the installation of turbine foundations at the German Dan Tysk Offshore Wind Farm (which is located in water depths of between 21 and 32 metres) where two types of bubble curtains were used, recorded a decrease in the broadband spectrum by an average of 8.7 dB (peak to peak) for a double bubble curtain. It was also found that the bubble curtains were most effective at reducing the higher frequency components above 1 kHz where there was a reduction of between 10 dB and 30 dB (peak to peak) (Dahne et al. 2017). Similar monitoring undertaken during the construction of the FINO 3 platform (at a depth of 22 metres) recorded a reduction in the broadband SEL level of between 7 dB and 12 dB, with higher levels of reduction up to 35 dB above 1.6 kHz (Theobald and Wood 2011). Overall, there can be a reduction of between 7 and 18 dB SELss when using bubble curtain(s) during pile-driving (Verfuss et al. 2019).

31. There are recognised limitations in the use of bubble curtains in areas of deeper water as its effectiveness relies upon the complete surrounding of the sound source structure and bubbles dissipate as they travel through the water column. The use of bubble curtains may also be limited by requiring current speeds of less than 3 m/s and significant wave heights of 3 m when deploying or using them (Verfuss et al. 2019). Although conditions within which bubble curtains can be effectively deployed have been reported to be lower than this with current speeds of less than 1.5 m/s and wave heights of less than 0.8 m (Hmax) and only in water depths of between 5 m and 40 m (TKOWL 2018, Ørsted 2018). Outwith these conditions it may not be feasible to use bubble curtains effectively. At Moray East Offshore Wind Farm, which is located in similar water depths as NnG, the use of a bubble curtain was not considered possible and other mitigation was identified that would effectively reduce the risk to marine mammals (MOWFL 2018).

3.8 Mitigation Measures Summary

32. All potential mitigation measures that have been considered and their potential effectiveness at ensuring marine mammals are not at risk of traumatic or permanent auditory injury are presented in Figure 3-2 and summarised below:

- Mitigation that avoids the necessity to detonate UXO is effective for all charge sizes and for all species.
- For a 50 kg charge weight, the use of MMO and PAM on their own are effective at ensuring dolphins and minke whale will be beyond the range at which the onset of PTS is predicted to occur; for larger charge sizes this mitigation is only effective for bottlenose dolphin where the onset of PTS is predicted to be within 1 km of the source.
- The use of an ADD as mitigation will ensure that all species of marine mammal are beyond the range of PTS for charges less than 50 kg and for charges of up to 1,000 kg NEQ the use of an ADD may be effective for dolphins and minke whale.
- The use of a series of small detonations to produce a soft-start is predicted to be effective for all species but the soft-start procedure will vary depending on the UXO charge weight.
- The use of a bubble curtain could reduce the extent of noise and be effective for all charge sizes and all species. However, there is uncertainty over the effectiveness of it as mitigation when operated in deeper waters. Given the effectiveness of previous mitigation and uncertainty regarding the efficacy of bubble curtains in deeper waters such as at NnG, their use is not proposed.

Mitigation	Effective Charge Size (NEQ)	Species
Leaving *in situ* or avoidance	All charge sizes	All species
Removal or relocation	All charge sizes	All species
Low Order Defraglation	All charge sizes	All species
MMOs and PAM	<1,000 kg	Dolphin species
	<50 kg	Dolphin species and Minke whale
Acoustic Deterrent Device	<50 kg	All species
	>50 kg	Dolphin species and Minke whale
Soft-start	All charge sizes	All species
Bubble curtains	All charge sizes	All species

Figure 3-2: Potential mitigation measures and their estimated effectiveness in reducing the risk of permanent auditory injury on marine mammals.

4 Proposed Mitigation

33. Based on the above it is evident that in the event that UXO is required to be detonated there is no single mitigation measure that will effectively ensure that no marine mammals are at risk of permanent auditory injury. Consequently, NnGOWL proposes to use multiple measures to reduce the risk of any marine mammals suffering traumatic or permanent auditory injury. Results from noise modelling indicate that UXO with relatively smaller charge weights may have a smaller impact compared with larger items of UXO. However, in determining the level of mitigation required it is recognised that evidence from monitoring UXO clearance indicates that the peak pressure levels do not necessarily correlate with charge size (Meriläinen *et al.* 2018). Consequently, it is proposed that the same mitigation will be undertaken for all UXO clearance greater than 50 kg NEQ.

