MachairWind Offshore Windfarm

Appendix 10.6 UXO Assessments for Marine Mammals and Leatherback Turtle

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Glossary of Acronyms

Term	Definition
ADD	Acoustic Deterrent Device
CGNS	Celtic Greater North Sea
CWSH	Coastal West Scotland Hebrides
EDR	Effective Deterrent Range
EIA	Environmental Impact Assessment
EPS	European Protected Species
ETG	Expert Topic Group
Defra	Department for Environment, Food & Rural Affairs
HF	High Frequency
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
MD-LOT	Marine Directorate Licensing and Operations Team
ML	Marine License
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Mammal Observer
MU	Management Unit
NA	North Atlantic
N/A	Not Applicable
NAS	Noise Abatement System
NEQ	Noise Equivalent Quanta
NOAA	National Oceanic Atmospheric Administration
NPL	National Physical Laboratory
OW	Offshore Waters
PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores (in Water)
PTS	Permanent Threshold Shift
SEL / $L_{E,p}$	Sound Exposure Level
SEL_{cum} / $L_{E,p,t}$	Cumulative Sound Pressure Level
SEL_{SS} / $L_{E,p,ss}$	Single Strike Sound Exposure Level
SPL / L_p	Sound Pressure Level
SPL_{peak} / $L_{p\text{-}pk}$	Peak Sound Pressure Level
TTS	Temporary Threshold Shift

Term	Definition
UXO	Unexploded Ordnance Clearance
VHF	Very High Frequency
WDA	Windfarm development Area
WS	West Scotland

Glossary of Terms

Term	Definition
Embedded mitigation measure	Mitigation measures, including industry good practice measures, that are directly incorporated into the design for the MachairWind Windfarm Development Area to avoid or reduce environmental effects.
Environmental Impact Assessment (EIA)	The process of evaluating the likely significant environmental effects of a proposed development over and above the existing circumstances (or 'baseline').
Environmental Impact Assessment (EIA) Regulations	A collective term referring to The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
EIA Scoping Windfarm Development Area (WDA) Boundary	The 510 km^2 WDA boundary presented at the Project's EIA Scoping Stage.
MachairWind Offshore Windfarm	An offshore windfarm capable of exporting around 2 GW of renewable energy to the National Electricity Transmission System. MachairWind Offshore Windfarm comprises three Development Areas: • The WDA – located on the west coast of Scotland to the northwest of Islay and west of Colonsay; • The Offshore Export Cable Corridor – a preliminary boundary extending from the WDA to mean high water springs at a landfall location near Girvan, South Ayrshire; and • The Onshore Transmission Development Area – a preliminary boundary which extends landward from mean low water springs and includes the land required for the landfall of the offshore export cable(s) and their route up to but not including the proposed high voltage direct current switching station which will be developed and constructed by Transmission Owner, ScottishPower Transmission. Separate consent and licence applications will be submitted for each Development Area.
Permanent Threshold Shift (PTS)	A permanent total or partial loss of hearing sensitivity caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity.
The Project	MachairWind Offshore Windfarm including all its Development Areas and associated infrastructure.
Temporary Threshold Shift (TTS)	A temporary reduction in hearing sensitivity caused by acoustic trauma.
Windfarm Development Area (WDA)	The application boundary within the OAA where consent will be sought for the proposed WDA infrastructure. The WDA infrastructure is subject to Section 36 consent and marine licence applications (generation and transmission) which are being applied for separately from the Offshore ECC infrastructure and OnTDA infrastructure.

1 INTRODUCTION

1. This appendix accompanies **Chapter 10 Marine Mammals and Leatherback Turtle** of the MachairWind Windfarm Development Area (WDA) Environmental Impact Assessment (EIA) Report. It presents an indicative evaluation of the potential risks of auditory injury and behavioural disturbance to marine mammals associated with any future clearance of unexploded ordnance (UXO) within the WDA. The assessment draws on the underwater noise modelling provided in **Section 6**, as well as in **Appendix 10.1 Underwater Noise Modelling Report**.

2. UXO clearance does not form part of the Section 36 or Marine Licence (ML) applications submitted for the WDA because detailed information on the presence and characteristics of UXO is not yet available. Once post-consent UXO investigations provide verified locations and quantities requiring clearance, a separate ML application will be prepared. This application will be supported by a Marine Mammal Mitigation Protocol (MMMP), which will be reviewed in consultation with the Marine Directorate – Licensing and Operations Team (MD-LOT) and NatureScot before any UXO clearance works commence.

3. A cumulative effect assessment for a range of impact pathways, including UXO clearance at other projects, is provided in Section 10.12 of **Chapter 10 Marine Mammals and Leatherback Turtle**.

4. The assessment within this appendix is in line with and has been supported by information from the following relevant policies and guidance, as noted in Section 10.2 within **Chapter 10 Marine Mammals and Leatherback Turtle**.

- Marine licensing – unexploded ordnance clearance: application guidance (Marine Directorate-Licensing Operations Team (MD-LOT), 2025), which sets out the regulatory expectations, environmental considerations, and required documentation for licence applications;
- Marine Environment: 'Unexploded Ordnance Clearance Joint Position Statement' (Department for Environment, Food & Rural Affairs (Defra) et al., 2025), which outlines the preferred approach to UXO clearance; and
- Joint Nature and Conservation Committee (JNCC) 'Guidelines for Minimising the Risk of Injury to Marine Mammals from UXO Clearance in the Marine Environment' (JNCC, 2025a), which outlines measures to minimise potential injury from the UXO clearance activities.

5. As outlined in Section 10.8.1 of **Chapter 10 Marine Mammals and Leatherback Turtle**, the receptors relevant to the Wider Study Area which will be assessed in the UXO assessment are:

- Toothed whales:
  - Harbour porpoise (*Phocoena Phocoena*);
  - Bottlenose dolphin (*Tursiops truncatus*);
  - Short-beaked common dolphin (*Delphinus delphis*);
  - Atlantic white-sided dolphin (*Lagenorhychus acutus*);
  - White-beaked dolphin (*Lagenorhynchus albirostris*);
  - Risso's dolphin (*Grampus griseus*);
  - Long-finned pilot whale (*Globicephala melaena*); and
  - Killer whale (*Orcinus orca*).
- Baleen whales:
  - Minke whale (*Balaenoptera acutorostrata*);
  - Fin whale (*Balaenoptera physalus*); and
  - Humpback whale (*Megaptera novaeangliae*).
- Pinnipeds:
  - Grey seal (*Halichoerus grypus*); and
  - Harbour seal (*Phoca vitulina)*.

- Turtles
    - Leatherback turtle (*Dermochelys coriacea*)

6. **Appendix 10.2 Marine Mammals and Leatherback Turtle Baseline** provides further information that is relevant for the assessments for each receptor, including details from the site-specific surveys, density and abundance estimates.

2 WORST-CASE SCENARIO

7. **Table 2.1** presents the indicative worst-case parameters for assessing the impacts of UXO clearance on marine mammals and leatherback turtle.

8. Any UXO clearance undertaken as part of the Project will, by default, employ low-order clearance methods in line with current MD-LOT guidance (2025). Accordingly, the mitigation measures presented for UXO clearance (**Section 3**) are representative of low-order clearance techniques. Further details on the approach to mitigation during UXO clearance is provided in **Appendix 9 Draft MMMP**. However, as a precautionary approach, a worst-case scenario assuming an accidental high-order clearance (without noise mitigation (both embedded and additional)) has also been assessed.

Table 2.1 Realistic worst-case parameters for marine mammals UXO assessment (indicative)

Worst-Case Scenario	Notes and Rationale
Types and sizes of UXO: various possible types and sizes of UXO, ranging from 0.25 kg to 750 kg.	Indicative only. A detailed UXO survey would be completed prior to the commencement of construction. The exact type, size and number of possible detonations and duration of UXO clearance operations is therefore not known at this stage.
Clearance techniques: low-order clearance is considered to be the default method for UXO that require clearance. However, in case of accidental high order detonation during low-order clearance attempts, assessments based on high-order clearance of a 750 kg UXO without noise mitigation (both embedded and additional) are provided.	Both low-order clearance and high-order clearance are assessed as presented to NatureScot in the second Expert Topic Group (ETG) meeting on 14th November 2025. High-order clearance would only be undertaken in the event that low-order clearance is not possible or failed to clear the device completely. However, in these cases Noise Abatement Systems (NAS) would be implemented (see **Appendix 9 Draft MMMP**). A high-order clearance (without noise mitigation) is very unlikely to occur in reality and is only assessed as a worst-case scenario.

