NORTH FALLS

Offshore Wind Farm

PRELIMINARY ENVIRONMENTAL INFORMATION REPORT

Appendix 12.4 Unexploded Ordnance Clearance Information and Assessment

Document Reference No: 004620467-02
Date: May 2023
Revision: 02

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Date May 2023

Project	North Falls Offshore Wind Farm
Sub-Project or Package	Environmental Impact Assessment
Document Title	Preliminary Environmental Information Report Appendix 12.4 Unexploded Ordnance Clearance Information and Assessment
Document Reference	004620467-02
Revision	02
Supplier Reference No	N/A

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
01 (draft B)	27/12/2022	1st draft for NFOW review	AS / GS	PP	-
02 (Draft A)	08/04/2023	2nd draft for NFOW review	AS / GS	GK/HF	
02 (Draft B)	27/04/2023	Final	AS / GS	GK/HF	TC/DH/AP

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Glossary of Acronyms

ADD	Acoustic Deterrent Device
CEA	Cumulative Effect Assessment
DCO	Development Consent Order
EDR	Effective Deterrent Radius
EQT	Effective Quiet Threshold
ML	Marine Licence
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Management Organisation
MMOb	Marine Mammal Observer
MTD	Marine Technical Directorate
NEQ	Net Explosive Quantity
PEIR	Preliminary Environmental Impact Report
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
SEL	Sound Exposure Level
SIP	Site Integrity Plan
SNCB	Statutory Nature Conservation Body
SPL_{peak}	Sound Pressure Level
TTS	Temporary Threshold Shift
UXO	Unexploded Ordnance

Glossary of Terminology

Array areas	The two distinct offshore wind farm areas(including the 'northern array area' and 'southern array area') which together comprise the North Falls offshore wind farm.
Array cables	Cables which link the wind turbine generators with each other and the offshore substation platform(s).
Horizontal directional drill	Trenchless technique to bring the offshore cables ashore at the landfall. The technique will also be used for installation of the onshore export cables at sensitive areas of the onshore cable route.
Interconnector cable	Cable between the northern and southern array areas
Interconnector cable corridor	The corridor of the seabed between the northern and southern array areas
Landfall	The location where the offshore cables come ashore.
Landfall search area	Locations being considered for the landfall, comprising the Essex coast between Clacton-on-Sea and Frinton-on-Sea.
Offshore cable corridor	The corridor of seabed from array areas to the landfall within which the offshore export cables will be located.
Offshore export cables	The cables which bring electricity from the offshore substation platform(s) to the landfall.
Offshore project area	The overall area of the array areas and the offshore cable corridor.

Offshore substation platform(s)	Fixed structure(s) located within the array areas, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable voltage for export to shore via offshore export cables.
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area
Scour protection	Protective materials to avoid sediment being eroded away from the base of the wind turbine generator foundations and offshore substation platform foundations as a result of the flow of water.
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project Or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Transition joint bay	Underground structures that house the joints between the offshore export cables and the onshore export cables
Trenchless crossing compound	Areas within the cable corridor which will house trenchless crossing (e.g. HDD) entry or exit points.
Wind turbine generator	Power generating device that is driven by the kinetic energy of the wind

1 Unexploded Ordnance Clearance Information and Assessment

1.1 Introduction

1. This appendix provides an assessment of potential auditory injury and disturbance effects on marine mammals during Unexploded Ordnance (UXO) clearance for the North Falls offshore project area. This assessment is provided with the Preliminary Environmental Impact Report (PEIR) for information purposes only. A separate Marine Licence (ML) application for UXO clearance will be submitted post-consent, once detailed information on the locations and extent of UXO required to be cleared is known.

2. A Cumulative Effect Assessment (CEA) for UXO clearance at other projects is provided in Section 12.7 of Chapter 12 Marine Mammal Ecology (Volume I).

1.2 Worst case scenario

3. Table 1.1 sets out the realistic worst-case parameters for the marine mammal UXO assessment.

Table 1.1 Realistic worst-case parameters for marine mammal 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, however, it is assessed as the worst-case.