34. The proposed mitigation will be:

- Leave *in situ* or avoid the UXO;
- Remove or relocate UXO, including relocating smaller items of UXO into a cluster for a single detonation;
- The use of MMOs and PAM;
- The use of a Lofitech ADD; and
- The use of a 'soft start' using a series of smaller charges increasing in weight over a period of time for UXO with charge size greater than 50 kg.

35. In the event that UXO is required to be detonated the proposed mitigation is predicted to be effective at ensuring that there is minimal risk of any marine mammal occurring in the area at which permanent auditory injury is predicted to occur for any UXO. This is on the basis that:

36. The use of MMOs and PAM will ensure that no marine mammals are at risk of traumatic injury;

37. The use of ADD will ensure that there is a very low risk of any marine mammals being within the range at which the onset of PTS will occur for charge sizes of 50 kg or less;

38. The use of a 'soft start' prior to any detonations will further reduce the risk of any marine mammals being within the range at which the onset of PTS will occur for all charge sizes between 50 kg and 1,000 kg;

39. There is evidence that noise modelling may overestimate the extent of any impact by up to 20 dB (Meriläinen *et al.* 2018) and therefore the potential areas for permanent auditory injury in this assessment may be smaller than predicted; and

40. In the event that UXO with a significant charge weight of greater than 750 kg is required to be detonated the appropriate soft-start procedures will be discussed with MSS and SNH prior to clearance.

5 Mitigation Procedures

5.1 UXO Clearance

41. The work will be undertaken by a specialist ordnance disposal contractor experienced in the removal of unexploded ordnance (UXO). Any UXO identified during the surveys will be examined to determine whether it can be safely removed or requires detonation in situ.

42. In the event that UXO is required to be detonated in situ the following protocols will be followed for each individual item of UXO:

43. No more than two items of UXO will be disposed of each day. In the event of multiple items needing to be cleared, the clearance activity will start with the smallest recognised UXO and increase in size over the course of the work. Thus providing an opportunity for marine mammals to move away from the sound source and reducing the risk of physical impacts.

44. Wherever possible small items of UXO will be clustered together to allow a 'single' detonation. The timing of each detonation will be delayed by a few milliseconds to reduce the overall size of the shockwave. This reduces the number of separate detonations required and consequently the number of occasions where there is a risk of marine mammals being impacted. It also reduces the overall duration of any disturbance.

45. Should any UXO require detonation then the smallest possible donor charge will be used to effectively dispose of it. Minimising the potential noise impact in the event that there is no explosive charge within the UXO.

46. All detonations will be undertaken during daylight hours and in good conditions of sea state 3 or less.

47. A 1 km mitigation zone will be established and visual observations using experienced, dedicated MMOs who have attended an approved JNCC course will be undertaken for at least one hour prior to the detonation and for at least 15 minutes post detonation. To compliment the visual observations passive acoustic monitoring will be undertaken simultaneously using experienced and trained PAM operators.

48. The JNCC guidelines (JNCC 2010) for UXO clearance will be followed at all times.

5.2 MMO and PAM

49. The following summarises the procedures and processes that will be in place prior, during and after any disposal of UXO:

   1 At least one MMO will be present for the duration of the clearance activities. If required, two MMOs may be present.

   2 Prior to any detonation a visual watch will be undertaken using trained and experienced MMO that have attended a JNCC recognised MMO course.

   3 The MMO and PAM operators will be dedicated to their roles throughout the course of the works.

   4 The MMO and PAM operators will be suitably equipped with personal safety equipment, binoculars and the correct recording forms.

   5 Clear lines of communication will be arranged between the Captain, MMO, PAM operator and members of the clearance crew to ensure no miscommunications occur.

   6 The MMO and PAM operator will be located as close as reasonably practicable and safely to the area of detonation, approximately 100 m from the source. Leaving the location only when necessary for safety reasons, i.e. immediately prior to the detonation.

   7 The platform upon which observations and recordings are to be made will have a viewing area that allows unimpeded 360o observations at all times.

   8 A watch and PAM for marine mammals will be maintained throughout each clearance activity.

   9 The pre-detonation watch and PAM will commence at least 1 hour before any planned detonation, including those arising from the soft-start procedure.