3 EMBEDDED MITIGATION MEASURES

9. Embedded mitigation relevant to the UXO Assessment for marine mammals and leatherback turtle is set out in **Table 3.1**. Latest guidance will inform the application of mitigation measures at the time of the ML application for UXO clearance.

Table 3.1 UXO clearance mitigation measures

ID	Mitigation Measure	Description	Securing Mechanism
M-10	Unexploded Ordnance Clearance	A detailed MMMP based on UXO clearance guidance (MD-LOT, 2025), the JNCC (2025a) guidelines for minimising the risk of injury to marine mammals from UXO clearance and Defra (2025) guidance on minimising environmental impacts from UXO clearance, will be included in the Final MMMP prepared for UXO clearance for the Marine Licence application, during the pre-construction phase. The Final MMMP will accord with **Appendix 9 Draft MMMP** submitted with the application. This will ensure there are adequate mitigation measures to minimise the risk of any physical or permanent auditory injury to marine mammals and leatherback turtle from UXO clearance. Following the latest guidance, low order clearance will be the default method. The Draft MMMP for UXO clearance is presented in Section 3 of **Appendix 9 Draft MMMP**.	Mitigation will be secured in the UXO MMMP as part of a separate Marine Licence application submission prior to construction.

4 UXO CLEARANCE TECHNIQUES

10. The assessments presented are based on the indicative worst-case scenario described in **Section 6**. This includes the use of the maximum predicted impact ranges associated with impulsive noise thresholds.

11. High-order clearance refers to UXO disposal methods that involve placing and detonating substantial donor charges adjacent to the ordnance, resulting in the simultaneous detonation of any explosive material contained within the UXO. In contrast, low-order clearance techniques aim to make the UXO safe or remove it without triggering a full detonation. These low-order approaches are the preferred method for UXO management (Defra et al., 2025; MD-LOT, 2025). Examples of low-order techniques include (National Physical Laboratory (NPL), 2020a):

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

12. Deflagration involves using a small shaped-charge device to create a focused plasma jet that ignites, rather than detonates, the explosive content of a UXO. This causes the material to burn rapidly at subsonic speeds, without generating the level of shock required to trigger a full high-order explosion (Merchant & Robinson, 2019; NPL, 2020a). In effect, the energetic material undergoes fast combustion rather than the chain reaction associated with detonation (NPL, 2020a).

13. Research shows that deflagration can achieve significant reductions in underwater noise compared to high-order clearance, with Peak Sound Pressure Levels (SPL_{peak} / $L_{p\text{-pk}}$) and Sound Exposure Levels (SEL / $L_{E,p}$) typically more than 20 dB lower. Additionally, the acoustic output from a deflagration event is influenced primarily by the size of the shaped charge used, rather than by the overall size of the UXO (NPL, 2020b; Robinson et al., 2020).

14. Although low-order methods such as deflagration are relatively new in civilian offshore operations, they have been routinely used by the UK military since 2005 (Merchant & Robinson, 2019). A recent

successful large-scale application was demonstrated during clearance works for the Moray West Offshore Wind Farm, where 82 UXOs were safely neutralised using low-order techniques (Ocean Winds et al., 2024).

15. According to the Joint Position Statement (Defra et al., 2025), and the MD-LOT guidance on ML applications (MD-LOT, 2025) low-noise clearance methods should be used as the default option when applying for Marine Licences. However, exceptional circumstances may arise in which low-order or low-noise approaches are not technically feasible, for example, when the condition, depth, construction, or degradation of a UXO exceeds the proven operational limits of available low-noise techniques. In such circumstances, high-order clearance may be required and may represent the only viable clearance method. In these cases, the Joint Position Statement (Defra et al., 2025) and the MD-LOT guidance on Marine Licence applications state that the use of NAS is required for high-order clearance, as set out in the JNCC guidelines for minimising the risk of injury to marine mammals from the use of explosives in the marine environment (JNCC, 2025a).

16. While low-order clearance is the preferred method for UXO disposal within the WDA and is assessed below, an assessment of high-order clearance without mitigation is also provided, although in reality, this would only occur in the event low-order clearance were to fail and trigger an unexpected high-order explosion.

5 POTENTIAL EFFECTS

17. Pre-construction UXO surveys will be carried out to determine whether any items of unexploded ordnance are present within the WDA that may require clearance. Where UXO is identified, the preferred approach would be to avoid the item or, if safe and feasible, to remove it for onshore disposal at a suitably licensed facility. However, in circumstances where relocation or recovery poses safety risks, in-water clearance may be necessary.

18. Underwater detonation of UXO has the potential to affect marine mammals and leatherback turtle in several ways, including:

- Physical injury caused by direct exposure to the blast or through secondary effects of the shock wave, which in severe cases may lead to immediate or delayed mortality;
- Hearing damage, arising from the intense sound pressure generated by the detonation, which may result in Permanent Threshold Shift (PTS) or Temporary Threshold Shift (TTS);
- Behavioural disruption, including changes to foraging, reproductive behaviour, resting, or movement patterns (Richardson et al., 1995; Ketten, 2004; von Benda-Beckmann et al., 2015); and
- Indirect effects on prey availability, for example through disturbance or displacement of fish or other prey species.

19. The magnitude of impacts on marine mammals and leatherback turtle from UXO clearance is influenced by several factors, with the most critical being the explosive charge mass and the distance between the detonation and the animal. Once a detonation occurs, the resulting shock wave moves outward in a spherical pattern and typically follows a straight-line path, unless altered by factors such as water stratification, seabed or surface reflections, or other environmental obstructions.

20. Available acoustic measurement data for UXO detonations are limited, and noise levels can vary widely depending on factors such as charge size, water depth, seabed characteristics, and local bathymetry, all of which affect how sound travels underwater. Water depth is particularly influential because greater depths generally allow sound to propagate over longer distances (von Benda-Beckmann et al., 2015).

21. It is important to highlight that underwater noise modelling for the impact assessment uses a worst-case scenario, assuming high-order clearance without noise mitigation (both embedded and additional). In practice, this scenario is expected to be highly unlikely, as low-order clearance techniques would normally be used first for any UXO that cannot be avoided, moved, or lifted, consistent with the guidance in the Joint Position Statement (Defra et al., 2025), the MD-LOT guidance on Marine Licence applications (MD-LOT, 2025) and the JNCC guidelines for minimising the risk of injury to marine mammals from UXO clearance in the marine environment (JNCC,2025a).

6 UNDERWATER NOISE MODELLING

22. A range of UXO types, each containing different quantities of explosive material, may potentially occur within the WDA. These items could include a variety of explosive compositions and may have undergone varying degrees of degradation, corrosion, or burial since their original deposition. As a result, two UXOs of the same design may not behave identically, as differences in environmental exposure can influence the energy released during a detonation.

23. A range of explosive charge sizes has been used to estimate the underwater noise levels associated with potential UXO detonation (details are provided in **Appendix 10.1 Underwater Noise Modelling Report**). These values were selected to represent a realistic spread of UXO types known from comparable sites in proximity to the WDA (see **Table 6.1**).

24. The maximum equivalent charge weight for UXO that could feasibly occur within the WDA has been estimated at 750 kg. Noise modelling was undertaken for this upper-end scenario, alongside a series of smaller representative charge weights of 25, 55, 120, 240, 525 and 698 kg, informed by experience from previous offshore projects. The assessment presented in **Section 7** adopts the maximum charge weight to ensure a precautionary, worst-case approach.