1.3 North Falls mitigation measures

4. North Falls has committed to the mitigation measures for any UXO clearance, as outlined in Table 1.2 below.

Table 1.2 UXO clearance mitigation measures

Parameter	Additional Mitigation Measures
Marine Mammal Mitigation Plan (MMMP) for UXO Clearance	A detailed MMMP will be prepared for UXO clearance during the post-consent phase, during the ML application process. The MMMP for UXO clearance will 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 will 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 will

Parameter	Additional Mitigation Measures
	be prepared in consultation with the Marine Management Organisation (MMO) and relevant Statutory Nature Conservation Bodies (SNCBs). The MMMP for UXO clearance will 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 limitations); • All UXO clearance to take place in daylight and, when possible, in favourable conditions with good visibility (sea state 3 or less); • Establishment of a monitoring area with minimum of 1km radius; • The observation of the monitoring area will be by dedicated and trained marine mammal observers (MMObs) during daylight hours and suitable visibility. • The activation of Acoustic Deterrent Device (ADDs); • The controlled explosions of the UXO will 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.
Site Integrity Plan (SIP) for the Southern North Sea Special Area of Conservation (SAC)	In addition to the MMMPs for piling and UXO clearance, a SIP for the Southern North Sea SAC will be developed. The SIP will 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 will be developed in the pre-construction period and will 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 will be submitted with the DCO application.

1.4 Assessment of potential effects from UXO clearance

5. The following assessments follow the approach set out in Section 12.4 of Chapter 12 (Volume I), including the definition of effect magnitudes.

1.4.1 Potential effects to marine mammals of UXO clearance

6. 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 will 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.

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

8. Prior to construction, there is the potential for UXO clearance to be required. While any identified UXO will 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 remove the UXO.

9. A detailed UXO survey will 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.

10. 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. 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).

11. 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.

12. The potential effects of underwater explosions on marine mammals include: (i) physical injury from direct or indirect blast wave effect of the high amplitude shock waves and sound wave produced by underwater detonation, which could result in immediate or eventual mortality; (ii) 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; or (iii) behavioural change, such as disturbance to feeding, mating, breeding, and resting (Richardson *et al.,* 1995; Ketten, 2004; von Benda-Beckmann *et al.,* 2015).

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

14. 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).

15. 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 would be a low-order clearance method.

1.4.2 Underwater noise modelling for UXO clearance

16. 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 will 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.

17. The Galloper Wind Farm UXO clearance report includes detonation of the UXO devices (and sizes) as shown in Table 1.3.

18. A selection of explosive sizes has been considered in the estimation of the underwater noise levels produced by detonation of UXO (Table 1.3). The assessment assumes the maximum explosive charge (see Appendix 12.2, Volume III).

Table 1.3 Selection of UXO potentially present at North Falls (data on UXO from Galloper Wind Farm is taken from Innogy Renewables UK Limited, 2019)

UXO devices potentially present (based on those found within Galloper Wind Farm)	UXO sizes potentially present (based on those found within Galloper Wind Farm)	NEQ for UXO devices included within the following assessment
– German E-Series sub-marine land buoyant mine – German LMB ground mine – Air delivered ground mine or explosive bomb – British buoyant mine – Allied (high) explosive device – Naval Projectiles – Torpedo bomb – Mortar Mk10 anti-submarine projectile or squid device	– 50kg – 250lb (113kg) – 500lb (227kg) – 1,000lb (454kg)	– 25kg – 55kg – 120kg – 240kg – 525kg – 698kg

1.4.2.1 Background to underwater noise

19. 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 unknown and cannot be directly considered in an 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.

20. 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.

21. 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 will have permanent hearing damage; this is assumed as a worst-case scenario).

22. 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.

23. 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 SPL values are referenced to 1 µPa and all SEL values are referenced to 1 μPa^2s.

24. 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, noise 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 Appendix 12.2, Volume III).

25. 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.

1.4.2.2 UXO clearance techniques

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

27. 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.

28. 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 and 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).

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

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

31. In the unlikely 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.

1.4.2.3 Underwater noise modelling methodology

32. The range of equivalent charge weights for the potential UXO devices that could be present within the North Falls boundaries have been estimated as 25kg, 55kg, 120kg, 240kg, 525kg and 698kg, plus the donor weight of 0.5kg to initiate detonation.

33. In addition, low-order clearance (such as deflagration) has been assessed, which assumes that the donor or shaped charge (donor charge weight of 0.5kg) detonates fully but without the follow-up high-order detonation of the UXO.

34. 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 Marine Technical Directorate (MTD) (1996) (see Appendix 12.2, Volume III).

