RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Environmental Statement

Volume 7

Appendix 11-6 Unexploded Ordnance Clearance Information and Assessment (Revision 2)

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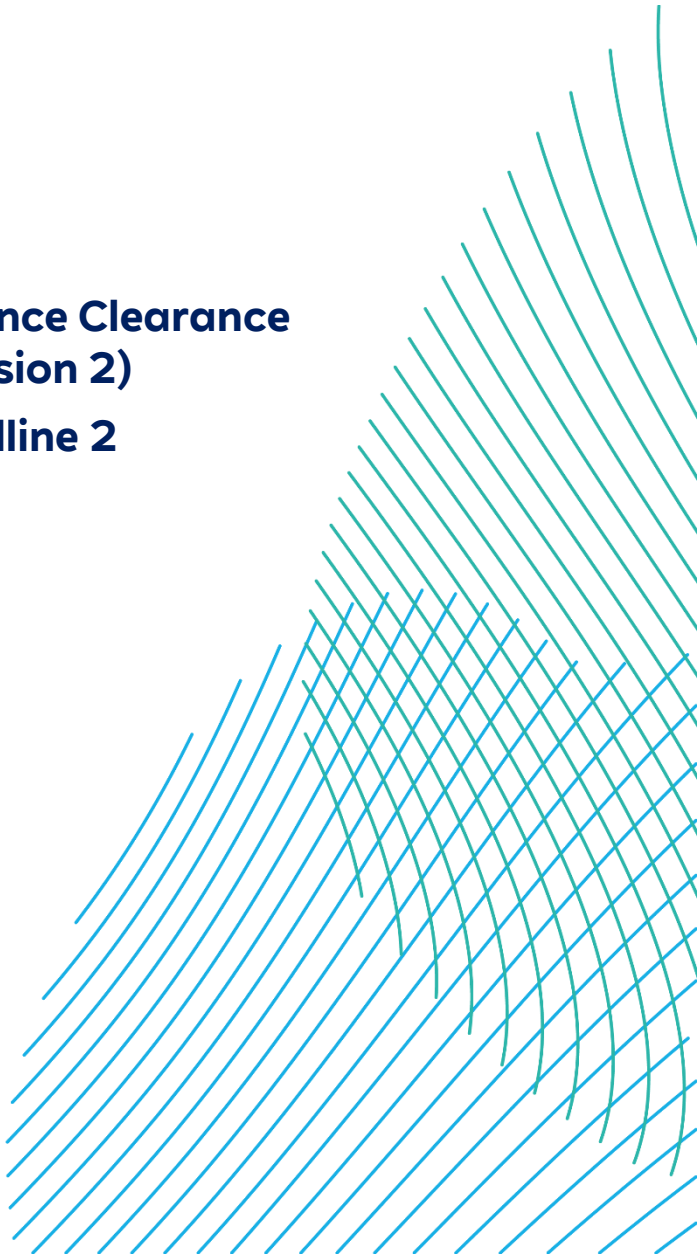

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02	15	11.6.4.2	Text added to explain table 11-6-3 in response to MMO RR-030: 5.7.2.
02	19	11.6.4.2.3	Text added to explain the maximum charge weight modelled for the Projects in response to MMO RR-030: 5.7.2.
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02	21	11.6.4.3	Paragraph added to clarify what has been assessed in the appendix. in response to MMO RR-030: 5.7.2.
02	22-25	11.6.4.3	Added in PTS impact ranges for low yield for all species in response to MMO RR-030: 5.7.2.
02	27-30	11.6.4.3	Added in TTS impact ranges for low yield for all species in response to MMO RR-030: 5.7.2.

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Glossary

Term	Definition
Concurrent Scenario	A potential construction scenario for the Projects where DBS East and DBS West are both constructed at the same time.
Cumulative Effects Assessment (CEA)	The assessment of the combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor/resource.~~Assessment of potential significant effects as a result of the incremental change caused by other past, present and reasonably foreseeable activities together with a development.~~
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP).
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the value, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
Electrical Switching Platform (ESP)	The Electrical Switching Platform (ESP), if required would be located either within one of the Array Areas (alongside an Offshore Converter Platform (OCP)) or the Export Cable Platform Search Area.
Impact	Used to describe a change resulting from an activity via the Projects, i.e. increased suspended sediments / increased noise.

Term	Definition
In Isolation Scenario	A potential construction scenario for one Project which includes either the DBS East or DBS West array, associated offshore and onshore cabling and only the eastern Onshore Converter Station within the Onshore Substation Zone and only the northern route of the onward cable route to the proposed Birkhill Wood National Grid Substation.
Offshore Development Area	The Offshore Development Area for ES encompasses both the DBS East and West Array Areas, Inter-Platform Cable Corridor, the Offshore Export Cable Corridor, plus the associated Construction Buffer Zones.
Offshore Export Cable Corridor (OECC)	This is the area which will contain the Offshore Export Cables (and potentially the ESP) between the offshore substation/converter platforms and Transition Joint Bays at the landfall.
Sequential Scenario	A potential construction scenario for the Projects where DBS East and DBS West are constructed with a lag between the commencement of construction activities. Either Project could be built first.
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).

Acronyms

Term	Definition
ADD	Acoustic Deterrent Device
CEA	Cumulative Effects Assessment
CES	Coastal East Scotland
CGNS	Celtic Greater North Sea
dB	Decibel
DBS	Dogger Bank South
DCO	Development Consent Order
EDR	Effective Deterrence Range
EPS	European Protected Species
EQT	Effective Quiet Threshold
ES	Environmental Statement
ESP	Electrical Switching Platform
GNS	Greater North Sea
JNCC	Joint Nature Conservation Committee
Kg	Kilograms
km	Kilometres
m	Metre
m/s	Meters per second
ML	Marine Licence
MMMP	Marine Mammal Mitigation Protocol

Term	Definition
MMO	Marine Management Organisation
MTD	Marine Technical Directorate Ltd
MU	Management Unit
NEQ	Net Explosive Quantity
NS	North Sea
OECC	Offshore Export Cable Corridor
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
SE	South East
SEL	Sound Exposure Level
SEL_{cum}	Sound Exposure Level from cumulative exposure
SEL_{ss}	Sound Exposure Level from single strike
SIP	Site Integrity Plan
SNCBs	Statutory Nature Conservation Bodies
SPL	Sound Pressure Level
SPL_{peak}	peak Sound Pressure Level
TTS	Temporary Threshold Shift
UK	United Kingdom
UXO	Unexploded Ordnance
µPa	~~Mirco~~Micro-pascal

11.6 Unexploded Ordnance Clearance Information and Assessment

11.6.1. Introduction

1. This appendix provides an assessment of potential auditory injury and disturbance effects on marine mammals during Unexploded Ordnance (UXO) clearance for the Dogger Bank South (DBS) Offshore Development Area. This assessment is provided with the Environment Statement (ES) for information purposes only. A separate Marine Licence (ML) application for UXO clearance would be submitted post-consent once detailed information on the locations and extent of UXO required to be cleared is known.

2. A Cumulative Effects Assessment (CEA) for UXO clearance at other projects is provided in section 11.7 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

11.6.2. Worst Case Scenario

3. **Table 11-6-1** sets out the realistic worst-case parameters for the marine mammals UXO assessment. The approach for the worst case assessment was discussed and agreed at the 4th Expert Topic Group meeting on the 15th January 2024 (further details in **Volume 7, Appendix 11-1 Marine Mammal Consultation Responses (application ref: 7.11.11.1)**.

Table 11-6-1 Realistic Worst Case Parameters for Marine Mammals UXO Assessment

Parameters	Notes and Rationale
Types and Sizes of UXO: Various possible types and sizes of UXO, ranging from 0.5kg to 698kg	Indicative only. A detailed UXO survey would be completed prior to construction. The exact type, size and number of possible detonations and duration of UXO clearance operations is therefore not known at this stage.
Number of UXO requiring clearance: Currently unknown.	
Clearance techniques: Low-order clearance would be the first and preferred method for UXO that require clearance. As a worst-case, assessments are based on high-order clearance.	High-order clearance would only be undertaken in the event that low-order clearance is not possible or failed to clear the device completely. This is therefore unlikely to be required in all cases, however, it is assessed as the worst-case.

11.6.3. DBS East and DBS West Mitigation Measures

4. The Projects have committed to the mitigation measures for any UXO clearance, as outlined ~~below~~ in **Table 11-6-2**. Current guidance from the Joint Nature and Conservation Committee (JNCC) guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC 2010[1]) would be used as the basis for the mitigation measures.

Table 11-6-2 UXO Clearance Mitigation and Monitoring Measures

Parameter	Additional Mitigation Measures
Marine Mammal Mitigation Plan (MMMP) for UXO Clearance	A detailed MMMP would be prepared for UXO clearance during the post-consent phase, during the ML application process. The MMMP for UXO clearance would ensure there are adequate mitigation measures to minimise the risk of any physical or permanent auditory injury to marine mammals as a result of UXO clearance. The MMMP for UXO clearance would be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time. The MMMP for UXO clearance would be prepared in consultation with the Marine Management Organisation (MMO) and relevant Statutory Nature Conservation Bodies (SNCBs). The MMMP for UXO clearance would include details of all the required mitigation measures to minimise the potential risk of permanent threshold shift (PTS) as a result of underwater noise during UXO clearance, for example, this would consider the options, suitability and effectiveness of mitigation measures such as, but not limited to: • Low-order clearance techniques, such as deflagration; • The use of bubble curtains if any high-order detonation is required (taking into consideration the environmental and safety limitations); • All UXO clearance to take place in daylight and, when possible, in favourable conditions with good visibility (sea state 3 or less);

[1] DRAFT guidelines for minimising the risk of injury to marine mammals from unexploded ordnance clearance in the marine environment (2023) has been issued for consultation and will be applied once finalised.