25. The modelling also considers low-order clearance techniques, including deflagration. For these scenarios, an additional 0.25 kg donor charge has been incorporated to initiate the burn. **Table 6.1** presents the source levels used for the UXO clearance modelling.

26. **Table 6.2** and **Table 6.3** present the impact ranges from the underwater noise modelling for low order and high order clearance.

27. The assessment is carried out on the worst-case high order clearance (750 kg Noise Equivalent Quantity (NEQ) without noise mitigation) and for low order clearance (0.25 kg NEQ).

Table 6.1 List of the SPL_{peak} / $L_{p\text{-}pk}$ and SEL / $L_{E,p}$ source levels used for UXO clearance modelling.

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

Charge Weight	SPL_{peak} Source Level (dB re 1 μPa @ 1m)	SEL_{ss} Source Level (dB re 1 μPa²s @ 1m)
750 kg (+ donor)	296.0 dB re 1 μPa	237.3 dB re 1 μPa²s

28. The SEL / $L_{E,p}$ criteria is weighted, which corrects the sound level based on the sensitivity of the receiver. The weighting takes the hearing range of each receptor into consideration. Southall et al. (2019) additionally includes criteria based on SPL_{peak} / $L_{p\text{-}pk}$, which are unweighted and do not take species sensitivity into account. Both SPL_{peak} / $L_{p\text{-}pk}$ and SEL / $L_{E,p}$ values are based on the impulsive and non-impulsive criteria. However, it is important to note that they are different criteria and as such they should not be compared directly. All decibel SPL / $L_{p\text{-}pk}$ values are referenced to 1 μPa and all SEL / $L_{E,p}$ values are referenced to 1 μPa²s.

Table 6.2 Unweighted L_{p-pk} (SPL$_{peak}$) impact ranges for marine mammals using the Southall et al. (2019) impulsive criteria for UXO clearance noise (impacts in ***bold*** *are the impact ranges being assessed)*

Southall et al. (2019) L_{p-pk}	PTS (Impulsive)				TTS (Impulsive)			
	Low Frequency (LF) (219 dB)	High Frequency (HF) (230 dB)	Very High Frequency (VHF) (202 dB)	Phocid Carnivores (in Water) (PCW) (218 dB)	LF (213 dB)	HF (224 dB)	VHF (196 dB)	PCW (212 dB)
Low order (0.25 kg)	170 m	60 m	990 m	190 m	320 m	100 m	1.8 km	360 m
25 kg (+ donor)	820 m	260 m	4.6 km	910 m	1.5 km	490 m	8.5 km	1.6 km
55 kg (+ donor)	1.0 km	340 m	6.0 km	1.1 km	1.9 km	640 m	11 km	2.1 km
120 kg (+ donor)	1.3 km	450 m	7.8 km	1.5 km	2.5 km	830 m	14 km	2.8 km
240 kg (+ donor)	1.7 km	560 m	9.8 km	1.9 km	3.2 km	1.0 km	18 km	3.5 km
525 kg (+ donor)	2.2 km	730 m	12 km	2.5 km	4.1 km	1.3 km	23 km	4.6 km
698 kg (+ donor)	2.4 km	810 m	13 km	2.7 km	4.5 km	1.4 km	25 km	5.0 km
750 kg (+ donor)	**2.5 km**	**830 m**	**14 km**	**2.8 km**	**4.6 km**	**1.5 km**	**26 km**	**5.1 km**

*Table 6.3 Weighted SEL / $L_{E,p,wtd}$ (single pulse) impact ranges for marine mammals using the Southall et al (2019) impulsive criteria for UXO clearance noise (impacts in **bold** are the impact ranges being assessed)*

Southall *et al.* (2019) $L_{E,p,wtd}$ (Single pulse)	**PTS (Impulsive)**				**TTS (Impulsive)**			
	LF (183 dB)	**HF (185 dB)**	**VHF (155 dB)**	**PCW (185 dB)**	**LF (168 dB)**	**HF (170 dB)**	**VHF (140 dB)**	**PCW (170 dB)**
Low order (0.25 kg)	**230 m**	**< 50 m**	**80 m**	**< 50 m**	**3.2 km**	**< 50 m**	**750 m**	**570 m**
25 kg (+ donor)	2.2 km	< 50 m	570 m	390 m	29 km	150 m	2.4 km	5.2 km
55 kg (+ donor)	3.2 km	< 50 m	740 m	570 m	41 km	210 m	2.8 km	7.5 km
120 kg (+ donor)	4.7 km	< 50 m	950 m	830 m	57 km	300 m	3.2 km	10 km
240 kg (+ donor)	6.5 km	< 50 m	1.1 km	1.1 km	76 km	390 m	3.5 km	14 km
525 kg (+ donor)	9.5 km	50 m	1.4 km	1.6 km	100 km	530 m	4.0 km	19 km
698 kg (+ donor)	10 km	60 m	1.5 km	1.9 km	110 km	590 m	4.1 km	22 km
750 kg (+ donor)	**11 km**	**60 m**	**1.5 km**	**2.0 km**	**110 km**	**600 m**	**4.2 km**	**22 km**

29. The noise generated by the detonation of explosives can vary widely because it depends on numerous factors, such as the ordnance's design, explosive composition, age, level of degradation, orientation, structural damage, degree of burial, and sediment coverage. As these characteristics are rarely known in advance, there is considerable uncertainty in estimating the source noise level (i.e. the noise at the UXO's position). To address this uncertainty, a worst-case assumption has been applied, whereby the UXO is treated as intact, unburied, and not naturally attenuated. In practice, many UXOs have corroded casings or reduced explosive content from long-term degradation, meaning the predicted noise levels in **The SEL** / $LE_{,p}$ criteria is weighted, which corrects the sound level based on the sensitivity of the receiver. The weighting takes the hearing range of each receptor into consideration. Southall et al. (2019) additionally includes criteria based on SPLpeak / *Lp-pk*, which are unweighted and do not take species sensitivity into account. Both SPLpeak / *Lp-pk* and SEL / $LE_{,p}$ values are based on the impulsive and non-impulsive criteria. However, it is important to note that they are different criteria and as such they should not be compared directly. All decibel SPL / *Lp-pk* values are referenced to 1 μPa and all SEL / $LE_{,p}$ values are referenced to 1 μPa2s.

30. Table 6.2, especially for larger devices, are likely to overstate the levels expected during real clearance operations.

31. The assessment also does not incorporate the influence of depth-dependent sound variation or ocean stratification layers. Sound transmitted near the surface typically attenuates more rapidly than that produced in deeper water. Consequently, marine mammals in shallower water may be exposed to lower sound levels than suggested by the model predictions, making the assessment conservative regarding depth-related exposure.

32. Potential effects on marine mammals and leatherback turtle have been evaluated using the most recent Southall et al. (2019) thresholds for species that may occur within the WDA (see Section 10.11.1 in **Chapter 10 Marine Mammals and Leatherback Turtle**). These criteria identify the conditions at which PTS, i.e. irreversible hearing damage, could begin. Although not all individuals within the modelled PTS range will suffer permanent hearing loss, the assessment assumes this outcome as a precautionary worst-case.

33. The SEL / $L_{E,p}$ thresholds used in the assessment are frequency-weighted to reflect the specific hearing sensitivities of different marine mammal groups. For example, harbour porpoises are comparatively less sensitive to low-frequency sound than minke whales because their hearing ability declines substantially at low frequencies compared with the mid-frequency range (Dyndo et al., 2015). In contrast, minke whales are classified as low-frequency cetaceans and rely heavily on low-frequency acoustic cues for communication (McGarry et al., 2017). Southall et al. (2019) also provide unweighted SPL / L_p criteria, which do not incorporate species-specific auditory weighting.

34. The assessment uses both SPL_{peak} / $L_{p\text{-pk}}$ and SEL / $L_{E,p}$ metrics for impulsive and non-impulsive sound categories. These criteria represent different types of acoustic exposure and cannot be directly compared. All SPL_{peak} / $L_{p\text{-pk}}$ values are referenced to 1 μPa, and all SEL / $L_{E,p}$ values are referenced to 1 $\mu Pa^2 s$.