35. Table 1.4 provides the source level used for the underwater noise modelling (further details on how these were calculated is provided in Appendix 12.2, Volume III).

Table 1.4 Source levels (unweighted SPL_{peak} and SEL_{ss}) used for UXO modelling

Charge weight (NEQ)	0.5kg	25kg + donor charge	55kg + donor charge	120kg + donor charge	240kg + donor charge	525kg + donor charge	698kg + donor charge
SPL_{peak} source level (dB re 1 µPa @ 1m)	272.1	284.9	287.5	290.0	292.3	294.8	295.7
SEL_{ss} source level (dB re 1 μPa^2s @ 1m)	217.1	228.0	230.1	232.3	234.2	236.4	237.1

36. See Appendix 12.2 (Volume III) for more detail on the underwater noise modelling methodologies.

1.4.2.4 Assessment methodology

37. The following assessments are undertaken in line with the methodology as set out in Section 12.4 of Chapter 12 (Volume I), including the definition of effect magnitude levels.

38. Assessments are carried out using the density and reference populations for harbour porpoise, minke whale, grey seal *Halichoerus grypus*, and harbour seal *Phoca vitulina* as provided in Section 12.5.5 of Chapter 12 (Volume I).

1.4.3 Impact 1: Auditory injury due to underwater noise associated with UXO clearance

1.4.3.1 Sensitivity of marine mammals

39. 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.

40. 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.

1.4.3.2 Potential auditory injury effect ranges

41. The results of the underwater noise modelling (Appendix 12.2, Volume III) for a range of potential charge weights (NEQ) are presented in Table 1.5 and Table

1.6 for PTS and 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.

Table 1.5 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 SPLpeak Unweighted (Impulsive criteria)	PTS SEL Weighted (Impulsive criteria)	PTS SEL Weighted (Non-impulsive criteria)
Harbour porpoise (Very High Frequency (VHF) cetacean)			
Threshold level	**202 dB re 1 µPa**	**155 dB re 1 µPa²s**	**173 dB re 1 µPa²s**
0.5kg (low-order clearance)	1.2km (4.52km²)	0.11km (0.04km²)	<0.05km (0.008km²)
25kg + donor charge	4.6km (66.48km²)	0.57km (1.02km²)	<0.05km (0.008km²)
55kg + donor charge	6.0km (113.10km²)	0.74km (1.72km²)	<0.05km (0.008km²)
120kg + donor charge	7.8km (191.13km²)	0.95km (2.84km²)	0.07km (0.02km²)
240kg + donor charge	9.8km (301.72km²)	1.1km (3.80km²)	0.10km (0.03km²)
525kg + donor charge	12km (452.39km²)	1.4km (6.16km²)	0.13km (0.05km²)
698kg + donor charge	**13km (530.93km²)**	1.5km (7.07km²)	0.15km (0.07km²)
Minke whale (Low Frequency (LF) cetacean)			
Threshold level	**219 dB re 1 µPa**	**183 dB re 1 µPa²s**	**199 dB re 1 µPa²s**
0.5kg (low-order clearance)	0.22km (0.15km²)	0.32km (0.32km²)	<0.05km (0.008km²)
25kg + donor charge	0.82km (2.11km²)	2.2km (15.21km²)	0.13km (0.05km²)
55kg + donor charge	1.0km (3.14km²)	3.2km (32.17km²)	0.19km (0.11km²)
120kg + donor charge	1.3km (5.31km²)	4.7km (69.40km²)	0.28km (0.25km²)
240kg + donor charge	1.7km (9.08km²)	6.5km (132.73km²)	0.39km (0.48km²)
525kg + donor charge	2.2km (15.21km²)	9.5km (282.53km²)	0.57km (1.02km²)
698kg + donor charge	2.4km (18.10km²)	**10km (314.16km²)**	0.66km (1.37km²)
Grey seal and harbour seal (Phocid Carnivores in Water (PCW))			
Threshold level	**218 dB re 1 µPa**	**185 dB re 1 µPa²s**	**201 dB re 1 µPa²s**
0.5kg (low-order clearance)	0.24km (0.18km²)	0.06km (0.01km²)	<0.05km (0.008km²)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km2))		
	PTS SPLpeak Unweighted (Impulsive criteria)	PTS SEL Weighted (Impulsive criteria)	PTS SEL Weighted (Non-impulsive criteria)
25kg + donor charge	0.91km (2.60km^2)	0.39km (0.48km^2)	<0.05km (0.008km^2)
55kg + donor charge	1.1km (3.80km^2)	0.57km (1.02km^2)	<0.05km (0.008km^2)
120kg + donor charge	1.5km (7.07km^2)	0.83km (2.16km^2)	<0.05km (0.008km^2)
240kg + donor charge	1.9km (11.34km^2)	1.1km (3.80km^2)	0.07km (0.02km^2)
525kg + donor charge	2.5km (19.64km^2)	1.4km (6.16km^2)	0.10km (0.03km^2)
698kg + donor charge	**2.7km (22.90km^2)**	1.5km (7.07km^2)	0.11km (0.04km^2)