Parameter	Additional Mitigation Measures
	Establishment of a monitoring area with minimum of 1km radius; • The observation of the monitoring area would be by dedicated and trained marine mammal observers (MMObs) during daylight hours and suitable visibility. • The observation of the monitoring area using Passive Acoustic Monitoring as an additional monitoring tool • The activation of Acoustic Deterrent Device (ADDs); • The controlled explosions of the UXO would be undertaken by specialist contractors, using the minimum amount of explosive required in order to achieve safe disposal of the UXO; and • Other UXO clearance techniques, such as avoidance of UXO; or relocation of UXO. UXO is not included in the Development Consent Order (DCO) application, as currently not enough detailed information is available. Therefore, UXO clearance would be in a separate ML post consent. An **Outline MMMP (application ref: 8.25)** has been consulted on with MMO and Natural England and is submitted as part of the DCO application.
Site Integrity Plan (SIP) for the Southern North Sea Special Area of Conservation (SAC)	A SIP for the Southern North Sea SAC would be developed (if required). The SIP would set out the approach to deliver any mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the Southern North Sea SAC Conservation Objectives. The SIP is an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the Southern North Sea SAC. The SIP would be developed in the pre-construction period as part of the separate Marine Licencing process (if deemed to be required) and would be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and the MMO. An **In Principle SIP for the Southern North Sea SAC (application ref: 8.26)** has been consulted on with MMO and NE and is submitted with the DCO application.

Parameter	Additional Mitigation Measures
Underwater noise monitoring for UXO clearances	Underwater noise monitoring would be undertaken for all UXO clearances following the Protocol for In-Situ Underwater Measurement of Explosive Ordnance Disposal for UXO (National Physical Laboratory 2020) (if required).

11.6.4. Assessment of Potential Effects from UXO Clearance

5. The following assessments follow the approach set out in section 11.4 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, including the definition of sensitivity and the effect magnitudes.

6. The potential for UXO clearance is anticipated to be during the construction phase only as clearance of any relevant UXO would have already been completed prior to the operation and decommissioning phases.

11.6.4.1. Potential Effects to Marine Mammals of UXO Clearance

7. It is important to note the assessments for UXO clearance are for information only and are not secured as part of the DCO application. A separate ML application would be submitted when a detailed UXO survey has been completed prior to construction, and a detailed assessment based on that latest available information (including potential UXO locations, size, type, and number) has been undertaken.

8. The following assessments are provided for information purposes only.

9. Prior to construction, there is the potential for UXO clearance to be required. While any identified UXO would either be avoided or removed and disposed of onshore in a designated place, there is the potential that underwater detonation could be required where it is necessary and unsafe to relocate / remove the UXO.

10. A detailed UXO survey would be completed prior to construction. Therefore, the number of possible UXO that may require to cleared and duration of UXO clearance operations are currently unknown.

11. For the assessment, a conservative estimate has been made, based on the best available information from other offshore wind farm UXO clearance operations nearby, and other published information, including the **Unexploded Ordnance (UXO) Risk Management Report (application ref: 8.29)**. It is not currently known the size or type of the UXO that could be present, therefore a range of sizes has been assessed, with the maximum charge weight of up to 698kg Net Explosive Quantity (NEQ).

12. When an item of UXO detonates on the seabed underwater, several effects are generated, most of which are localised at the point of detonation, such as crater formation and movement of sediment and dispersal of nutrients and contaminants. After detonation, there is the rapid expansion of gaseous products known as the "bubble pulse". Once it reaches the surface, the energy of the bubble is dissipated in a plume of water and the detonation shock front rapidly attenuates at the water / air boundary. Fragmentation (that is shrapnel from the weapon casing and surrounding seabed materials) is also ejected but does not pose a significant hazard beyond 10m from source.

13. The potential effects of underwater UXO detonations on marine mammals include physical injury from direct or indirect blast wave effect of the high amplitude shock waves and sound wave produced by underwater detonation. This could result in immediate or eventual mortality. Additionally, there is auditory impairment from exposure to the acoustic wave, resulting in a temporary or permanent loss in hearing sensitivity such as temporary threshold shift (TTS) or PTS. Moreover, there is behavioural change, such as disturbance to feeding, mating, breeding, and resting (Richardson *et al.* 1995; Ketten 2004; von Benda-Beckmann *et al.* 2015).

14. The severity of the consequences of UXO detonation would depend on many variables, but principally, on the charge weight and its proximity to the receptor. After detonation, the shock wave would expand spherically outwards and would travel in a straight line (i.e. line of sight), unless the wave is reflected, channelled or meets an intervening obstruction.

15. There are limited acoustic measurements for underwater explosions, and there can be large differences in the noise levels, depending on the charge size, as well as water depth, bathymetry, and seabed sediments at the site, which can also influence noise propagation. The water depth in which the explosion occurs has a significant influence on the effect range for a given charge mass (von Benda-Beckmann *et al.* 2015).

16. It is important to note that assessments are based on the worst-case for high-order UXO detonations with no mitigation, which is highly unlikely, as the preferred and first option for any UXO requiring detonation (i.e. those which cannot be avoided, relocated or removed) would be a low-order clearance method.

11.6.4.2. Underwater Noise Modelling for UXO Clearance

17. A number of UXOs with a range of charge weights (or quantity of contained explosive) could be located within the offshore project area. There is the potential for there to be a variety of explosive types, which would have been subject to degradation and burying over time. Two otherwise identical explosive devices are therefore likely to produce different blasts if one has been subject to different environmental factors.

18. The **Unexploded Ordnance (UXO) Risk Management Report (application ref: 8.29)** includes detonation of the UXO devices (and sizes) as shown in **Table 11-6-3**.

19. A selection of explosive sizes has been considered in the estimation of the underwater noise levels produced by detonation of UXO (**Table 11-6-3**). The first column lists potential UXO devices that could be present, with their potential NEQ presented in the second column. The third column in the table represents the NEQ values that were modelled by Subacoustech Environmental Ltd in **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**).

20. The potential impact ranges for permanent and temporary auditory injury for the NEQ weights that were modelled are~~is~~ presented in **Table 11-6-5**. However, the assessment assumes that the maximum explosive charge required for the Projects is 698kg (see **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**).

21. For a conservative approach based on the potential UXO identified, 698kg has been modelled as the largest required alongside a range of smaller devices for the assessment. The NEQ of 698kg will be used for the worst case high order detonation assessment. Natural England's Best Practice Advice (Parker *et al.* 2022) suggest a maximum charge weight of 750kg, however this is not expected to be required for the DBS Projects based on the **Unexploded Ordnance (UXO) Risk Management Report (application ref: 8.29).** A review of potential impact ranges shows that the increase in noise impacts from a 698kg to 750kg charge weight was <0.5 dB and would lead to negligible increases in impact range from those presented.

~~19. Therefore, 698kg has been predicted to be the largest required weight and has been modelled alongside a range of smaller devices for the assessment. The NEQ of 698kg will be used for the worst case high order detonation assessment. Natural England's Best Practice Advice (2022) suggest a maximum charge weight of 750kg, however this is not expected for the DBS Projects and a quick check showed that the increase in noise from a 698 kg to 750 kg charge weight was <0.5 dB and would lead to negligible increases in impact range from those presented.~~

Table 11-6-3 Selection of UXO Potentially Present at the Projects

UXO devices potentially present	NEQ for UXO sizes potentially present	NEQ for UXO devices included within the following assessment
• German SC-50 Bomb • British 250lb MC Bomb • WWI German V Mine • British 500lb MC Bomb • German SC-500 Bomb • British 1000lb MC Bomb • WWII U-Boat Torpedo (Multiple Variants) • German LMB Mine • German SC-1000 Bomb • German Luftmine B Mine	• 25kg • 55kg • 82kg • 116kg • 163kg • 220kg • 239kg • 280kg • 483kg • 554kg • 620kg	• 25kg • 55kg • 120kg • 240kg • 525kg • 698kg

11.6.4.2.1. Background to Underwater Noise

~~20.~~22. The noise produced by the detonation of explosives is affected by a number of different elements (e.g. its design, composition, age, position, orientation, whether it is covered by sediment) which are currently unknown and cannot be directly considered in this assessment. This leads to a high degree of uncertainty in the estimation of the source noise level (i.e. the noise level at the position of the UXO). A worst case estimation has therefore been used for calculations, assuming that the UXO to be detonated is not buried, degraded or subject to any other significant attenuation. The consequence of this is that the noise levels produced, particularly by the larger explosives under consideration, are likely to be over-estimated as they are likely to be covered by sediment and degraded.

~~21.~~23. The assessment also does not take into account the variation in the noise level at different depths. Where animals are swimming near the surface, the acoustics at the surface cause the noise level, and hence the exposure, to be lower at this position. The risk to animals near the surface may therefore be lower than indicated by the range estimate and therefore this can be considered conservative in respect of impact at different depths.

~~22.~~24. The potential impact has been assessed based on the latest Southall *et al.* (2019) thresholds and criteria for marine mammals that could be present in the area. The thresholds indicate the point at which there is an increase in risk of permanent hearing damage in an underwater receptor (although not all individuals within the maximum PTS range would have permanent hearing damage; this is assumed as a worst-case scenario).

~~23.~~25. The Sound Exposure Level (SEL) criteria are weighted, which takes into account the sound level based on the sensitivity of the receiver, for example, harbour porpoise *Phocoena phocoena* are less sensitive to low frequency sound than minke whales *Balaenoptera acutorostrata*. Southall *et al.* (2019) also includes criteria based on peak Sound Pressure Level ($SPL_{peak)}$, which are unweighted and do not take species hearing sensitivity into account.

~~24.~~26. Both SPL_{peak} and SEL values based on the impulsive and non-impulsive criteria are included in the assessments. However, it is important to note that they are different criteria and as such they should not be compared directly. All decibel Sound Pressure Level (SPL) values are referenced to 1 µPa and all SEL values are referenced to 1 μPa^2s.