10 In the event of any marine mammals being observed or detected, no detonations will take place until at least 20 minutes since the last sighting. Reducing the risk of a marine mammal still being within the 1,000 m mitigation zone.

11 A formal chain of communication from the MMO (or PAM operative) to the person who can delay activities and the company's representative will be established.

12 No detonations will take place until a clear and unambiguous communication from the MMO or PAM operator has been made to the Explosive Ordnance Disposal (EOD) supervisor that it is safe to do so and that no marine mammals have been observed for at least 20 minutes.

13 In order to establish the chain of communication and command, MMOs and PAM operatives will attend any relevant pre-detonation meetings.

14 If there is any uncertainty as to whether marine mammals may be present within the mitigation zone, the MMO or PAM operator will advise the EOD supervisor that the activity should be delayed until they are certain that no marine mammals are present.

15 Following detonation, the MMO will return to the location as soon as it is safe to do so and record any environmental effects, e.g. injured or dead fish. The MMO will remain in the area, keeping watch, for at least 15 minutes, or longer if necessary.

16 Following completion of the clearance activity a report will be prepared detailing the activities undertaken, all marine mammals recorded and details of any relevant observations before, during and after the detonation(s).

5.3 ADD

50. It is planned that an ADD will be used during all UXO clearance activities. By deploying an ADD an effective deterrence range of up to 7 km can be expected thus ensuring no harbour porpoise, minke whale or dolphins are within a range at which the onset of PTS could occur for 100 kg NEQ UXO.
51. The ADD will only be operated when required so as to avoid any unnecessary disturbance to marine mammals.
52. For all UXO with a charge weight of 50 kg or less the ADD will be deployed for 60 minutes (plus soft-start period) prior to the detonation of any UXO. For items with a charge weight of 100 kg the ADD will be deployed for 90 minutes (plus soft-start period). This will allow marine mammals the time required to relocate away from the area within which the onset of PTS is predicted to arise [4].
53. The ADD will be deployed and operated by a specialised contractor, experienced in the use of ADD during UXO clearance.
54. The ADD will start at the lowest possible sound level, gradually increasing over a period of fifteen minutes to full power.
55. The ADD will be tested prior to each deployment to ensure that it is working effectively.
56. The ADD operator will be responsible for ensuring the ADD is operating effectively and confirm with both the PAM operator and the EOD supervisor that it is.
57. A clear line of communication will be established between the ADD operator, MMO and PAM operator to ensure that they are aware of when the ADD are being deployed and will be able to observe any

[4] This calculation is based on a harbour porpoise swimming speed of 1.5 m/s (5.4 km/h) (SNH 2016) and the predicted onset of PTS occurring within 5.9 km for UXO with a 50 kg charge and 7.4 km for UXO with a 100 kg charge weight.

behavioural responses by marine mammals when the ADD is operating. The PAM will also be able to confirm that the ADD is operating correctly.

58. No detonations will take place until a clear and unambiguous communication from the ADD operator to the EOD supervisor that the ADD has been operating continuously for either 60 minutes or 90 minutes, depending on UXO charge size.

59. Immediately prior to detonation the ADD will be located to the vessel safety zone it will continue to operate during the period that the MMO and PAM are relocating.

60. Following completion of the clearance activity a report will be prepared detailing the activities undertaken and details of any relevant issues during and after the detonation(s).

5.4 Soft-start Detonation

61. It is planned that soft-start detonations will be undertaken for all UXO clearance activities for charge sizes greater than 50 kg. By undertaking a soft-start an effective deterrence range in excess of 16 km can be expected thus ensuring there is minimal risk of any marine mammals within a range at which the onset of PTS is predicted to occur for all UXO charge sizes.

62. Undertaking the 'soft-start' procedure will be the responsibility of the EOD supervisor.

63. For UXO with a charge weight of 50 kg or less, over a period of 30 minutes five charges increasing in size from 50 g to 250 g will be detonated every six minutes, commencing with the smallest charge. This will allow marine mammals to swim away from the area within which the onset of PTS is predicted to arise. In particular for species for which the use of an ADD on its own may have limited effect, e.g. seals [5].

64. In the event that UXO with a charge weight of between 50 kg and 100 kg is detonated up to six small charges of between 10 g and 250 g will be used over a period of 90 minutes. This will allow time for any marine mammals to relocate away from the area of potential impact.