Table 1.6 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 SPLpeak Unweighted (Impulsive criteria)	TTS SEL Weighted (Impulsive criteria)	TTS SEL Weighted (Non-impulsive criteria)
Harbour porpoise (VHF)			
Threshold level	**196 dB re 1 µPa**	**140 dB re 1 µPa^{2}s**	**153 dB re 1 µPa^{2}s**
0.5kg (low-order clearance)	2.3km (16.62km^2)	0.93km (2.72km^2)	0.15km (0.07km^2)
25kg + donor charge	8.5km (226.98km^2)	2.4km (18.10km^2)	0.73km (1.67km^2)
55kg + donor charge	11km (380.13km^2)	2.8km (24.63km^2)	0.94km (2.78km^2)
120kg + donor charge	14km (615.75km^2)	3.2km (32.17km^2)	1.1km (3.80km^2)
240kg + donor charge	18km (1,017.88km^2)	3.5km (38.49km^2)	1.4km (6.16km^2)
525kg + donor charge	23km (1,661.90km^2)	3.8km (45.37km^2)	1.7km (9.08km^2)
698kg + donor charge	**25km (1,963.50km^2)**	4.0km (50.27km^2)	1.8km (10.18km^2)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km2))		
	TTS SPLpeak Unweighted (Impulsive criteria)	TTS SEL Weighted (Impulsive criteria)	TTS SEL Weighted (Non-impulsive criteria)
Minke whale (LF)			
Threshold level	**213 dB re 1 µPa**	**168 dB re 1 µPa²s**	**179 dB re 1 µPa²s**
0.5kg (low-order clearance)	0.41km (0.53km²)	4.5km (63.62km²)	0.65km (1.33km²)
25kg + donor charge	1.5km (7.07km²)	29km (2,642.08km²)	4.4km (60.82km²)
55kg + donor charge	1.9km (11.34km²)	41km (5,281.02km²)	6.4km (128.68km²)
120kg + donor charge	2.5km (19.64km²)	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)	**10km (38,013.27km²)**	21km (1,385.44km²)
Grey seal and harbour seal (PCW)			
Threshold level	**212 dB re 1 µPa**	**170 dB re 1 µPa²s**	**181 dB re 1 µPa²s**
0.5kg (low-order clearance)	0.45km (0.64km²)	0.8km (2.01km²)	0.11km (0.38km²)
25kg + donor charge	1.6km (8.04km²)	5.2km (84.95 km²)	0.79km (1.96km²)
55kg + donor charge	2.1km (13.85km²)	7.5km (176.72km²)	1.1km (3.8km²)
120kg + donor charge	2.8km (24.63km²)	10km (314.16km²)	1.6km (8.04km²)
240kg + donor charge	3.5km (38.49km²)	14km (615.75km²)	2.3km (16.62km²)
525kg + donor charge	4.6km (66.48km²)	19km (1,134.12km²)	3.3km (34.21km²)
698kg + donor charge	5.0km (78.54km²)	**22km (1,520.53km²)**	3.8km (45.36km²)

1.4.3.3 Magnitude of effect for PTS

42. The number of harbour porpoise, minke whale, grey seal and harbour seal that could potentially be impacted by a high-order UXO detonation (up to 698kg NEQ), and low-order clearance (0.5kg) has been estimated for North Falls based on the maximum potential PTS impact ranges (Table 1.7).