~~25.~~27. Peak noise levels are difficult to predict accurately in a shallow water environment (von Benda Beckmann *et al.*~~,~~ 2015) and would tend to be significantly over-estimated by the modelling over increased distances from the source. With increased distance from the source, impulsive noise, such as UXO detonation, becomes more of a non-impulsive noise, unfortunately it is currently difficult to determine the distance at which an impulsive noise becomes more like a non-impulsive noise. Therefore, modelling was conducted using both the impulsive and non-impulsive criteria for PTS weighted SEL to give an indication of the difference between maximum potential impact ranges (see **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**)

~~26.~~28. Impulsive noise sources are described as having a rapid rise time, short duration and high peak pressure. A study into the distance at which underwater noise sources (from offshore wind farm piling and seismic surveys) 'transformed' from an impulsive to a non-impulsive noise revealed that, at a distance of between 2 and 3km the noise sources no longer contained the characteristics (in particular a high enough peak pressure) to be classed as an impulsive noise (Hastie *et al.* 2019). However, this study was completed in a shallow water environment, with a relatively flat seabed, and the actual range at which a sound source transforms into a non-impulsive noise is likely to be dependent on a number of environmental variables and other sound source characteristics (Hastie *et al.* 2019). The work by Hastie *et al.* (2019) is preliminary work, and Martin *et al.* (2020) suggest that the change in noise characteristics from impulsive to non-impulsive does not make a difference to assessment of injury because sounds retain impulsive character when SPLs are above effective quiet threshold (EQT). However, as outlined in the Hornsea Project Four Environmental Statement Chapter 4 (Orsted~~,~~ 2021), some of the results presented by Martin *et al.* (2020) indicate that some of the piling sound loses its impulsiveness with increasing distance from the piling site, therefore the sound loses its harmful impulsive characteristics with increased distance.

11.6.4.2.2. UXO Clearance techniques

~~27.~~29. All assessments have been based on the worst-case scenario and maximum predicted effect ranges for impulsive thresholds.

~~28.~~30. Low-order clearance techniques, where the ordnance is disposed of or rendered safe without a high-order detonation is the preferred option for UXO clearance. Examples of low-order clearance techniques include (NPL~~,~~ 2020):

- Freezing the munition to render it inactive;
- Water abrasive suspension cutting in order to physically disrupt the munition;
- Disposal in a Static Detonation Chamber;
- Photolytic destruction of the munition; and
- Low-order deflagration.

~~29.~~31. Deflagration is a technique whereby the explosive within the UXO is rapidly burned at subsonic speeds using plasma from a small-shaped charge that generates insufficient shock to detonate the UXO (Merchant & Robinson~~,~~ 2020; NPL~~,~~ 2020). The explosive material inside the UXO reacts with a rapid burning rather than a chain reaction that would lead to a full explosion (NPL~~,~~ 2020).

~~30.~~32. Substantial noise reduction for deflagration over high-order (SPL_{peak} and SEL are more than 20dB lower) and acoustic output for deflagration depends only on the size of the shaped charge (rather than the size of the UXO) (NP~~L~~, 2020; Robinson *et al.*~~,~~ 2020).

~~31.~~33. The technique of low-order clearance appears to present a viable option to avoid high-order explosive detonation in some cases. Low-order clearance techniques, such as deflagration, are relatively new to civilian applications but have been used by the UK military since 2005 (Merchant & Robinson~~,~~ 2020).

~~32.~~34. In the event that low order clearance was unsuccessful or deemed unsuitable for a specific UXO (e.g., due to its condition), high-order clearance may be undertaken. Therefore, as a worst-case, high-order detonations have been considered, alongside low-order clearance.

11.6.4.2.3. Underwater Noise Modelling Methodology

~~33.~~ The maximum equivalent charge weight for the potential UXO devices that could be present within the Projects has been estimated as 698kg. This has been modelled alongside a range of smaller devices, at charge weights of 25, 55, 120, 240, 525 and 698kg. In each case, an additional donor weight of 0.5kg has been included to initiate detonation.

35. In addition, low-order clearance (such as deflagration) has been assessed, an additional donor weight of 0.25kg has been included to initiate detonation. Estimation of the source noise level for each charge weight has been carried out in accordance with the methodology of Soloway and Dahl (2014), which follows Arons (1954) and the Marine Technical Directorate Ltd (MTD) (1996).

~~34.~~36. The low-yield clearance is associated with the HYDRA UXO clearance system developed by EORCA and involves a small charge to initiate destruction. Unlike low-order clearance, the HYDRA uses shaped charges to produce high pressure water jets that disintegrate the explosive material, whilst still generating a sound from the donor charge.

~~35.~~37. **Table 11-6-4** provides the source level used for the underwater noise modelling (further details on how these were calculated is provided in **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**.

Table 11-6-4 Summary of the Unweighted SPL_{peak} and SEL_{ss} Source levels Used for UXO Clearance.

Charge weight	SPL_{peak} source level (dB re 1 µPa @ 1m)	SEL_{ss} source level (dB re 1 µPa²s @ 1m)
Low yield (0.75kg)	281.9	276.6
Low order (0.25 kg)	269.8	215.2
25kg + donor	284.9	228.0
55kg + donor	287.5	230.1
120kg + donor	290.0	232.3
240kg + donor	292.3	234.2
525kg + donor	294.8	236.4
698kg + donor	295.7	237.1

11.6.4.2.4. Assessment methodology

~~36.~~38. The following assessments are undertaken in line with the methodology as set out in section 11.4 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, including the definition of effect magnitude levels.

~~37.~~39. Assessments are carried out using the density and reference populations for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal, and harbour seal provided in section 11.5.5 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

11.6.4.3. Impact 1: Auditory Injury Due To Underwater Noise Associated With UXO Clearance

11.6.4.3.1. Sensitivity of Marine Mammals

~~38.~~40. In this assessment, all species of marine mammal are considered to have high sensitivity to UXO detonations if they are within the potential impact ranges for permanent auditory injury (PTS). Marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and unable to recover from physical injury or auditory injury.

~~39.~~41. The sensitivity of marine mammals to TTS and flee response as a result of underwater UXO detonations is considered to be medium in this assessment as a precautionary approach. This is for animals within the potential TTS and flee response range, but beyond the potential effect range for PTS. Marine mammals within the potential effect area are considered to have limited capacity to avoid such effects, although any effects on marine mammals would be temporary and they would be expected to return to the area once the activity had ceased.

11.6.4.3.2. Potential Auditory Injury Effect Ranges

42. The results of the underwater noise modelling (**Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**) for a range of potential charge weights (NEQ) are presented in **Table 11-6-4** and **Table 11-6-5** for PTS and **Table 11-6-6** TTS, respectively. The potential effect ranges have been modelled based on the latest Southall *et al.* (2019) thresholds and criteria. The effect ranges (and areas, based on the area of a circle) are used to inform the assessments.

43. The highest impact range for high order denotation and low order deflagration will be taken forward for the marine mammal assessment as low order deflagration will be the preferred method and high order to represent the Projects' worst case scenario. The impact ranges will be reviewed pre-construction when further details are known on the likely size and approach to UXO clearance, and updated as needed within the ML application.

Table 11-6-5 Potential Maximum Impact Ranges (and areas) of PTS for Marine Mammals During UXO Clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)

Potential maximum charge weight (NEQ)	**Maximum predicted impact range (km) (and area (km²))**		
	PTS SPL_{peak} Unweighted (Impulsive criteria)	**PTS SEL Weighted (Impulsive criteria)**	**PTS SEL Weighted (Non-impulsive criteria)**
Harbour porpoise (Very High Frequency (VHF) cetacean)			
	202 dB re 1 µPa	**155 dB re 1 µPa²s**	**173 dB re 1 µPa²s**
Low yield (0.75kg)	3.4km (36.32km²)	450m (<0.64km²)	<50m (<0.008km²)
0.25kg (low-order clearance)	**990m (3.08km²)**	80m (0.02km²)	<50m (<0.008km²)
25kg+ donor charge	4.6km (66.48km²)	570m (1.02km²)	<50m (<0.008km²)
55kg + donor charge	6.0km (113.1km²)	740m (1.72km²)	<50m (<0.008km²)
120kg + donor charge	7.8km (191.13km²)	950m (2.84km²)	<50m (<0.008km²)
240kg + donor charge	9.8km (301.72km²)	1.1km (3.8km²)	70m (0.015km²)
525kg + donor charge	12km (452.39km²)	1.4km (6.16km²)	100m (0.031km²)
698kg + donor charge	**13km (530.93km²)**	1.5km (7.07km²)	110m (0.038km²)
Bottlenose dolphin, common dolphin, and white-beaked dolphin (High Frequency (HF) cetaceans)			
	230 dB re 1 µPa	**185 dB re 1 µPa²s**	**198 dB re 1 µPa²s**
Low yield (0.75kg)	190m (0.11km²)	<50m (<0.008km²)	<50m (<0.008km²)
0.25kg (low-order clearance)	**60m (0.011km²)**	<50m (<0.008km²)	<50m (<0.008km²)
25kg+ donor charge	260m (0.21km²)	<50m (<0.008km²)	<50m (<0.008km²)
55 kg + donor charge	340m (0.36km²)	<50m (<0.008km²)	<50m (<0.008km²)
120kg + donor charge	450m (0.64km²)	<50m (<0.008km²)	<50m (<0.008km²)
240kg + donor charge	560m (0.99km²)	<50m (<0.008km²)	<50m (<0.008km²)
525kg + donor charge	730m (1.67km²)	<50m (<0.008km²)	<50m (<0.008km²)
698kg + donor charge	**810m (2.06km²)**	60m (<0.011km²)	<50m (<0.008km²)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km²))		
	PTS SPL_{peak} Unweighted (Impulsive criteria)	**PTS SEL Weighted (Impulsive criteria)**	**PTS SEL Weighted (Non-impulsive criteria)**
Minke whale (Low Frequency (LF) cetacean)			
	219 dB re 1 µPa	**183 dB re 1 µPa²s**	**199 dB re 1 µPa²s**
Low yield (0.75kg)	600m (1.13km²)	1.6km (8.04km²)	100m (0.031km²)
0.25kg (low-order clearance)	170m (0.091km²)	**230m (0.17km²)**	<50m (<0.008km²)
25kg+ donor charge	820m (2.11km²)	2.2km (15.21km²)	130m (0.053km²)
55 kg + donor charge	1km (3.14km²)	3.2km (32.17km²)	190m (0.11km²)
120kg + donor charge	1.3km (5.31km²)	4.7km (69.4km²)	280m (0.25km²)
240kg + donor charge	1.7km (9.08km²)	6.5km (132.73km²)	390m (0.48km²)
525kg + donor charge	2.2km (15.21km²)	9.5km (283.53km²)	570m (1.02km²)
698kg + donor charge	2.4km (18.1km²)	**10km (314.16km²)**	660m (1.37km²)
Grey seal and harbour seal (Phocid Carnivores in Water (PCW))			
	218 dB re 1 µPa	**185 dB re 1 µPa²s**	**201 dB re 1 µPa²s**
Low yield (0.75kg)	660m (1.37km²)	290m (0.26km²)	<50m (<0.008km²)
0.25kg (low-order clearance)	**190m (0.11km²)**	40m (0.005km²)	<50m (<0.008km²)
25kg+ donor charge	910m (2.6km²)	390m (0.48km²)	<50m (<0.008km²)
55 kg + donor charge	1.1km (3.8km²)	570m (1.02km²)	<50m (<0.008km²)
120kg + donor charge	1.5km (7.07km²)	830m (2.16km²)	<50m (<0.008km²)
240kg + donor charge	1.9km (11.34km²)	1.1km (3.8km²)	70m (0.015km²)
525kg + donor charge	2.5km (19.63km²)	1.6km (8.01km²)	100m (0.031km²)
698kg + donor charge	**2.7km (22.9km²)**	1.9km (11.34km²)	110m (0.038km²)