65. In the event that a UXO with a charge weight of greater than 100 kg is identified both the number and size of charges used will be increased over time designed to ensure adequate levels of noise and time is provided to allow marine mammals to swim beyond the area of potential impact. See Table 3-3 for possible scenarios.

66. The soft-start procedure will only commence once the MMO, PAM and ADD activities have been completed and all vessels are located within the vessel safety zone.

67. The soft-start procedure will commence within approximately five minutes of it being safe to do so.

68. The MMO and PAM operator will continue observations from the vessel safety zone for the duration of the soft-start and communicate any marine mammal sightings to the EOD Supervisor.

69. In the event of any marine mammals are observed or detected within the 1,000 m mitigation zone the soft-start will be delayed until at least 20 minutes since the last sighting, after which the whole soft-start procedure will be restarted. This reduces the risk of a marine mammal still being within the mitigation zone.

[5] A seal travelling at 1.8 m/s (SNH 2016) will be able to swim up to 3.2 km over a period of 30 minutes and therefore beyond the range at which the onset of PTS is predicted to arise for all UXO charge sizes (See Table 24 in Appendix B).

6 Reporting Framework

70. Monitoring of this protocol will be undertaken by NnG. Weekly reports will provide details on all compliance related issues, monitoring effort and marine mammal observation. The report will be approved by the Lead Consents Manager and lessons learned communicated to all relevant staff and contractors to ensure continual improvement.

71. A final report will be prepared following completion of the planned UXO clearance period.

6.1 Reporting

72. Reports will be produced detailing marine mammal sightings during planned UXO clearance. All sightings of marine mammals will be recorded and reported to Marine Scotland and Scottish Natural Heritage within the time period specified in the EPS license.

73. The reports will include:

- A record of all UXO detected and removed, including dates and times and procedures followed;
- Details of watches undertaken, including times and observers;
- Details of all marine mammals recorded and completed marine mammal recording forms;
- Any specific mitigation measures undertaken; and
- Details of any issues of concerns.

6.2 Responsibilities

74. The Lead Consents Manager will be responsible for ensuring all compliance related issues. A summary of the responsibilities of key personnel is presented in Table 6-1.

Table 6-1: Responsibilities relating to the MMMP of key personnel

KEY PERSONNEL	RESPONSIBILITIES
Lead Consents Manager	• Overall responsibility for ensuing compliance documents such as the MMMP are included in construction contract documents. Responsible for reporting marine mammal monitoring via field reports and written reports. The Lead Consents Manager will consult with the MMO and Explosive Ordnance Disposal (EOD) Supervisor before making any decisions affecting the MMMP.
Explosive Ordnance Disposal (EOD) Supervisor	Take offshore responsibility for ensuring that the requirements of the MMMP are met. Ensuring no UXO detonations occur without explicit consent from the EOD Supervisor. The EOD Supervisor has the responsibility to delay work activities to meet the requirements of the MMMP. Responsible for ensuring 'soft-start' procedures are complied with in line with the MMMP Responsible for liaising with the Lead Consents Manager, Vessel Master, MMO and other personnel as required.

KEY PERSONNEL	RESPONSIBILITIES
	Responsible for ensuring clear lines of communication between the Vessel Master, members of the crew, MMO, PAM and ADD operators to ensure no miscommunications occur. Responsible for informing the vessel masters of the environmental considerations relevant to the vessel's activities.
Marine Mammal Observer(s)	Responsible for reporting to the EOD and Lead Consents Manager. Responsible for ensuring that the requirements of the MMMP are met and managed, including taking action to avoid any activities that could cause traumatic or permanent auditory injury to marine mammals. Manage and undertake the monitoring of marine mammals.
PAM Operator	Responsible for reporting to the EOD and Lead Consents Manager. Undertake acoustic monitoring to the requirements of the MMMP. Responsible for ensuring that relevant parts of the MMMP are met and managed. Liaise and advise the EOD and Lead Consents Manager as appropriate.
ADD Operator	Responsible for reporting to the EOD and Lead Consents Manager. Operating the ADD in line with the requirements set out in the MMMP. Responsible for ensuring that relevant parts of the MMMP are met and managed. Liaise and advise the EOD and Lead Consents Manager as appropriate. Provide final report(s) on the use of ADD during the UXO clearance campaign.

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