35. Accurately predicting peak noise levels in shallow water environments is challenging (von Benda-Beckmann et al., 2015), and model outputs often overpredict peak levels, particularly at greater ranges. Southall (2021) notes that as an impulsive sound moves away from the source, its kurtosis (a measure of impulsiveness) decreases significantly, and at sufficient distance the sound propagates into a non-impulsive like noise, which generally poses a lower risk of impact to all receptors due to reduced potential for behavioural disruption and auditory injury. Consequently, the application of impulsive sound criteria at distances of several kilometres is likely to be highly precautionary, as the signal will have degraded into a predominantly non-impulsive form with substantially lower impact potential.

36. Because the distance at which an impulsive signal transitions to a non-impulsive one cannot be precisely determined, underwater noise modelling for the UXO clearance in the WDA incorporates both impulsive and non-impulsive PTS-weighted SEL / $L_{E,p}$ criteria. This dual approach provides a useful indication of the potential range of maximum impact distances (**Appendix 10.1 Underwater Noise Modelling Report**).

7 ASSESSMENT OF EFFECTS

7.1 UNDERWATER NOISE DURING UXO CLEARANCE

37. To carry out any UXO clearance activities, a Marine Licence must be obtained from MD-LOT, in accordance with the Marine (Scotland) Act 2010 as it is assumed that any UXO clearance would be within 12 nautical miles, due to the WDA being inside the 12 nautical mile boundary. In addition, an European Protected Species (EPS) Licence application will be submitted, alongside a separate Marine Licence application once a detailed UXO survey has been completed, and a comprehensive assessment has been undertaken using the most current available data.

38. At present, the number of UXO devices that may require clearance, and the expected duration of these operations remains unknown. The indicative assessments presented in this appendix are based on both the most likely scenario of a low-order UXO clearance and the worst-case scenario of high-order UXO clearance without mitigation (both embedded and additional) (see **Appendix 9 Draft MMMP**).

7.2 RECEPTOR SENSITIVITIES

7.2.1 Harbour Porpoise

39. Recent research has demonstrated that harbour porpoise is at high risk of auditory injury from high-order detonations. A population-scale study in the Dutch Continental Shelf estimated that 88 UXO detonations in a single year likely caused between 1,280 and 5,450 permanent hearing loss events in harbour porpoises, based on sound exposure modelling and seasonal distribution data (Von Benda-Beckmann et al., 2015).

40. Post-mortem analysis of porpoise strandings after mine blasts in the Fehmarnbelt region revealed blast-related trauma, including haemorrhaging in the melon and lower jaw, and dislocation of auditory ossicles, highlighting the potential for direct physical injury from underwater explosions (GEOMAR, 2022).

41. UXO detonations are classified as impulsive noise sources, producing a single, high-energy pulse of short duration. This can lead to behavioural responses by marine mammals (Southall et al., 2019; National Oceanic Atmospheric Administration (NOAA), 2024). Evidence from recent studies has documented widespread behavioural changes in Special Areas of Conservation (SACs), particularly among harbour porpoise. These include reduced echolocation activity, altered dive patterns, and avoidance of impacted areas, all of which may contribute to increased energetic costs and reduced fitness over time (JNCC, 2025b).

42. Due to the above and their high international value, the sensitivity for PTS is considered to be **high** and for TTS and disturbance is considered to be **medium** due to harbour porpoise having some ability to adapt and recover.

7.2.2 Delphinids

43. Delphinids are highly vocal and social marine mammals that rely on mid to high frequency acoustic signals for communication, navigation, and foraging. Their auditory sensitivity makes them particularly vulnerable to impulsive underwater noise generated by UXO clearance, especially high-order detonations.

44. Bottlenose dolphin have been observed to experience TTS following exposure to single explosive events. Studies applying Southall et al. (2007) criteria suggest that TTS onset is a suitable proxy for

behavioural disturbance in response to UXO detonations, with recovery dependent on the intensity and duration of exposure (Finneran and Jenkins, 2012).

45. Due to the above and their high international value, the sensitivity for PTS is considered to be **high** and for TTS and disturbance is **medium** due to delphinids having some ability to adapt.

7.2.3 Mysticetes

46. There is limited data on mysticetes responses to UXO clearance, however, due to the sensitivity of mysticetes to underwater noise, high order UXO clearance can pose significant risk due to the intensity of the acoustic energy released.

47. Underwater noise from UXO clearance has the potential to cause auditory injury, and physiological stress to mysticetes as well as behavioural disturbance. Behavioural disturbance can include altering the whales' ability to communicate, navigate, and forage, especially given their reliance on low-frequency vocalisation that travels vast distances underwater (Clark and Garland, 2022). Cai et al. (2022) argues that such disturbances may have population-level consequences, particularly for species with long lifespans and slow reproductive rates.

48. Due to the above and their high international value, the sensitivity for PTS is considered to be **high** and for TTS and disturbance is **medium** due to mysticetes having some ability to adapt.

7.2.4 Pinnipeds

49. There are limited data on response of pinnipeds to UXO clearance, while pinnipeds are generally less acoustically sensitive than cetaceans, they remain vulnerable to underwater noise from UXO clearance, particularly from high-order detonations.

50. Both grey and harbour seal rely on underwater hearing for navigation, prey detection, and social interaction, and are known to exhibit behavioural responses to sudden acoustic disturbances. Field studies have shown that seals exposed to detonations display displacement of preferred sites, startle responses, and increased haul-out behaviour (Kastelein et al., 2012; Lepper et al., 2024).

51. Pinnipeds have been recorded to respond to high order clearance with a startle reaction, increased haul-out behaviour, and temporary abandonment of preferred haul-out sites. Studies have confirmed long-term displacement and physiological stress in seals and porpoises during offshore windfarm construction (Dähne et al., 2013; Brandt et al., 2018; Kastelein et al., 2012; Lepper et al., 2024). However, UXO clearance is typically short in duration and spatially limited, suggesting that while disturbance may occur, animals are likely to return once the activity ceases.

52. Due to the high international value, the sensitivity for PTS is considered to be **high** and for TTS and disturbance **medium** due to pinnipeds having some ability to adapt.

7.2.5 Leatherback Turtle

53. As deep-diving marine reptiles, leatherbacks rely heavily on acoustic cues for navigation and foraging, particularly when targeting gelatinous prey such as jellyfish in turbid or low-visibility conditions.

54. Although less acoustically sensitive than cetaceans, leatherbacks are still vulnerable to impulsive underwater noise, especially from high-order detonations. Observational data and modelling studies suggest that sudden acoustic disturbances can trigger startle responses, altered dive patterns, and temporary displacement from foraging grounds (Southall et al., 2021; Witt et al., 2023). One study looked into how sea turtles, including leatherbacks, respond to underwater noise such as explosions (Harms et al., 2023). The evidence showed that turtles often exhibit avoidance behaviour, like sudden diving or changes in swimming direction, when exposed to loud sounds. Though this area of research

is still new, these reactions suggest a possible link to stress. Though no studies have directly published a link, it's possible that underwater detonations could result in physiological stress responses (e.g., increased cortisol levels, heart rate changes). Research indicates sea turtles as low-frequency hearing specialists to impulsive noise (Popper et al., 2014). While PTS risk is considered low due to limited residency, behavioural disturbance and stress responses may still occur, especially in juveniles or individuals engaged in prolonged surface basking.

55. Due to the above and their high international value, the sensitivity for PTS is considered to be **high** and for TTS and disturbance **medium** due to leatherback turtle having some ability to adapt.

7.3 MAGNITUDE OF IMPACT

56. The assessment of potential auditory injury to marine mammals and leatherback turtle within the WDA is based on the impact criteria outlined by NMFS (2018) / Southall et al. (2019). These criteria incorporate species-specific hearing sensitivity thresholds and weightings (see Section 10.11.1.1 in **Chapter 10 Marine Mammals and Leatherback Turtle**), identifying the onset of PTS and TTS for marine mammals and leatherback turtle that may be present in or around the UXO clearance zones.