~~eria) PTS SEL~~

~~Weighted (Non-impulsive criteria)~~

Table 11-6-6 Potential Maximum Impact Ranges (and areas) of TTS for Marine Mammals During UXO Clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)

Potential maximum charge weight (NEQ)	**Maximum predicted impact range (km) (and area (km²))**		
	TTS SPL_{peak} Unweighted (Impulsive criteria)	**TTS SEL Weighted (Impulsive criteria)**	**TTS SEL Weighted (Non-impulsive criteria)**
Harbour porpoise (VHF)			
	196 dB re 1 µPa	**140 dB re 1 µPa²s**	**153 dB re 1 µPa²s**
Low yield (0.75kg~~750g~~)	6.2km (120.76km²)	2.1km (13.85km²)	590m (1.09km²)
0.25kg (low-order clearance)	**1.8km (10.18km²)**	750m (1.77km²)	110m (0.038km²)
25 kg + donor charge	8.5km (226.98km²)	2.4km (18.1km²)	730m (1.67km²)
55 kg + donor charge	11km (380.13km²)	2.8km (24.63km²)	940m (2.78km²)
120kg + donor charge	14km (615.75km²)	3.2km (32.17km²)	1.1km (3.8km²)
240kg + donor charge	18km (1,017.88km²)	3.5km (38.48km²)	1.4km (6.16km²)
525kg + donor charge	23km (1,661.9km²)	4.0km (50.27km²)	1.7km (9.08km²)
698kg + donor charge	**25km (1,963.5km²)**	4.1km (52.81km²)	1.8km (10.18km²)
Bottlenose dolphin, common dolphin, and white-beaked dolphin (High Frequency (HF) cetaceans)			
	~~230~~ 224 dB re 1 µPa	**170 dB re 1 µPa²s**	**178 dB re 1 µPa²s**
Low yield (0.75kg~~750g~~)	360m (0.41km²)	110m (0.038km²)	<50m (<0.008km²)
0.25kg (low-order clearance)	**100m (0.031km²)**	<50m (<0.008km²)~~)~~	<50m (<0.008km²)
25 kg + donor charge	490m (0.75km²)	150m (0.071km²)	<50m (<0.008km²)
55 kg + donor charge	640m (1.29km²)	210m (0.14km²)	60m (0.011km²)
120kg + donor charge	830m (2.16km²)	300m (0.28km²)	80m (0.02km²)
240kg + donor charge	1km (3.14km²)	390m (0.48km²)	110m (0.038km²)
525kg + donor charge	1.3km (5.31km²)	530m (0.88km²)	160m (0.08km²)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km²))		
	TTS SPL_{peak} Unweighted (Impulsive criteria)	**TTS SEL Weighted (Impulsive criteria)**	**TTS SEL Weighted (Non-impulsive criteria)**
698kg + donor charge	**1.4km (6.16km²)**	590m (1.09km²)	180m (0.1km²)
Minke whale (LF)			
	213 dB re 1 µPa	**168 dB re 1 µPa²s**	**179 dB re 1 µPa²s**
Low yield (0.75kg~~750g~~)	1.1km (3.80km²)	22km (1,520.53km²)	3.3km (34.21km²)
0.25kg (low-order clearance)	320m (0.32km²)	**3.2km (32.17km²)**	460m (0.66km²)
25 kg + donor charge	1.5km (7.07km²)	29km (2,642.08km²)	4.4km (60.82km²)
55 kg + donor charge	1.9km (11.34km²)	41km (5,281.02km²)	6.4km (128.68km²)
120kg + donor charge	2.5km (19.63km²)	57km (10,207.03km²)	9.4km (277.59km²)
240kg + donor charge	3.2km (32.17km²)	76km (18,145.84km²)	13km (530.93km²)
525kg + donor charge	4.1km (52.81km²)	100km (31,415.93km²)	18km (1,017.88km²)
698kg + donor charge	4.5km (63.62km²)	**100km (31,415.93km²)**	21km (1,385.44km²)
Grey seal and harbour seal (PCW)			
	212 dB re 1 µPa	**170 dB re 1 µPa²s**	**181 dB re 1 µPa²s**
Low yield (0.75kg~~750g~~)	1.2km (4.52km²)	3.9km (47.78km²)	590m (1.09km²)
0.25kg (low-order clearance)	360m (0.41km²)	**570m (1.02km²)**	80m (0.02km²)
25 kg + donor charge	1.6km (8.04km²)	5.2km (84.95km²)	790m (1.96km²)
55 kg + donor charge	2.1km (13.85km²)	7.5km (176.71km²)	1.1km (3.8km²)
120kg + donor charge	2.8km (24.63km²)	10km (314.16km²)	1.6km (8.04km²)
240kg + donor charge	3.5km (38.48km²)	14km (615.75km²)	2.3km (16.62km²)
525kg + donor charge	4.6km (66.48km²)	19km (1,134.11km²)	3.3km (34.21km²)
698kg + donor charge	5.0km (75.54km²)	**22km (1,520.53km²)**	3.8km (45.36km²)

11.6.4.3.3. Sensitivity of Marine Mammals

~~40.~~44. In this assessment, all species of marine mammal are considered to have high sensitivity to UXO detonations if they are within the potential impact ranges for physical injury or PTS. Marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and unable to recover from physical injury or auditory injury.

~~41.~~45. The sensitivity of marine mammals to TTS and flee response as a result of underwater UXO detonations is considered to be medium in this assessment as a precautionary approach. This is for animals within the potential TTS and flee response range, but beyond the potential effect range for PTS. Marine mammals within the potential effect area are considered to have limited capacity to avoid such effects, although any effects on marine mammals would be temporary and they would be expected to return to the area once the activity had ceased.

11.6.4.3.4. Potential Auditory Injury Effect Ranges

~~42.~~46. The results of the underwater noise modelling (**Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**) for a range of potential charge weights (NEQ) are presented in **Table 11-6-4** and **Table 11-6-5** for PTS and **Table 11-6-6** TTS, respectively. The potential effect ranges have been modelled based on the latest Southall *et al.* (2019) thresholds and criteria. The effect ranges (and areas, based on the area of a circle) are used to inform the assessments in the following sections.

11.6.4.3.5. Magnitude Of Effect For PTS

~~43.~~47. The number of harbour porpoise, bottlenose dolphin, common dolphin, minke whale, grey seal and harbour seal that could potentially be impacted by a high-order UXO detonation (up to 698kg NEQ) (**Table 11-6-7**), and low-order clearance (0.25kg) has been estimated for the Offshore Development Area based on the maximum potential PTS impact ranges (**Table 11-6-8**)

~~44.~~48. For high order the magnitude for harbour porpoise medium to low with the site-specific densities. The magnitude for minke whale is medium to negligible and for bottlenose dolphin, is medium (for the Costal East Scotland (CES) Management Unit (MU)) to negligible. The magnitude for grey seal is medium to low and the magnitude for common dolphin, white-beaked dolphin and harbour seal are all negligible (**Table 11-6-7**).