43. For the high-order detonation of the maximum potential UXO with an NEQ of 698kg plus donor charge, the magnitude for PTS is assessed as a worst-case (Table 1.7) to be:

- Medium for harbour porpoise
- Medium for minke whale
- Low to medium for grey seal, depending on reference population assessed
- Negligible to medium for harbour seal, depending on project area and reference population assessed

44. For low-order clearance (0.5kg donor charge for all sizes of UXO) the magnitude for PTS is assessed to be:

- Low for harbour porpoise
- Negligible for minke whale
- Negligible for grey seal
- Negligible for harbour seal

Table 1.7 Maximum number of marine mammals potentially at risk of PTS during UXO clearance

Species	Criteria	Maximum effect range (and area)*	Maximum number of individuals	% of reference population	Magnitude (permanent effect)*
Harbour porpoise	PTS SPL_{peak} (unweighted, impulsive)	High-order detonation (698kg (NEQ) + donor charge) 13km (530.93km^2)	1,498.3 (based on the worst-case HiDef survey density for the winter period of 2.82/km^2)	0.43% NS MU	**Medium**
		Low-order clearance (0.5kg (NEQ)) 1.2km (4.52km^2)	12.8 (based on the worst-case HiDef survey density for the winter period of 2.82/km^2)	0.004% NS MU	**Low**
Minke whale	PTS SEL_{ss} (weighted, impulsive)	High-order detonation (698kg (NEQ) + donor charge) 10km (314.16km^2)	6.3 (based on the SCANS-III density of 0.0201/km^2)	0.03% CGNS MU	**Medium**
		Low-order clearance (0.5kg (NEQ)) 0.32km (0.32km^2)	0.006 (based on the SCANS-III density of 0.0201/km^2)	0.00003% CGNS MU	**Negligible**
Grey seal	PTS SPL_{peak} (unweighted, impulsive)	High-order detonation (698kg (NEQ) + donor charge) 2.7km (22.90km^2)	4.1 (based on the average cable area density of 0.18/km^2)	0.012% SE E MU (0.004% wider population)	**Low to medium**
			3.9 (based on the worst-case array area density for array area north) of 0.168/km^2)	0.011% SE E MU (0.006% wider population)	**Low to medium**
		Low-order clearance (0.5kg (NEQ)) 0.24km (0.18km^2)	0.033 (based on the average cable area density of 0.18/km^2)	0.00009% SE U MU (0.00005% wider population	**Negligible**
			0.03 (based on the worst-case array area density for array area north) of 0.168/km^2)	0.00009% SE U MU (0.00005% wider population	**Negligible**
Harbour seal	PTS SPL_{peak} (unweighted, impulsive)	High-order detonation (698kg (NEQ) + donor charge) 2.7km (22.90km^2)	2.2 (based on the average cable area density of 0.097/km^2)	0.046% SE E MU (wider population)	**Low to medium**
			0.08 (based on the worst-case array area	0.002% SE E MU	**Negligible to low**

Species	Criteria	Maximum effect range (and area)*	Maximum number of individuals	% of reference population	Magnitude (permanent effect)*
			density for array area north) of 0.0034km^2)		
		Low-order clearance (0.5kg (NEQ)) 0.24km (0.18km^2)	0.02 (based on the average cable area density of 0.097km^2)	0.0004% SE E MU	**Negligible**
			0.0006 (based on the worst-case array area density for array area north) of 0.0034km^2)	0.00001% SE E MU	**Negligible**

1.4.3.4 Magnitude of effect for TTS

45. The number of harbour porpoise, minke whale, grey seal and harbour seal that could potentially be impacted by a high-order UXO detonation (up to 698kg NEQ), and low-order clearance (0.5kg) has been estimated for North Falls, based on the maximum potential TTS effect ranges (Table 1.8).

46. 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 1.8), to be:

- Low for harbour porpoise
- Low for minke whale
- Negligible for grey seal
- Negligible to low for harbour seal

47. For low-order clearance (0.5kg donor charge for all sizes of UXO) the magnitude is assessed to be:

- Negligible for harbour porpoise
- Negligible for minke whale
- Negligible for grey seal
- Negligible for harbour seal

Table 1.8 Maximum number of marine mammals potentially at risk of TTS during UXO clearance