57. The severity of UXO clearance impacts depends on several factors, primarily the charge weight and distance to the receptor. The methodology used to assess receptor impacts includes the quantification of permanent and irreversible effects (e.g., auditory injury) as well as temporary or intermittent effects (e.g., TTS and behavioural disturbance), all of which are relevant to the exposed receptors and their habitats.

58. For the potential of auditory injury and disturbance, the assessment includes consideration of a low-order clearance which is the default method and as a worst-case scenario high-order clearance (without noise mitigation (both embedded and additional)) in case of accidental high order detonation.

7.3.1 Construction

7.3.1.1 Auditory Injury

59. **Table 6.1** presents the source levels used for the UXO clearance modelling. **Table 6.2** and **Table 6.3** present the impact ranges from the underwater noise modelling for low-order and high-order clearance. The assessment is carried out based on a worst-case high-order clearance (750 kg NEQ) without noise mitigation (both embedded and additional) and for low-order clearance (0.25 kg NEQ).

7.3.1.1.1 PTS

7.3.1.1.1.1 Low-Order Clearance

60. The use of low-order clearance techniques significantly reduces both the sound intensity and total acoustic energy released during detonation. Experimental data (Merchant and Robinson, 2020) show that the noise levels generated are primarily influenced by the size of the small initiating charge. The estimated maximum distances at which marine mammals and leatherback turtle may be affected by low-order clearance (0.25 kg) are provided in **Table 6.2** and **Table 6.3**. **Table 6.3** presents the weighted SEL / $L_{E,p}$ impact ranges for marine mammals and leatherback turtle using the NMFS (2018) / Southall et al. (2019).

61. The predicted impact range for delphinids (HF cetaceans) and pinnipeds (PCW) is less than 50 m for low-order clearance (0.25 kg charge). This indicates that PTS is not expected to occur, as the hearing threshold would not be exceeded. **Table 7.1** shows that using low-order clearance, the magnitude for PTS is assessed as low for harbour porpoise, bottlenose dolphin in the Coastal West Scotland Hebrides (CWSH) Management Unit (MU) and minke whale, and all other receptors are

negligible. However, this quantitative assessment does not account for embedded mitigation such as the use of MMOs (see **Appendix 9 Draft MMMP**) which would ensure marine mammals are clear of the area prior to any low-order clearance (and therefore any accidental high-order clearance). On this basis, the below magnitudes are considered to be over-precautionary.

Table 7.1 PTS assessment in marine mammals and leatherback turtle during low-order UXO clearance (N/E = non-exceedance)

Marine mammal species	PTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (permanent)*
Harbour porpoise	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	1 (0.005% West Scotland (WS) MU)	Low
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.00003% WS MU)	Negligible
Bottlenose dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.001% CWSH MU) & (0.00004% Offshore Waters (OW) MU)	Low (negligible)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/E	Negligible (negligible)
Common dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.00002% Celtic Greater North Sea (CGNS) MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/E	Negligible
Atlantic white-sided dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.000002% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/E	Negligible
White-beaked dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.000009% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/E	Negligible
Risso's dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.000001% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/E	Negligible
Killer whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.000001% WCC & 0.000000001% North Atlantic (NA) MU)	Negligible (negligible)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/E	Negligible (negligible)
Long-finned pilot whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.000000002% NA)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/E	Negligible
Minke whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.002% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.003% CGNS MU)	Negligible
Fin whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.000006% of the NA)	Negligible

Marine mammal species	PTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (permanent)*
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	<1 (0.00001% of the NA)	Negligible
Humpback whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	Not Applicable (N/A)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	N/A	Negligible
Grey seal	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	<1 (0.0006% WS MU) & (0.0002% Wider MU)	Negligible (negligible)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	N/E	Negligible (negligible)
Harbour seal	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	<1 (0.00005% WS MU) & (0.00003% Wider MU)	Negligible (negligible)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	N/E	Negligible (negligible)
Leatherback turtle	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	N/A	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	N/A	Negligible
*Magnitudes in brackets are for the wider reference populations used in the assessment			

7.3.1.1.1.2 High-Order Clearance

62. Low-order clearance is the default method for UXO disposal within the WDA (**Appendix 9 Draft MMMP**). However, the quantitative assessment also considers the use of high-order clearance without noise mitigation (both embedded and additional). In practice, this would only occur in the unlikely event that a low-order clearance attempt failed and triggered an unexpected high-order explosion. This scenario is considered highly unlikely; for example UXO clearance at Moray West Offshore Windfarm successfully removed 82 UXO with net explosive quantities up to 700 kg using low-order clearance methods (Ocean Winds et al., 2024).

63. In the absence of noise mitigation (both embedded and additional), the number of harbour porpoise potentially at risk of PTS could reach up to 259 individuals, resulting in a high magnitude (see **Table 7.2**). The magnitude is assessed as medium for bottlenose dolphin (CWSH MU), killer whale (west coast community), minke whale, fin whale, humpback whale, grey seal (both WS and wider MU) and harbour seal (WS MU), low for common dolphin and harbour seal (wider MU) and negligible for all other receptors. However, this quantitative assessment does also not account for embedded mitigation such as the use of MMOs (see **Appendix 9 Draft MMMP**) which would ensure marine mammals are clear of the area prior to any low-order clearance (and therefore any accidental high-order clearance). On this basis, the below magnitudes are considered to be over-precautionary.

Table 7.2 Assessment of PTS in marine mammals and leatherback turtle during high-order UXO clearance without mitigation

Marine mammal species	PTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (permanent)*
Harbour porpoise	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	259 (1.1% WS MU)	High
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	3 (0.01% WS MU)	Medium
Bottlenose dolphin	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	<1 (0.2% CWSH MU & 0.007% OW MU)	Medium (CWSH MU) Low (OW MU)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.001% CWSH MU & 0.00004% OW MU)	Low (negligible)
Common dolphin	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	<2 (0.003% CGNS MU)	Low
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.00002% CGNS MU)	Negligible
Atlantic white-sided dolphin	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	<1 (0.0004% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.000002% CGNS MU)	Negligible
White-beaked dolphin	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	<1 (0.00001% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.000009% CGNS MU)	Negligible
Risso’s dolphin	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	<1 (0.0003% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.000001% CGNS MU)	Negligible
Killer whale	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	<1 (0.03% WCC MU & 0.00001% NA MU)	Medium (WCC) Negligible (NA MU)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.0001% WCC MU & 0.0000001% NA MU)	Negligible (negligible)
Long-finned pilot whale	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	<1 (0.00005% NA)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.0000002% NA)	Negligible
Minke whale	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	4 (0.04% CGNS MU)	Medium
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	80 (0.8% CGNS MU)	Medium

Marine mammal species	PTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (permanent)*
Fin whale	SPL$_{peak}$ / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	<1 (0.001% NA)	Low
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa^{2}s)	<1 (0.02% NA)	Medium
Humpback whale	SPL$_{peak}$ / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	N/A	Low
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa^{2}s)	N/A	Medium
Grey seal*	SPL$_{peak}$ / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	23 (0.1% WS MU & 0.05% Wider MU)	Medium (medium)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa^{2}s)	11 (0.06% WS MU & 0.02% Wider MU)	Medium (medium)
Harbour seal*	SPL$_{peak}$ / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	2 (0.01% WS MU & 0.006% Wider MU)	Medium (low)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa^{2}s)	1 (0.005% WS MU & 0.003% Wider MU)	Low (low)
Leatherback turtle	SPL$_{peak}$ / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	N/A	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa^{2}s)	N/A	Negligible
*Magnitudes in brackets are for the wider reference populations used in the assessment			

7.3.1.1.2 TTS

7.3.1.1.2.1 Low-Order Clearance

64. The maximum impact ranges, without mitigation (both embedded and additional) for TTS for all receptors are presented in **Table 6.2** and **Table 6.3**.

65. The magnitude for all receptors for any potential TTS from low-order UXO clearance is assessed as negligible (**Table 7.3**).