~~45.~~49. For low order the magnitude for harbour porpoise; bottlenose dolphin; common dolphin; white-beaked dolphin; minke whale; grey seal and harbour seal is negligible (**Table 11-6-8)**

Table 11-6-7 Maximum Number of Marine Mammals Potentially at Risk of PTS During High Order UXO Clearance

Species	Maximum Impact Area	Location	Maximum number of individuals and % of reference population based on maximum impact area	Magnitude*
Harbour porpoise	PTS SPL_{peak} ($530.93km^2$) unmitigated	DBS East	318.6 (0.091% of North Sea (NS) MU)	Medium
		DBS West	350.4 (0.101% of NS MU)	Medium
	PTS weighted SEL impulsive criteria ($7.07km^2$) unmitigated	DBS East	4.2 (0.001% of NS MU)	Low
		DBS West	4.7 (0.001% of NS MU)	Low
Bottlenose dolphin	PTS SPL_{peak} ($0.011km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.10 (0.005% of Greater North Sea (GNS) MU and 0.045% of CES MU)	Low (Medium)
	PTS weighted SEL impulsive criteria ($6.16km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.0005 (0.00002% of GNS MU and 0.0002% of CES MU)	Negligible (Negligible)
Common dolphin	PTS SPL_{peak} ($0.011km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.035 (0.00003% of Celtic and Greater North Sea (CGNS) MU)	Negligible
	PTS weighted SEL impulsive criteria ($6.16km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.0002 (0.0000002% of CGNS MU)	Negligible
White-beaked dolphin	PTS SPL_{peak} ($0.011km^2$) unmitigated	DBS East	0.07 (0.00016% of CGNS MU)	Negligible
		DBS West	0.08 (0.00019% of CGNS MU)	Negligible
	PTS weighted SEL impulsive criteria ($6.16km^2$) Unmitigated	DBS East	0.0003 (0.0000009% of CGNS MU)	Negligible
		DBS West	0.0004 (0.000001% of CGNS MU)	Negligible

Species	Maximum Impact Area	Location	Maximum number of individuals and % of reference population based on maximum impact area	Magnitude*
Minke whale	PTS SPL_{peak} ($18.1km^2$) unmitigated	DBS East	0.18 (0.0009% of CGNS MU)	Negligible
		DBS West	0.36 (0.002% of CGNS MU)	Low
	PTS weighted SEL impulsive criteria ($314.16km^2$) unmitigated	DBS East	3.1 (0.016% of CGNS MU)	Medium
		DBS West	6.3 (0.031% of CGNS MU)	Medium
Grey seal	PTS SPL_{peak} ($22.9km^2$) unmitigated	DBS East	4.1 (0.014% of South East (SE) MU & 0.0073% of Wider MU)	Medium (Low)
		DBS West	6.0 (0.019% of SE MU & 0.011% of Wider MU)	Medium (Medium)
		OECC	12.2 (0.04% of SE MU & 0.022% of Wider MU)	Medium (Medium)
		Offshore Development Area	8.8 (0.029% of SE MU & 0.016% of Wider MU)	Medium (Medium)
	PTS weighted SEL impulsive criteria ($11.34km^2$) unmitigated	DBS East	2.1 (0.0067% of SE MU & 0.0036% of Wider MU)	Low (Low)
		DBS West	2.9 (0.0096% of SE MU & 0.0052% of Wider MU)	Low (Low)
		OECC	6.0 (0.02% of SE MU & 0.011% of Wider MU)	Medium (Medium)
		Offshore Development Area	4.4 (0.014% of SE MU & 0.0077% of Wider MU)	Medium (Low)
Harbour seal	PTS SPL_{peak} ($22.9km^2$) unmitigated	DBS East	0.039 (0.0008% of SE MU)	Negligible
		DBS West	0.023 (0.00047% of SE MU)	Negligible
		OECC	0.039 (0.0008% of SE MU)	Negligible
		Offshore Development Area	0.034 (0.00071% of SE MU)	Negligible
	PTS weighted SEL impulsive criteria ($11.34km^2$) unmitigated	DBS East	0.019 (0.0004% of SE MU)	Negligible
		DBS West	0.011 (0.0002% of SE MU)	Negligible
		OECC	0.019 (0.0004% of SE MU)	Negligible
		Offshore Development Area	0.017 (0.0004% of SE MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species and the CES MU for bottlenose dolphin*

Table 11-6-8 Maximum Number of Marine Mammals Potentially at Risk of PTS During Low-Order UXO Clearance

Species	Maximum Impact Area	Location	Maximum number of individuals and % of reference population based on maximum impact area	Magnitude*
Harbour porpoise	PTS SPL_{peak} ($3.08km^2$) unmitigated	DBS East	1.8 (0.0005% of NS MU)	Negligible
		DBS West	2.0 (0.0006% of NS MU)	Negligible
	PTS weighted SEL impulsive criteria ($0.02km^2$) unmitigated	DBS East	0.012 (0.000003% of NS MU)	Negligible
		DBS West	0.013 (0.000004% of NS MU)	Negligible
Bottlenose dolphin	PTS SPL_{peak} ($0.011km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.0005 (0.00003% of GNS MU and 0.0002% of CES MU)	Negligible (Negligible)
	PTS weighted SEL impulsive criteria ($0.0078km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.0004 (0.00002% of GNS MU and 0.0002% of CES MU)	Negligible (Negligible)
Common dolphin	PTS SPL_{peak} ($0.011km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.002 (0.000002% of CGNS MU)	Negligible
	PTS weighted SEL impulsive criteria ($0.0078km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.0001 (0.0000001% of CGNS MU)	Negligible
White-beaked dolphin	PTS SPL_{peak} ($0.011km^2$) unmitigated	DBS East	0.0004 (0.0000009% of CGNS MU)	Negligible
		DBS West	0.0005 (0.000001% of CGNS MU)	Negligible
	PTS weighted SEL impulsive criteria ($0.0078km^2$) unmitigated	DBS East	0.00027 (0.0000006% of CGNS MU)	Negligible
		DBS West	0.00032 (0.0000007% of CGNS MU)	Negligible

Species	Maximum Impact Area	Location	Maximum number of individuals and % of reference population based on maximum impact area	Magnitude*
Minke whale	PTS SPL_{peak} ($0.91km^2$) unmitigated	DBS East	0.0009 (0.000005% of CGNS MU)	Negligible
		DBS West	0.002 (0.000009% of CGNS MU)	Negligible
	PTS weighted SEL impulsive criteria ($0.17km^2$) unmitigated	DBS East	0.0017 (0.000008% of CGNS MU)	Negligible
		DBS West	0.0034 (0.00002% of CGNS MU)	Negligible
Grey seal	PTS SPL_{peak} ($0.11km^2$) unmitigated	DBS East	0.02 (0.00007% of SE MU & 0.00004% of Wider MU)	Negligible (Negligible)
		DBS West	0.03 (0.00009% of SE MU & 0.0001% of Wider MU)	Negligible (Negligible)
		OECC	0.06 (0.0002% of SE MU & 0.0001% of Wider MU)	Negligible (Negligible)
		Offshore Development Area	0.04 (0.0001% of SE MU & 0.00008% of Wider MU)	Negligible (Negligible)
	PTS weighted SEL impulsive criteria ($0.005km^2$) unmitigated	DBS East	0.0009 (0.000003% of SE MU & 0.000002% of Wider MU)	Negligible (Negligible)
		DBS West	0.0013 (0.000004% of SE MU & 0.000002% of Wider MU)	Negligible (Negligible)
		OECC	0.0027 (0.000009% of SE MU & 0.000005% of Wider MU)	Negligible (Negligible)
		Offshore Development Area	0.0019 (0.000006% of SE MU & 0.000003% of Wider MU)	Negligible (Negligible)
Harbour seal	PTS SPL_{peak} ($0.11km^2$) unmitigated	DBS East	0.00019 (0.0000038% of SE MU)	Negligible
		DBS West	0.00011 (0.0000023% of SE MU)	Negligible
		OECC	0.00019 (0.0000038% of SE MU)	Negligible
		Offshore Development Area	0.00017 (0.0000034% of SE MU)	Negligible
	PTS weighted SEL impulsive criteria ($0.005km^2$) unmitigated	DBS East	0.000009 (0.00000017% of SE MU)	Negligible
		DBS West	0.000005 (0.0000001% of SE MU)	Negligible
		OECC	0.000009 (0.00000017% of SE MU)	Negligible
		Offshore Development Area	0.000008 (0.00000015% of SE MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species and the CES MU for bottlenose dolphin*

11.6.4.3.6. Magnitude Of Effect For TTS

~~46.~~50. The number of harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal that could potentially be impacted by a high-order UXO detonation (up to 698kg NEQ), has been estimated for the Projects in **Table 11-6-9** and low-order clearance (0.25kg) has been estimated for the Projects based on the maximum potential TTS effect ranges in **Table 11-6-10.**

~~47.~~51. For the high-order detonation of the maximum potential UXO with an NEQ of 698kg plus donor charge, the magnitude for TTS is assessed, as a worst-case (**Table 11-6-9**), to be negligible for harbour porpoise; bottlenose dolphin; common dolphin; white-beaked dolphin and harbour seal. The magnitude for TTS for minke whale and grey seal is low to negligible.

~~48.~~52. For low order of the maximum potential UXO with an NEQ of 0.25kg plus donor charge, the magnitude for TTS is assessed, as a worst-case (**Table 11-6-10**), to be negligible for harbour porpoise; bottlenose dolphin; common dolphin; white-beaked dolphin; minke whale; grey seal and harbour seal.