Species	Criteria	Maximum effect range (and area)	Maximum number of individuals	% of reference population	Magnitude (temporary effect)
Harbour porpoise	TTS SPL_{peak} (unweighted, impulsive)	High-order detonation (698kg (NEQ) + donor charge) 25km (1,963.50km^2)	5,540.98 (based on the worst-case HiDef survey density for the winter period of 2.82/km^2)	1.6% NS MU	**Low**
		Low-order clearance (0.5kg (NEQ)) 2.3km (16.62km^2)	46.90 (based on the worst-case HiDef survey density for the winter period of 2.82/km^2)	0.014% NS MU	**Negligible**
Minke whale	TTS SEL_{ss} (weighted, impulsive)	High-order detonation (698kg (NEQ) + donor charge) 110km (38,013.27km^2)*	764.1 (based on the SCANS-III density of 0.0201/km^2)	3.78% CGNS MU	**Low**
		Low-order clearance (0.5kg (NEQ)) 4.5km (63.62km^2)	1.3 (based on the SCANS-III density of 0.0201/km^2)	0.006% CGNS MU	**Negligible**
Grey seal	TTS SEL_{ss} (weighted, impulsive)	High-order detonation (698kg (NEQ) + donor charge) 22km (1,520.53km^2)	273.7 (based on the average cable area density of 0.18/km^2)	0.79% SE E MU (0.45% wider population)	**Negligible**
			255.4 (based on the worst-case array area density for array area north) of 0.168/km^2)	0.74% SE E MU (0.42% wider population)	**Negligible**
		Low-order clearance (0.5kg (NEQ)) 0.8km (2.01km^2)	0.36 (based on the average cable area density of 0.18/km^2)	0.001% SE E MU (0.0006% wider population)	**Negligible**
			0.34 (based on the worst-case array area density for array area north) of 0.168/km^2)	0.001% SE E MU (0.0006% wider population)	**Negligible**
Harbour seal	TTS SEL_{ss} (weighted, impulsive)	High-order detonation (698kg (NEQ) + donor charge) 22km (1,520.53km^2)	147.5 (based on the average cable area density of 0.097/km^2)	3.04% SE E MU (wider population)	**Negligible to low**
			5.2	0.11% SE E MU	**Negligible**

Species	Criteria	Maximum effect range (and area)	Maximum number of individuals	% of reference population	Magnitude (temporary effect)
			(based on the worst-case array area density for array area north) of 0.0034km^2)		
		Low-order clearance (0.5kg (NEQ)) 0.8km (2.01km^2)	0.20 (based on the average cable area density of 0.097/km^2)	0.004% SE E MU	**Negligible**
			0.0068 (based on the worst-case array area density for array area north) of 0.0034km^2)	0.0001% SE E MU	**Negligible**

1.4.3.5 Effect significance

48. 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 adverse for harbour porpoise and minke whale, moderate to major adverse for grey seal, and minor to major adverse for harbour seal (Table 1.9).

49. For low-order clearance, without mitigation measures, and based on a high sensitivity for all marine mammals to PTS from low-order clearance, the effect significance has been assessed as moderate adverse for harbour porpoise, and minor adverse for all other species (Table 1.9).

50. 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.

51. 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 minor adverse for all species (Table 1.9).

52. 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 1.9 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 and minke whale	High	Medium	Major adverse	MMMP for UXO clearance	**Minor adverse**
Grey seal	High	Low to medium	Moderate to major adverse		**Minor adverse**
Harbour seal	High	Negligible to medium	Minor to major adverse		**Minor adverse**
PTS during low-order UXO clearance					
Harbour porpoise	High	Low	Moderate adverse	MMMP for UXO clearance	**Minor adverse**
Minke whale, grey seal and harbour seal	High	Negligible	Minor adverse		**Minor adverse**
TTS during high-order UXO clearance					
Harbour porpoise and minke whale	Medium	Low	Minor adverse	MMMP for UXO clearance	**Minor adverse**
Grey seal	Medium	Negligible	Minor adverse		**Minor adverse**
Harbour seal	Medium	Low to negligible	Minor adverse		**Minor adverse**

Species	Sensitivity	Magnitude	Effect significance	Mitigation	Residual effect significance
TTS during high-order UXO clearance					
Harbour porpoise, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse	MMMP for UXO clearance	**Minor adverse**

1.4.3.6 Mitigation

53. As outlined in Section 1.3, a MMMP for UXO clearance will be produced post-consent in consultation with the MMO and relevant SNCBs. The final MMMP for UXO clearance will be based on the latest scientific understanding and guidance, pre-construction UXO surveys in the offshore project area, as well as detailed project design.