Table 7.3 Assessment for TTS in marine mammals and leatherback turtle during low-order UXO clearance

Marine mammal species	TTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (temporary)*
Harbour porpoise	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	4 (0.02% WS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $μPa^2s$)	1 (0.004% WS MU)	Negligible
Bottlenose dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.003% CWSH MU & 0.0001% OW MU)	Negligible (CWSH & OW MU)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $μPa^2s$)	<1 (0.0009% CWSH MU & 0.00003% OW MU)	Negligible (negligible)
Common dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.00004% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $μPa^2s$)	<1 (0.00001% CGNS MU)	Negligible
Atlantic white-sided dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.000006% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $μPa^2s$)	<1 (0.000002% CGNS MU)	Negligible
White-beaked dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.00002% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $μPa^2s$)	<1 (0.000009% CGNS MU)	Negligible
Risso's dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.000004% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $μPa^2s$)	<1 (0.000001% CGNS MU)	Negligible

Marine mammal species	TTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (temporary)*
Killer whale	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 µPa)	<1 (0.0004% WCC & 0.0000002% NA MU)	Negligible (WCC & NA MU)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	<1 (0.0001% WCC & 0.0000001% NA MU)	Negligible (negligible)
Long-finned pilot whale	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 µPa)	<1 (0.0000006% NA)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	<1 (0.0000002% NA)	Negligible
Minke whale	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 µPa)	<1 (0.0007% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	7 (0.07% CGNS MU)	Negligible
Fin whale	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 µPa)	<1 (0.00002% NA)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	<1 (0.002% NA)	Negligible
Humpback whale	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 µPa)	N/A	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	N/A	Negligible
Grey seal*	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 µPa)	<1 (0.002% WS MU & 0.0007% Wider MU)	Negligible (negligible)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 µPa²s)	1 (0.006% WS MU) & 0.002% Wider MU)	Negligible (negligible)
Harbour seal*	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 µPa)	<1 (0.0002% WS MU & 0.0001% Wider MU)	Negligible (negligible)

Marine mammal species	TTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (temporary)*
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	<1 (0.0004% WS MU & 0.0003% Wider MU)	Negligible (negligible)
Leather-back Turtle	SPL$_{peak}$ / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	N/A	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/A	Negligible
*Magnitudes in brackets are for the wider reference populations used in the assessment			

7.3.1.1.2.2 High-Order Clearance

66. The TTS ranges associated with high-order detonations, as shown in **Table 6.2** and **Table 6.3** are considered highly conservative and unlikely to occur in reality as low-order clearance is the default method. It should be noted that TTS ranges are very precautionary, an article by Southall (2021) discusses this aspect and notes that "…*when onset criteria levels were applied to relatively high-intensity impulsive sources (e.g. pile driving), TTS onset was predicted in some instances at ranges of tens of kilometres from the sources. In reality, acoustic propagation over such ranges transforms impulsive characteristics in time and frequency (see Hastie et al. 2019; Amaral et al. 2020; Martin et al., 2020). Changes to received signals include less rapid signal onset, longer total duration, reduced crest factor, reduced kurtosis, and narrower bandwidth (reduced high-frequency content). A better means of accounting for these changes can avoid overly precautionary conclusions, although how to do so is proving vexing*". The point is reinforced later in the discussion which points out that "…*it should be recognised that the use of impulsive exposure criteria for receivers at greater ranges (tens of kilometres) is almost certainly an overly precautionary interpretation of existing criteria*". This acoustic wave elongation effect is particularly pronounced at larger ranges of several kilometres and, in particular, it is considered highly unlikely that predicted PTS or TTS ranges for impulsive noise which are found to be in the tens of kilometres are realistic (Southall, 2021).

67. In addition, studies such as Robinson et al. (2022) measured sound levels from high-order detonations up to 58 km away. Even at those distances, peak SPL / L_p were below 180 dB re 1 µPa, and SEL / $L_{E,p}$ was significantly lower. Therefore, results from the underwater noise modelling predicting a 110 km TTS impact range for mysticetes is extremely overestimated, as the received levels at that distance would be non-damaging and likely below 160 dB SPL, which is insufficient to cause TTS in any marine mammal group.

68. **Table 7.4** outlines the assessed magnitude of potential TTS to marine mammals and leatherback turtles from high-order clearance without noise mitigation (both embedded and additional). The magnitude is assessed as high for minke whale, medium for grey seal (WS MU), low for harbour porpoise, fin whale, humpback whale and grey seal (wider MU) and negligible for all other receptors. However, this quantitative assessment does not account for embedded mitigation such as the use of MMOs (see **Appendix 9 Draft MMMP**) which would ensure marine mammals are clear of the area prior to any low-order clearance (and therefore any accidental high-order clearance). On this basis, the below magnitudes are considered to be over-precautionary.

Table 7.4 Assessment for TTS in marine mammals and leatherback turtle during high-order UXO clearance without noise mitigation (both embedded and additional)

Marine mammal species	TTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (temporary)
Harbour porpoise	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	892 (3.7% WS MU)	Low
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $\mu Pa^2 s$)	23 (0.1% WS MU)	Negligible
Bottlenose dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.7% CWSH MU & 0.02% OW MU)	Negligible (CWSH & OW MU)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $\mu Pa^2 s$)	<1 (0.1% CWSH MU & 0.004% OW MU)	Negligible (CWSH & OW MU)
Common dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	6 (0.01% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $\mu Pa^2 s$)	1 (0.002% CGNS MU)	Negligible
Atlantic white-sided dolphin	S SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.001% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $\mu Pa^2 s$)	<1 (0.0002% CGNS MU)	Negligible
White-beaked dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	2 (0.005% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $\mu Pa^2 s$)	<1 (0.0008% CGNS MU)	Negligible
Risso's dolphin	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 μPa)	<1 (0.0008% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 $\mu Pa^2 s$)	<1 (0.0001% CGNS MU)	Negligible

Marine mammal species	TTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (temporary)
Killer whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	<1 (0.09% WCC MU & 0.00005% NA)	Negligible (WCC & NA)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^2s)	<1 (0.01% WCC MU & 0.000008% NA)	Negligible (WCC & NA)
Long-finned pilot whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	<1 (0.0002% NA)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^2s)	<1 (0.00002% NA)	Negligible
Minke whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	14 (0.1% CGNS MU)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^2s)	7,983 (77.6% CGNS MU)	High
Fin whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	<1 (0.004% NA)	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^2s)	76 (2.3% NA)	Low
Humpback whale	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	N/A	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^2s)	N/A	Low
Grey seal*	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	72 (0.4% WS MU & 0.1% Wider MU)	Negligible (negligible)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^2s)	1,315 (7.7% WS MU & 2.6% Wider MU)	Medium (low)
Harbour seal*	SPL_{peak} / $L_{p\text{-}pk}$ Unweighted Impulsive (re 1 µPa)	7 (0.03% WS MU & 0.02% Wider MU)	Negligible (negligible)

Marine mammal species	TTS Criteria	Maximum number of animals and % of reference population	Magnitude of impact (temporary)
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	104 (0.5% WS MU & 0. 3% Wider MU)	Negligible (negligible)
Leatherback turtle	SPL_{peak} / L_{p-pk} Unweighted Impulsive (re 1 μPa)	N/A	Negligible
	SEL / $L_{E,p}$ Weighted Impulsive (re 1 μPa^{2}s)	N/A	Negligible
*Magnitudes in brackets are for the wider reference populations used in the assessment			

7.3.1.2 Disturbance

69. There is currently no universally accepted threshold for behavioural disturbance from underwater noise. However, it is commonly assumed that a fleeing response may occur at sound levels similar to those causing TTS. Southall et al. (2007) proposed that behavioural disturbance begins at the lowest level of noise exposure that causes a measurable, transient impact on hearing (i.e. TTS onset) (Southall et al., 2007).