Table 11-6-9 Maximum Number of Marine Mammals Potentially at Risk of TTS During High-Order UXO Clearance

Species	Maximum Impact Area	Location	Maximum number of individuals and % of reference population based on maximum impact area	Magnitude *
Harbour porpoise	TTS SPL_{peak} ($1963.5km^2$) unmitigated	DBS East	1178.1 (0.34% of NS MU)	Negligible
		DBS West	1295.9 (0.37% of NS MU)	Negligible
	TTS weighted SEL impulsive criteria ($52.81km^2$) unmitigated	DBS East	31.7 (0.009% of NS MU)	Negligible
		DBS West	34.9 (0.01% of NS MU)	Negligible
Bottlenose dolphin	TTS SPL_{peak} ($6.16km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.3 (0.015% of GNS MU and 0.14% of CES MU)	Negligible (Negligible)
	TTS weighted SEL impulsive criteria ($1.09km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.05 (0.003% of GNS MU and 0.02% of CES MU)	Negligible (Negligible)
Common dolphin	TTS SPL_{peak} ($6.16km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.1 (0.0001% of CGNS MU)	Negligible
	TTS weighted SEL impulsive criteria ($1.09km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.002 (0.00002% of CGNS MU)	Negligible
White-beaked dolphin	TTS SPL_{peak} ($6.16km^2$) unmitigated	DBS East	0.21 (0.0005% of CGNS MU)	Negligible
		DBS West	0.25 (0.0006% of CGNS MU)	Negligible
	TTS weighted SEL impulsive criteria ($1.09km^2$) unmitigated	DBS East	0.037 (0.00008% of CGNS MU)	Negligible
		DBS West	0.045 (0.0001% of CGNS MU)	Negligible
Minke Whale	TTS SPL_{peak} ($63.62km^2$) unmitigated	DBS East	0.64 (0.003% of CGNS MU)	Negligible
		DBS West	1.3 (0.006% of CGNS MU)	Negligible
		DBS East	380.1 (1.9% of CGNS MU)	Low

Species	Maximum Impact Area	Location	Maximum number of individuals and % of reference population based on maximum impact area	Magnitude *
	TTS weighted SEL impulsive criteria (38,013.27km^2) unmitigated	DBS West	760.3 (3.8% of CGNS MU)	Low
Grey seal	TTS SPL_{peak} (78.54km^2) unmitigated	DBS East	14.2 (0.046% of SE MU & 0.025% of Wider MU)	Negligible (Negligible)
		DBS West	20.4 (0.067% of SE MU & 0.036% of Wider MU)	Negligible (Negligible)
		OECC	41.7 (0. 14% of SE MU & 0.074% of Wider MU)	Negligible (Negligible)
		Offshore Development Area	30.3 (0.099% of SE MU & 0.054% of Wider MU)	Negligible (Negligible)
	TTS weighted SEL impulsive criteria (1,520.53km^2) unmitigated	DBS East	275.2 (0.9% of SE MU & 0.49% of Wider MU)	Negligible (Negligible)
		DBS West	395.3 (1.29% of SE MU & 0.70% of Wider MU)	Low (Negligible)
		OECC	807.4 (2.64% of SE MU & 1.43% of Wider MU)	Low (Low)
		Offshore Development Area	586.9 (1.92% of SE MU & 1.04% of Wider MU)	Low (Low)
Harbour seal	TTS SPL_{peak} (78.54km^2) unmitigated	DBS East	0.13 (0.003% of SE MU)	Negligible
		DBS West	0.08 (0.002% of SE MU)	Negligible
		OECC	0. 13 (0.003% of SE MU)	Negligible
		Offshore Development Area	0. 12 (0.002% of SE MU)	Negligible
	TTS weighted SEL impulsive criteria (1,520.53km^2) unmitigated	DBS East	2.6 (0.053% of SE MU)	Negligible
		DBS West	1. 5 (0.031% of SE MU)	Negligible
		OECC	2.6 (0.053% of SE MU)	Negligible
		Offshore Development Area	2.3 (0.047% of SE MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species and the CES MU for bottlenose dolphin*

Table 11-6-10 Maximum Number of Marine Mammals Potentially at Risk of TTS During Low-Order UXO Clearance

Species	Maximum Impact Area	Location	Maximum number of individuals and % of reference population based on maximum impact area	Magnitude*
Harbour porpoise	TTS SPL_{peak} ($10.18km^2$) unmitigated	DBS East	6.1 (0.0018% of NS MU)	Negligible
		DBS West	6.7 (0.0019% of NS MU)	Negligible
	TTS weighted SEL impulsive criteria ($1.77km^2$) unmitigated	DBS East	1.1 (0.00031% of NS MU)	Negligible
		DBS West	1.2 (0.00034% of NS MU)	Negligible
Bottlenose dolphin	TTS SPL_{peak} ($0.031km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.002 (0.00008% of GNS MU and 0.0006% of CES MU)	Negligible (Negligible)
	TTS weighted SEL impulsive criteria ($0.0078km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.002 (0.0007% of GNS MU and 0.0001% of CES MU)	Negligible (Negligible)
Common dolphin	TTS SPL_{peak} ($0.031km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.0005 (0.0000005% of CGNS MU)	Negligible
	TTS weighted SEL impulsive criteria ($0.0078km^2$) unmitigated	DBS East, DBS West, OECC, and Offshore Development Area	0.0001 (0.0000001% of CGNS MU)	Negligible
White-beaked dolphin	TTS SPL_{peak} ($0.031km^2$) unmitigated	DBS East	0.0011 (0.000002% of CGNS MU)	Negligible
		DBS West	0.0013 (0.000003% of CGNS MU)	Negligible
	TTS weighted SEL impulsive criteria ($0.0078km^2$) Unmitigated	DBS East	0.00027 (0.0000006% of CGNS MU)	Negligible
		DBS West	0.00032 (0.0000007% of CGNS MU)	Negligible

Species	Maximum Impact Area	Location	Maximum number of individuals and % of reference population based on maximum impact area	Magnitude*
Minke whale	TTS SPL_{peak} ($0.32km^2$) unmitigated	DBS East	0.003 (0.00002% of CGNS MU)	Negligible
		DBS West	0.006 (0.00003% of CGNS MU)	Negligible
	TTS weighted SEL impulsive criteria ($32.17km^2$) unmitigated	DBS East	0.32 (0.002% of CGNS MU)	Negligible
		DBS West	0.64 (0.003% of CGNS MU)	Negligible
Grey seal	TTS SPL_{peak} ($0.41km^2$) unmitigated	DBS East	0.074 (0.0002% of SE MU & 0.0001% of Wider MU)	Negligible (Negligible)
		DBS West	0.11 (0.0003% of SE MU & 0.0002% of Wider MU)	Negligible (Negligible)
		OECC	0.22 (0.0007% of SE MU & 0.0004% of Wider MU)	Negligible (Negligible)
		Offshore Development Area	0.16 (0.0005% of SE MU & 0.0003% of Wider MU)	Negligible (Negligible)
	TTS weighted SEL impulsive criteria ($1.02km^2$) unmitigated	DBS East	0.18 (0.0006% of SE MU & 0.0003% of Wider MU)	Negligible (Negligible)
		DBS West	0.27 (0.0003% of SE MU & 0.0009% of Wider MU)	Negligible (Negligible)
		OECC	0.54 (0.002% of SE MU & 0.001% of Wider MU)	Negligible (Negligible)
		Offshore Development Area	0.39 (0.001% of SE MU & 0.0007% of Wider MU)	Negligible (Negligible)
Harbour seal	TTS SPL_{peak} ($0.41km^2$) unmitigated	DBS East	0.0007 (0.000014% of SE MU)	Negligible
		DBS West	0.0004 (0.000008% of SE MU)	Negligible
		OECC	0.0007 (0.000014% of SE MU)	Negligible
		Offshore Development Area	0.0006 (0.000013% of SE MU)	Negligible
	TTS weighted SEL impulsive criteria ($1.02km^2$) unmitigated	DBS East	0.0017 (0.00004% of SE MU)	Negligible
		DBS West	0.001 (0.00002% of SE MU)	Negligible
		OECC	0.0017 (0.00004% of SE MU)	Negligible
		Offshore Development Area	0.0015 (0.00003% of SE MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species and the CES MU for bottlenose dolphin*

11.6.4.3.7. Effect Significance

~~49.~~53. Taking into account the high sensitivity for all species to PTS from UXO clearance, the effect significance, for a high-order detonation without mitigation, has been assessed as major to minor adverse for harbour porpoise and minke whale, major to moderate adverse for grey seal, and moderate to minor adverse for bottlenose dolphin. Common dolphin, white-beaked dolphin and harbour seal are all minor adverse (**Table 11-6-11**).

~~50.~~54. For low-order clearance, without mitigation measures, and based on a high sensitivity for all marine mammals to PTS, the effect significance has been assessed as **minor adverse** for all marine mammal species (**Table 11-6-11**).

~~51.~~55. With mitigation measures, as laid out below, the residual effect significance would be **minor** (**not significant**) for the potential for PTS in all marine mammal species.

~~52.~~56. For TTS, taking into account the medium sensitivity for all species to UXO clearance, the effect significance, for both a high-order detonation and low-order detonation, without mitigation, has been assessed as moderate adverse for minke whale and grey seal, minor adverse for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal (**Table 11-6-11**).

~~53.~~57. It should be noted that the conclusion of moderate or major adverse (significant) without mitigation for PTS is very precautionary, as the assessment is based on the worst-case scenario of the largest possible UXO device as a high-order detonation.

Table 11-6-11 Assessment of Effect Significance for Auditory Injury From UXO Clearance

Species	Sensitivity	Magnitude*	Effect significance*	Mitigation	Residual effect significance
PTS during high-order UXO clearance					
Harbour porpoise	High	Medium and Negligible	Major to Minor adverse	MMMP for UXO clearance	**Minor adverse**
Bottlenose dolphin	High	Low (Medium) to Negligible (Negligible)	Moderate adverse (Major adverse) to Minor adverse	MMMP for UXO clearance	**Minor adverse**

Species	Sensitivity	Magnitude*	Effect significance*	Mitigation	Residual effect significance
Common dolphin	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
White-beaked dolphin	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Minke whale	High	Medium to Negligible	Major to Minor adverse	MMMP for UXO clearance	**Minor adverse**
Grey seal	High	Medium (Medium) to Low (Low)	Major to Moderate adverse	MMMP for UXO clearance	**Minor adverse**
Harbour seal	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
PTS during low-order UXO clearance					
Harbour porpoise	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Bottlenose dolphin	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Common dolphin	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
White-beaked dolphin	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Minke whale	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**

Species	Sensitivity	Magnitude*	Effect significance*	Mitigation	Residual effect significance
Grey seal	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Harbour seal	High	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
TTS during high-order UXO clearance					
Harbour porpoise	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Bottlenose dolphin	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Common dolphin	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
White-beaked dolphin	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Minke whale	Medium	Low to Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Grey seal	Medium	Low (Low) to Negligible (Negligible)	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Harbour seal	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
TTS during low-order UXO clearance					

Species	Sensitivity	Magnitude*	Effect significance*	Mitigation	Residual effect significance
Harbour porpoise	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Bottlenose dolphin	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Common dolphin	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
White-beaked dolphin	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Minke whale	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Grey seal	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Harbour seal	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**

** Magnitudes and significance given in brackets are for the secondary MU assessed for the wider population for grey seal species and the CES MU for bottlenose dolphin*

11.6.4.3.8. Mitigation

~~54.~~58. As outlined in section 11.6.3, a MMMP for UXO clearance would be produced post consent in consultation with the MMO and relevant SNCBs. The final MMMP for UXO clearance would be based on the latest scientific understanding and guidance, pre-construction UXO surveys in the offshore project area, as well as detailed project design.