70. Although TTS is not a behavioural effect in itself, any temporary compromise in hearing ability could influence behaviour, particularly in species that rely heavily on acoustic cues for survival (Tougaard et al., 2021). The assessment of potential disturbance ranges has used TTS/fleeing response thresholds because the noise is so short-term that displacement or other behavioural responses is unlikely. Therefore, based on the worst-case scenario involving the largest UXO likely to be present and high-order clearance without noise mitigation (both embedded and additional), the magnitude of disturbance is assessed as high for minke whale, medium for grey seal (WS MU), low for harbour porpoise, fin whale, humpback whale and grey seal (wider MU) and negligible for all other receptors (**Table 7.4**).

71. To further evaluate potential disturbance, for low-order UXO clearance; the recommended Effective Deterrent Range (EDR) of 5 km (equating to 78.54 km²) from JNCC (2025c) has been applied to all receptors. This precautionary buffer is used to assess the spatial extent of disturbance from low-order UXO clearance. Based on this approach, the assessed magnitude is medium for bottlenose dolphin (CWSH MU), low for killer whale (west coast community) and negligible for all other receptors (**Table 7.5**).

72. A similar methodology was applied to assess for disturbance from high-order UXO clearance without noise mitigation, incorporating the recommended EDR of 20 km (JNCC, 2025c), which corresponds to an area of approximately 1,256.64 km².

73. The magnitude from high-order clearance without noise mitigation (both embedded and additional) is assessed as high for bottlenose dolphin (CWSH MU) and the west coast community population of killer whale, and medium for grey seal (WS MU) (**Table 7.5**). The magnitude is assessed as low for harbour porpoise, bottlenose dolphin (OW MU), common dolphin, white-beaked dolphin, minke whale and grey seal (wider MU) (**Table 7.5**). For all other receptors the magnitude for disturbance from high-order clearance is assessed as negligible (**Table 7.5**).However, this quantitative assessment does not account for embedded mitigation such as the use of MMOs (see **Appendix 9 Draft MMMP**) which would ensure marine mammals are clear of the area prior to any low-order clearance (and therefore any accidental high-order clearance). On this basis, the below magnitudes are considered to be over-precautionary.

Table 7.5 Maximum number of individuals (and % of reference population) that could be exposed to disturbance as a result of underwater noise associated with UXO clearance at WDA

Species	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact (temporary)	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact (temporary)
	Low-order UXO clearance		High-order UXO clearance without mitigation	
Harbour porpoise	33 (0.1% WS MU)	Negligible	528 (2.1% WS MU)	Low
Bottlenose dolphin	3 (6.7% CWSH MU & 0.2% OW MU)	Medium (CWSH MU) Negligible (OW MU)	54 (100% CWSH MU & 4.2% OW MU)	High (CWSH MU) Low (OW MU)
Common dolphin	63 (0. 1% CGNS MU)	Negligible	1,009 (1.8% CGNS MU)	Low
Atlantic white-sided dolphin	2 (0.02% CGNS MU)	Negligible	28 (0. 2% CGNS MU)	Negligible
White-beaked dolphin	20 (0.06% CGNS MU)	Negligible	320 (% CGNS MU)	Low
Risso's dolphin	1 (0.01% CGNS MU)	Negligible	13 (0.1% CGNS MU)	Negligible
Killer whale	<1 (1% WCC & 0.0005% NA)	Low (WCC) Negligible (NA	1 (15.7% WCC & 0.008% NA)	High (WCC) Negligible (NA)
Long-finned pilot whale	3 (0.002% NA)	Negligible	41 (0.03% NA)	Negligible
Minke whale	17 (0.2% CGNS MU)	Negligible	264 (2.6% CGNS MU)	Low
Fin whale	<1 (0.005% NA)	Negligible	3 (0.09% NA)	Negligible
Humpback whale	N/A	Negligible	N/A	Negligible
Grey seal*	69 (0. 4% WS MU & 0.1% Wider MU)	Negligible (negligible)	1,106 (6.3% WS MU & 2.1% Wider MU)	Medium (low)
Harbour seal*	6 (0.03% WS MU & 0.02% Wider MU)	Negligible (negligible)	101 (0.5% WS MU & 0.3% Wider MU)	Negligible (negligible)

Species	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact (temporary)	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact (temporary)
	Low-order UXO clearance		High-order UXO clearance without mitigation	
Leatherback Turtle	N/A	Negligible	N/A	Negligible
*Magnitudes in brackets are for the wider reference populations used in the assessment				

7.3.2 O&M

74. No UXO clearance is expected to take place during the O&M phase. However, if there was, the magnitude of impact would be similar to construction. See **Section 7.3.1**.

7.3.3 Decommissioning

75. No UXO clearance is expected to take place during decommissioning. However, if there was, the magnitude of impact would be similar to construction. See **Section 7.3.1**.

7.3.4 Significance of Effect

7.3.4.1 PTS

76. For auditory injury (PTS), all receptors have been assigned a **high** sensitivity, based on having a high international value, and low recoverability (**Section 7.2**).

77. For low-order UXO clearance, the quantitative assessment, which does not account for embedded mitigation such as the use of Marine Mammal Observer (MMOs), Passive Acoustic Monitoring (PAM), and Acoustic Deterrent Devices (ADD), the magnitude is assessed as **low** for harbour porpoise, minke whale and bottlenose dolphin (CWSH), which results in a significance of effect of moderate adverse. However, with embedded mitigation as secured through **Appendix 9 Draft MMMP** the effect would not be significant. For all other receptors, the magnitude is assessed as **negligible**, resulting in a **minor adverse** effect, which is **not significant** in EIA terms (**Table 7.6**).

78. In the very unlikely event of an accidental high-order clearance, the magnitude would be **high** for harbour porpoise, and **medium** for bottlenose dolphin (CWSH), west coast community killer whales, minke whale, fin whale, humpback whale, grey seal (both WS and wider MU) and harbour seal (WS MU) resulting in a major adverse effect which is significant in EIA terms. However, with embedded mitigation as secured through **Appendix 9 Draft MMMP**, which includes a pre-clearance search by MMOs and a passive acoustic monitoring operator, followed by acoustic deterrent device activation to ensure marine mammals are deterred from the area, the effect would not be significant. The magnitude is assessed as **low** for bottlenose dolphin (OW MU), common dolphin and harbour seal (wider MU), resulting in a **minor adverse** effect, which is **not significant** in EIA terms. For all other receptors, the magnitude is assessed as **negligible**, resulting in a **minor adverse** effect, which is **not significant** in EIA terms.

79. It is important to reiterate that low-order clearance is the default method of UXO clearance, that high-order clearance is unlikely to be required and if it were, additional mitigation such as the use of NAS would be applied (**Appendix 9 Draft MMMP**). However, in the highly unlikely event a low-order clearance technique was to fail and trigger a high-order detonation, the magnitudes and effect significance described above are predicted.

7.3.4.2 TTS

80. For auditory injury (TTS), all receptors were assigned a **medium** sensitivity due to their ability to recover (see **Section 7.2** for more information).

81. For low-order UXO clearance, the magnitude of impact is assessed as **negligible** for all receptors, resulting in a **negligible adverse** effect, which is **not significant** in EIA terms.

82. In the very unlikely event of an accidental high-order clearance without noise mitigation, the magnitude is assessed as high for minke whale and medium for grey seal (WS MU), which results in a **major** and **moderate adverse** effect respectively, which is **significant in EIA terms**. However, this scenario is only included in case of an accidental high-order detonation, which is not expected to occur, and therefore this effect is not expected to be realised. A full and realistic assessment will

be provided at the time of the separate ML application, and the mitigation will be designed to ensure there is no risk of TTS to marine mammal species, whichever approach is used, however it should be noted that the potential for an accidental high-order clearance event to occur is considered to be unrealistic, and the worst-case scenario is likely to be refined to remove this scenario from the envelope. The magnitude is assessed as **low** for harbour porpoise, fin whale, humpback whale and grey seal (wider MU) resulting in a **minor adverse** effect, which is **not significant** in EIA terms and **negligible** for all other receptors, resulting in a **negligible adverse** effect, which is **not significant** in EIA terms (**Table 7.6**).

7.3.4.3 Disturbance

83. For disturbance, all receptors were assigned a **medium** sensitivity from underwater noise during UXO clearance, due to their high international value and the ability to adapt and move away (**Section 7.2**).