~~55.~~59. The proposed mitigation measures for consideration in the **Outline MMMP (application ref: 8.25)** for UXO clearance include, the use of low-order clearance techniques, such as deflagration, establishing a monitoring zone and surveying prior to UXO clearance, the use of ADDs to ensure the potential PTS range has been cleared.

~~56.~~60. For high-order clearance, an ADD would be required to be activated for a maximum of 80 minutes, during which harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal, and harbour seal would move at least 7.2km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.* 2000), and minke whale would move 15.6km, based on swimming speed of 3.25m/s (Blix & Folkow, 1995).

~~57.~~61. This is less than the highest PTS effect range of 13km for harbour porpoise. Alternative mitigation such as noise reduction options could be required (e.g. bubble curtains) to avoid injury to this European Protected Species (EPS), or, if not possible to wholly mitigate the potential for auditory injury, a EPS licence for injury would be applied for, at the time of the ML application.

~~58.~~62. The implementation of the mitigation measures within the MMMP for UXO clearance would reduce the risk of any PTS during UXO clearance. The mitigation measure would also reduce the risk of TTS.

~~59.~~63. A marine wildlife licence application, if required, would be submitted post-consent. At this time, pre-construction UXO surveys would have been conducted, and full consideration would have been given to any necessary mitigation measures that may be required following the development of the MMMP for UXO clearance.

11.6.4.4. Impact 2: Disturbance Due To Underwater Noise Associated With UXO Clearance

11.6.4.4.1. Sensitivity of Marine Mammals

~~60.~~64. The sensitivity of marine mammals to disturbance as a result of underwater UXO detonations is considered to be medium for harbour porpoise and minke whale and low for dolphin spp. and grey and harbour seals in this assessment as a precautionary approach. Any effects on marine mammals would be temporary and they would be expected to return to the area once the activity had ceased.

11.6.4.4.2. Magnitude of Effect

~~61.~~65. There are currently no agreed thresholds or criteria for the behavioural response and disturbance of marine mammals, therefore it is not possible to conduct underwater noise modelling to predict potential effect ranges.

~~62.~~66. For marine mammals, a fleeing response is assumed to occur at the same noise levels as TTS for high-order UXO detonation. As outlined in Southall *et al.* (2007), the onset of behavioural disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing (i.e. TTS). Although, as Southall *et al.* (2007) recognised that this is not a behavioural effect per se sound exposures to lower noise levels from a single pulse are not expected to cause disturbance. However, any compromise, even temporarily, to hearing functions could have the potential to affect behaviour.

~~63.~~67. The use of the TTS threshold is appropriate for UXO disturbance because the noise from the UXO explosion is only fleetingly in the environment. Therefore, the assumption is that although noise levels lower than TTS threshold may startle the individual, this has no lasting effect. TTS results in a temporary reduction in hearing ability, and therefore may affect the individuals' fitness temporarily (as recommended in Southall *et al.* (2007) for a single pulse).

~~64.~~68. As outlined in Southall *et al.* (2021) thresholds that attempt to relate single noise exposure parameters (e.g. received noise level) and behavioural response across broad taxonomic grouping and sound types can lead to severe errors in predicting effects. Differences between species, individuals, exposure situational context, the temporal and spatial scales over which they occur, and the potential interacting effects of multiple stressors can lead to inherent variability in the probability and severity of behavioural responses.

~~65.~~69. The assessments for TTS / fleeing response have therefore been used for assessing the potential disturbance ranges for UXO high-order detonation for those species where no further information is currently available for potential disturbance ranges due to UXO clearances. Therefore, the potential range and areas for TTS presented in **Table 11-6-6**, with the estimated number and percentage of reference populations that could be affected as assessed in section 11.6.4.3.6, provides an indication of possible fleeing response. The SNCBs currently recommend that a potential disturbance range based on an Effective Deterrent Radius (EDR) of 26km around UXO high-order detonations is used to assess harbour porpoise disturbance in SACs (JNCC *et al.* 2020); the offshore project area lies within the Southern North Sea SAC. The assessment for the potential disturbance for high-order detonation, therefore, also includes the maximum number of harbour porpoise based on maximum potential impact area for 26km EDR (an area of 2,123.7km^2).

~~66.~~70. The potential disturbance for low-order clearance (the first option and preferred method) is currently unknown, however, as a precautionary approach, it has been assumed that there could be an estimated worst-case of 5km disturbance range (78.54km^2) including vessels. As a worst-case assessment, it has been assumed that marine mammals could be temporarily disturbed from this area for UXO low-order clearances.

~~67.~~71. In addition, the MMMP for UXO clearance would include ADD activation prior to all UXO clearance, to ensure marine mammals are beyond the maximum potential effect ranges for PTS. The duration for ADD activation would depend on the clearance method, and would vary for low-order clearance, high-order detonation, size of UXO (NEQ) and location (e.g., marine mammal species that could be present in nearshore and offshore areas).

~~68.~~72. The duration of ADD activation required would be determined for the final MMMP for UXO clearance, based on detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time, in consultation with the MMO and relevant SNCBs. Therefore, assessments provided are for information only and would be reviewed and updated for the marine licence and marine wildlife licence application prior to UXO clearance.

11.6.4.4.3. Magnitude of Effect for Disturbance Due to UXO Clearance

~~69.~~73. As assessed in section 11.6.4.3.6 for a high-order detonation of the maximum potential UXO with an NEQ of 698kg plus donor charge, the magnitude for TTS / fleeing response is assessed, as a worst-case, to be negligible for all marine mammal species.

~~70.~~74. For low-order clearance (0.25kg donor charge for all sizes of UXO) the magnitude for TTS / fleeing response is assessed to be negligible for all marine mammal species.

~~71.~~75. The maximum number of harbour porpoise that could potentially be disturbed in a 26km radius of a high-order UXO detonation without mitigation has been estimated. The resulting magnitude is assessed to be negligible (**Table 11-6-12**).

~~72.~~76. There would be only one high-order UXO detonation at a time during UXO clearance operation, i.e., there would be no simultaneous high-order UXO detonations. Although, more than one UXO clearance (low order) could occur in a 24-hour period.

Table 11-6-12 Estimated Number of Harbour Porpoise that Could Potentially be Disturbed During UXO Clearance Based on 26km EDR for High-Order Detonation With No Mitigation.

Location	Maximum effect area	Maximum number of individuals	% Of reference population	Magnitude (temporary effect)
DBS East	2,123.7km^2	1274.2	0.37% of NS MU	Negligible
DBS West		1401.6	0.40% of NS MU	

~~73.~~77. Based on an estimated worst-case of 5km disturbance range (78.54km^2) including vessels for low-order clearance (such as deflagration), the magnitude of effect has been assessed as negligible for all marine mammal species (**Table 11-6-13**).

Table 11-6-13 Estimated Number of Marine Mammals that Could Potentially be Disturbed During Low-Order UXO Clearance Based on 5km Disturbance Ranges With a Maximum Area of Effect of 78.54km^2

Species	Location	Maximum number of individuals and of reference population	Magnitude (temporary effect)*
Harbour porpoise	DBS East	47.1 (0.014% of NS MU)	Negligible
	DBS West	51.8 (0.015% of NS MU)	Negligible
Bottlenose dolphin	DBS East, DBS West, OECC. Offshore Development Area	3.9 (0.19% of GNS MU & 1.7% of CES MU)	Negligible (Low)
Common dolphin	DBS East, DBS West, OECC. Offshore Development Area	1.3 (0.0013% of CGNS MU)	Negligible
White-beaked dolphin	DBS East	2.7 (0.0061% of CGNS MU)	Negligible
	DBS West	3.2 (0.0073% of CGNS MU)	Negligible
Minke whale	DBS East	0.8 (0.0039% of CGNS MU)	Negligible
	DBS West	1.6 (0.0078% of CGNS MU)	Negligible
Grey seal	DBS East	14.2 (0.046% of SE MU & 0.025% of Wider MU)	Negligible (Negligible)

Species	Location	Maximum number of individuals and of reference population	Magnitude (temporary effect)*
	DBS West	20.4 (0.067% of SE MU & 0.036% of Wider MU)	
	OECC	41.7 (0.14% of SE MU & 0.074% of Wider MU)	
	Offshore Development Area	30.3 (0.099% of SE MU & 0.054% of Wider MU)	
Harbour seal	DBS East	0.13 (0.0027% of SE MU)	Negligible
	DBS West	0.08 (0.0016% of SE MU)	
	OECC	0.13 (0.0027% of SE MU)	
	Offshore Development Area	0.12 (0.0024% of SE MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species and the CES MU for bottlenose dolphin*

11.6.4.4.4. Magnitude of Effect for Disturbance from ADD Activation

~~74.~~78. The estimated maximum ADD activation prior to UXO clearance has been determined based on the maximum predicted effect range for low-order clearance of 990m for harbour porpoise, and for high-order detonation a PTS range of 13km for harbour porpoise (**Table 11-6-5)**.

~~75.~~79. For low-order clearance, ADD would be activated for 12 minutes, during which harbour porpoise; bottlenose dolphin; common dolphin; white-beaked dolphin; grey seal, and harbour seal would move at least 1.08km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.* 2000) and minke whale would move 2.34km, based on swimming speed of 3.25m/s (Blix & Folkow, 1995).

~~76.~~80. For high-order clearance, an ADD would be activated for a maximum of 80 minutes, during which harbour porpoise; bottlenose dolphin; common dolphin; white-beaked dolphin; grey seal, and harbour seal would move at least 7.2km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.* 2000), and minke whale would move 15.6km, based on swimming speed of 3.25m/s (Blix & Folkow, 1995). The ADD activation period does not provide enough time for harbour porpoise to deter from the PTS range (13km), therefore additional mitigation measures would be required.

~~77.~~81. The magnitude of effect for ADD activation prior to UXO clearance has been assessed as negligible for all marine mammal species (**Table 11-6-14**).

~~78.~~82. ADD would only be activated for the minimum time required to ensure effective mitigation. The disturbance as a result of ADD activation is within the maximum effect range assessed for TTS / disturbance from UXO clearance and is therefore not an additive effect to the overall area of potential disturbance.

Table 11-6-14 Estimated Number of Marine Mammals that Could Potentially be Disturbed During ADD Activation for UXO Clearance.

Species (Highest density)	Low-order clearance up to 12 minutes		High-order clearance up to a maximum to 80 minutes	
	Number of individuals potentially disturbed (% of reference population)	Magnitude of effect	Number of individuals potentially disturbed (% of reference population)	Magnitude of effect*
Harbour porpoise	2.5 (0.0007% of NS MU)	Negligible	110.4 (0.032% of NS MU)	Negligible
Bottlenose dolphin	0.18 (0.0091% of GNS MU & 0.082% of CES MU)	Negligible	8.2 (0.41% of GNS MU & 3.7% of CES MU)	Negligible (Low)
Common dolphin	0.064 (0.00006% of CGNS MU)	Negligible	2.8 (0.003% of CGNS MU)	Negligible
White-beaked dolphin	0.15 (0.00035% of CGNS MU)	Negligible	6.9 (0.016% of CGNS MU)	Negligible
Minke whale	0.34 (0.0017% of CGNS MU)	Negligible	15.3 (0.076% of CGNS MU)	Negligible
Grey seal	2.0 (0.0065% of SE MU & 0.0035% of Wider MU)	Negligible	88.8 (0.29 of SE MU & 0.16% of Wider MU)	Negligible
Harbour seal	0.0064 (0.00013% of SE MU)	Negligible	0.28 (0.0058% of SE MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species and the CES MU for bottlenose dolphin*

11.6.4.4.5. Effect Significance

~~79.~~83. Taking into account the medium sensitivity of marine mammals to disturbance from UXO clearance and the magnitudes of effect (**Table 11-6-13** and **Table 11-6-14),** the temporary disturbance during UXO clearance has been assessed as negligible to minor adverse (not significant) for all marine mammals (**Table 11-6-15**).

Table 11-6-15 Assessment of Effect Significance for Disturbance of Marine Mammals During UXO Clearance

Species	Sensitivity	Magnitude*	Effect significance
Disturbance effect (26km EDR for high-order clearance)			
Harbour porpoise	Medium	Negligible	**Minor adverse**
Disturbance effect (5km disturbance for low-order clearance)			
Harbour porpoise and minke whale	Medium	Negligible	**Minor adverse**
C~~c~~ommon dolphin; white-beaked dolphin; grey seal, and harbour seal	Low	Negligible	**Negligible adverse**
Bottlenose dolphin	Low	Negligible (Low)	**Negligible adverse**
Disturbance from ADD activation			
Harbour porpoise and minke whale	Medium	Negligible	**Minor adverse**
~~c~~Common dolphin; white-beaked dolphin; grey seal, and harbour seal	Low	Negligible	**Negligible adverse**
Bottlenose dolphin	Medium	Negligible (Low)	**Minor adverse**

** Magnitudes given in brackets are for the secondary MU assessed for the CES MU for bottlenose dolphin*

11.6.4.4.6. Mitigation

~~80.~~84. No mitigation is required for disturbance to marine mammals due to UXO clearance.

11.6.4.5. Impact 3: Changes To Prey Availability as a Result of Underwater Noise from UXO Clearance Activities

11.6.4.5.1. Sensitivity

~~81.~~85. As outlined in Appendix 11-3, the diet of harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.* 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes in prey resources.

~~82.~~86. Bottlenose dolphin are opportunistic feeders and take a wide variety of fish and invertebrate species. Benthic and pelagic fish (both solitary and schooling species), however, they are selective opportunists and although they may have preference for a type of prey, their diet seems to be determined largely by prey availability (see **Volume 7, Appendix 11-2 Marine Mammal Information Report (application ref: 7.11.11.2)**). Therefore, bottlenose dolphin are considered to have a low to medium sensitivity to changes in prey resource.

~~83.~~87. Common dolphin are cooperative feeders, working within a pod to capture prey and have a varied diet (see **Volume 7, Appendix 11-2 Marine Mammal Information Report (application ref: 7.11.11.2)**). Therefore, common dolphin are considered to have a low to medium sensitivity to changes in prey resource.

~~84.~~88. White-beaked dolphin have a varied diet (see **Volume 7, Appendix 11-2 Marine Mammal Information Report (application ref: 7.11.11.2)**). Therefore, common dolphin are considered to have a low to medium sensitivity to changes in prey resource.

~~85.~~89. Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species at the population level (see **Volume 7, Appendix 11-2 Marine Mammal Information Report (application ref: 7.11.11.2)**). Therefore, minke whale are considered to have a low to medium sensitivity to changes in prey resource.

~~86.~~90. Grey and harbour seal feed on a variety of prey species, both are considered to be opportunistic feeders, feeding on wide range of prey species and they are able to forage in other areas and have relatively large foraging ranges (see **Volume 7, Appendix 11-2 Marine Mammal Information Report (application ref: 7.11.11.2)**). Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources.

11.6.4.5.2. Magnitude of Effect

~~87.~~91. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** assessed the potential impact of underwater noise and vibration as a result of UXO clearance activities to fish species. The assessment found in all cases, high risks are only anticipated at short distances. Taking this into considering and the short term and intermittent nature of this activity (limited to instances when detonation of UXO is required) the magnitude of the impact is considered to be low for fish species.

~~88.~~92. Therefore, the magnitude of effect for changes to prey resources as a result of UXO clearance activity, has been assessed as low for all marine mammal species.

11.6.4.5.3. Effect of Significance

~~89.~~93. Taking into account the low sensitivity of bottlenose dolphin; common dolphin; white-beaked dolphin; grey seal and harbour seal and the low to medium sensitivity of harbour porpoise and minke whale, as well as the low magnitude of effect for all species, the changes to prey resources as a result of underwater noise from UXO clearance activity has been assessed as negligible for bottlenose dolphin; common dolphin; white-beaked dolphin; grey seal and harbour seal; and negligible to minor adverse for harbour porpoise and minke whale.

11.6.4.5.4. 1.4.5.4 Mitigation

~~90.~~94. No mitigations are required for changes to prey availability as a result of underwater noise from UXO clearance activities.

11.6.5. Summary

~~91.~~95. The potential effects on marine mammals from UXO clearance at the Offshore Development Area are summarised in **Table 11-6-16**.

Table 11-6-16 Summary of Potential Effects to Marine Mammals due to UXO Clearance

Potential effect	Receptor	Sensitivity	Magnitude*	Pre-mitigation effect	Mitigation measures	Residual effect
Impact 1: Auditory injury from underwater noise associated with UXO clearance						
PTS for UXO high-order detonation with no mitigation	Harbour porpoise and minke whale	High	Medium-Negligible	Major to minor adverse	MMMP for UXO clearance	Minor adverse
	Bottlenose dolphin	High	Low (Medium) - Negligible (Negligible)	Moderate (major) to minor adverse		Minor adverse
	Common dolphin and white-beaked dolphin	High	Negligible	Minor adverse		Minor adverse
	Grey seal	High	Medium (Medium) to Low (Low)	Major to moderate adverse		Minor adverse
	Harbour seal	High	Negligible	Minor adverse		Minor adverse
PTS for UXO low-order detonation with no mitigation	All marine mammals	High	Negligible	Minor adverse	MMMP for UXO clearance	Minor adverse
TTS for UXO high-order detonation with no mitigation	Harbour porpoise, Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal	Medium	Negligible	Minor adverse	MMMP for UXO clearance	Minor adverse
	Minke whale and grey seal	Medium	Low - Negligible	~~Moderate to m~~Minor adverse		Minor adverse
TTS for UXO low-order detonation with no mitigation	All marine mammals	Medium	Negligible	Minor adverse	None required	Minor adverse
Impact 2: Disturbance from underwater noise associated with UXO clearance						
Disturbance from UXO clearance	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	None required	Minor adverse
	Common dolphin; white-beaked dolphin; grey seal, and harbour sea	Low	Negligible	Negligible adverse		Negligible adverse
	Bottlenose dolphin	Low	Negligible (Low)	Negligible (~~M~~minor) adverse		Negligible adverse
Disturbance from ADD activation	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	None required	Minor adverse
	Bottlenose dolphin; common dolphin; white-beaked dolphin; grey seal, and harbour sea	Low	Negligible	Negligible adverse		Negligible adverse

Potential effect	Receptor	Sensitivity	Magnitude*	Pre-mitigation effect	Mitigation measures	Residual effect
Impact 3: Changes to prey resources						
Changes to prey availability as a result of underwater noise from UXO clearance activities	Harbour porpoise and minke whale	Medium	Low	Minor adverse	None required	Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin,	Low	Low	Minor adverse	None required	Minor adverse
	Grey seal and harbour seal	Low	Low	Minor adverse	None required	Minor adverse

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species and the CES MU for bottlenose dolphin*

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