84. The magnitude for disturbance during low-order UXO clearance is assessed as **medium** for bottlenose dolphin (CWSH MU), resulting in a major adverse effect, which is significant in EIA terms. However, this outcome is considered overly precautionary, as the percentage-based calculations can appear disproportionately large when applied to such a small reference population, thereby overstating the apparent scale of effect. Consequently, expert judgement is required to interpret the results in a more ecologically realistic manner. This involves looking beyond the numerical outputs, recognising when the calculations introduce misleading scale distortions, and applying specialist understanding of species ecology, population dynamics, and impact pathways. Furthermore, the EDR used to assess for disturbance is based on the response of harbour porpoise, not delphinids, which is highly precautionary as harbour porpoise is more sensitive to underwater noise and disturbance compared to delphinids. Therefore, based on expert judgement, bottlenose dolphin (CWSH MU) is assessed as **low** magnitude, which is still precautionary as other delphinids have been assessed as negligible. Having a low magnitude results in a **minor adverse** effect, which is **not significant** in EIA terms (**Table 7.6**). For killer whale (WCC) the magnitude has been assessed as **low** and for all other receptors the magnitude has been assessed as **negligible**, resulting in a **negligible** to **minor adverse** effect, which is **not significant** in EIA terms.

85. In the very unlikely event of an accidental high-order clearance, the magnitude is assessed as **high** for bottlenose dolphin (CWSH MU) and killer whale (west coast community) and **medium** for grey seal which results in moderate to major adverse effects, significant in EIA terms. However, this scenario is only included in case of an accidental high-order detonation, which is not expected to occur, and therefore this effect is not expected to be realised. A full and realistic assessment will be provided at the time of the separate ML application, and the mitigation will be designed to ensure there is no risk of significant disturbance to marine mammal species, whichever approach is used, however it should be noted that the potential for an accidental high-order clearance event to occur is considered to be unrealistic, and the worst-case scenario is likely to be refined to remove this scenario from the envelope.. The magnitude for harbour porpoise, bottlenose dolphin (OW MU), common dolphin, white-beaked dolphin, minke whale, and grey seal (wider MU) is assessed as **low**, which results in a **minor adverse** effect, not significant in EIA terms. For all other receptors, the magnitude is assessed as **negligible** resulting in a **negligible adverse** effect, not significant in EIA terms (**Table 7.6**).

7.3.4.3.1 Designated Sites

86. As shown in Table 10.7 in **Chapter 10 Marine Mammals and Leatherback Turtle**, there are a number of marine mammal designated sites that may be affected by UXO clearance at the WDA. For harbour porpoise, the SAC populations (of the Inner Hebrides and the Minches and Skerries and

Causeway SACs) are part of the WS MU, which is the focus if the harbour porpoise assessment provided in this appendix. Therefore, there would be no significant effect on the harbour porpoise populations of either SAC, as there is no significant effect on the WS MU due to underwater noise emitted from UXO clearance, as shown by **Table 7.6** below.

87. For minke whale, there is one designated site that may be affected by UXO clearance at the WDA; the Sea of the Hebrides NCMPA. Based on the NCMPA specific minke whale density, as presented in **Report to Inform Marine Protected Area Assessment**, up to one minke whale may be at risk of PTS onset, and up to two at risk of TTS from low-order UXO clearance, equating less than 0.001% and 0.8% of the NCMPA population respectively. For any disturbance to occur, up to three individuals could be temporarily disturbed during any low-order clearance event, representing 0.12% of the NCMPA population.

88. For pinnipeds, there are a number of designated sites that may be affected by UXO clearance at the WDA; Treshnish Isles SAC (for grey seal), and South-East Islay Skerries, Eileanan agus Sgeiran Lios mor, Sound of Barra and Ascrib, Isay and Dunvegan SACs, all designated for harbour seal. These SAC populations are part of the wider population, which is assessed as part of the EIA assessments. As there are no significant effects on the wider populations, there would also not be any significant effect to grey or harbour seal of any of the above listed designated sites (**Table 7.6**).

Table 7.6 Significance of effect for impact 2: Underwater noise during UXO clearance (blue = with embedded mitigation)

Impact	Receptor	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect
PTS – Low-Order UXO	Harbour porpoise	High	Low	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Bottlenose dolphin		Low (CWSH MU) Negligible (OW MU)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Common dolphin		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Atlantic white-sided dolphin		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	White-beaked dolphin		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Risso' dolphin		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Killer whale		Negligible (WCC) Negligible (NA)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Long-finned pilot whale		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Minke whale		Low	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Fin whale		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Humpback whale		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Grey seal*		Negligible (negligible)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Harbour seal*		Negligible (negligible)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Leatherback turtle		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
PTS – High Order UXO	Harbour porpoise	High	High	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Bottlenose dolphin		Medium (low)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Common dolphin		Low	Not significant (minor adverse)	N/A	Not significant (minor adverse)

Impact	Receptor	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect
	Atlantic white-sided dolphin		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	White-beaked dolphin		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Risso' dolphin		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Killer whale		Medium (WCC) Negligible (NA)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Long-finned pilot whale		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Minke whale		Medium	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Fin whale		Medium	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Humpback whale		Medium	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Grey seal*		Medium (medium)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Harbour seal*		Medium (low)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Leatherback turtle		Negligible	Not significant (minor adverse)	N/A	Not significant (minor adverse)
TTS – Low-Order UXO	Harbour porpoise	Medium	Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Bottlenose dolphin		Negligible (CWSH & OW MU)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Common dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Atlantic white-sided dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	White-beaked dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)

Impact	Receptor	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect
	Risso' dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Killer whale		Negligible (WCC & NA)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Long-finned pilot whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Minke whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Fin whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Humpback whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Grey seal*		Negligible (negligible)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Harbour seal*		Negligible (negligible)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Leatherback turtle		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
TTS – High Order UXO	Harbour porpoise	Medium	Low	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Bottlenose dolphin		Negligible (CWSH & OW MU)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Common dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Atlantic white-sided dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	White-beaked dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Risso' dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)

Impact	Receptor	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect
	Killer whale		Negligible (WCC & NA)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Long-finned pilot whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Minke whale		High	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Fin whale		Low	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Humpback whale		Low	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Grey seal*		Medium (low)	Not significant (minor adverse (negligible adverse))	N/A	Not significant (minor adverse (negligible adverse))
	Harbour seal*		Negligible (negligible)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Leatherback turtle		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
Disturbance – Low-Order UXO	Harbour porpoise	Medium	Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Bottlenose dolphin		Medium (CWSH & OW MU) Negligible (OW MU)	Not significant (minor adverse (negligible adverse))	N/A	Not significant (minor adverse (negligible adverse))
	Common dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Atlantic white-sided dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	White-beaked dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Risso' dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Killer whale		Low (WCC) Negligible (NA)	Not significant (minor adverse (negligible adverse))	N/A	Not significant (minor adverse (negligible adverse))

Impact	Receptor	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect
	Long-finned pilot whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Minke whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Fin whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Humpback whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Grey seal*		Negligible (negligible)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Harbour seal*		Negligible (negligible)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Leatherback turtle		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
Disturbance – High Order UXO	Harbour porpoise	Medium	Low	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Bottlenose dolphin		High (CWSH MU) Low (OW MU)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Common dolphin		Low	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Atlantic white-sided dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	White-beaked dolphin		Low	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Risso' dolphin		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Killer whale		High (WCC) Negligible (NA)	Not significant (minor adverse (negligible adverse))	N/A	Not significant (minor adverse (negligible adverse))
	Long-finned pilot whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)

Impact	Receptor	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect
	Minke whale		Low	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Fin whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Humpback whale		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Grey seal*		Medium (low)	Not significant (minor adverse)	N/A	Not significant (minor adverse)
	Harbour seal*		Negligible (negligible)	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
	Leatherback turtle		Negligible	Not significant (negligible adverse)	N/A	Not significant (negligible adverse)
*Magnitudes and significance of effect in brackets are for the wider reference populations used in the assessment						

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