54. For high-order clearance, an ADD would be activated for a maximum of 80 minutes, during which harbour porpoise, 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 and Folkow, 1995). This is less than the highest PTS effect range of 13km for harbour porpoise, but higher than the highest PTS effect range for minke whale (of 10km), and 2.7km for grey seal and harbour seal. An ADD activation period of 80 minutes would ensure harbour porpoise are outwith the potential PTS effect range for a high-order UXO clearance of up to 55kg, while high-order clearance for UXO of higher than 55kg would result in potential PTS ranges that exceed the predicted ADD deterrence range for 80 minutes of ADD activation. There is therefore the potential for injury to occur for harbour porpoise for a high-order clearance of UXO of higher than 55kg. Alternative mitigation or noise reduction options would 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 Marine Licence application.

55. The implementation of the mitigation measures within the MMMP for UXO clearance will reduce the risk of any permanent auditory injury (PTS) during UXO clearance. The mitigation measure would also reduce the risk of TTS.

56. The proposed mitigation measures for consideration in the MMMP 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 if any high-order detonations are required.

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

1.4.4 Impact 2: Disturbance due to underwater noise associated with UXO clearance

1.4.4.1 Sensitivity of marine mammals

58. The sensitivity of marine mammals to disturbance as a result of underwater UXO detonations is considered to be medium 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.

1.4.4.2 Magnitude of effect

59. 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.

60. 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, 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.

61. 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).

62. 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.

63. 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 1.8, with the estimated number and percentage of reference populations that could be affected as assessed in Section 1.4.3.4, provides an indication of possible fleeing response.

64. 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).

65. 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.

66. In addition, the MMMP for UXO clearance will 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 will depend on the clearance method, and will 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).

67. The duration of ADD activation required will 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 will be reviewed and updated for the marine licence and marine wildlife licence application prior to UXO clearance.

1.4.4.3 Magnitude of effect for disturbance due to UXO clearance

68. As assessed in Section 1.4.3.4, 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:

- Low for harbour porpoise
- Negligible for minke whale, harbour seal, and grey seal

69. For low-order clearance (0.5kg donor charge for all sizes of UXO) the magnitude for TTS / fleeing response is assessed to be:

- Negligible for all species

70. 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 low (Table 1.10 Estimated number of harbour porpoise that could potentially be disturbed during UXO clearance based on 26km EDR for high-order detonation with no mitigation).

71. 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 1.10 Estimated number of harbour porpoise that could potentially be disturbed during UXO clearance based on 26km EDR for high-order detonation with no mitigation

Species	Maximum effect area	Maximum number of individuals	% of reference population	Magnitude (temporary effect)
Harbour porpoise	2,123.7km^2	5,993.1 (based on the worst-case HiDef survey density for the winter period of 2.82/km^2)	1.73% NS MU	Low

72. 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 1.11 Estimated number of marine mammals that could potentially be disturbed during low-order UXO clearance based on 5km disturbance range).

Table 1.11 Estimated number of marine mammals that could potentially be disturbed during low-order UXO clearance based on 5km disturbance range

Species	Maximum effect area	Maximum number of individuals	% of reference population	Magnitude (temporary effect)
Harbour porpoise	78.54km^2	221.6 (based on the worst-case HiDef survey density for the winter period of 2.82/km^2)	0.064% NS MU	Negligible
Minke whale	78.54km^2	1.6 (based on the SCANS-III density of 0.0201/km^2)	0.008% CGNS MU	Negligible
Grey seal	78.54km^2	14.1 (based on the average cable area density of 0.18/km^2)	0.041% SE E MU (0.023% wider population)	Negligible
		13.2 (based on the worst-case array area density for array area north) of 0.168/km^2)	0.038% SE E MU (0.022% wider population)	Negligible
Harbour seal	78.54km^2	7.6 (based on the average cable area density of 0.097/km^2)	0.16% SE E MU (same as wider population)	Negligible
		0.27 (based on the worst-case array area density for array area north) of 0.0034km^2)	0.006% SE E MU	Negligible

1.4.4.4 Magnitude of effect for disturbance from ADD activation

73. The estimated maximum ADD activation prior to UXO clearance has been determined based on the maximum predicted effect range for low-order clearance of 1.2km for harbour porpoise, and for high-order detonation a PTS range of 13km for harbour porpoise (Table 1.5).

74. For low-order clearance, ADD would be activated for 14 minutes, during which harbour porpoise, grey seal, and harbour seal would move at least 1.26km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000) and minke whale would move 2.73km, based on swimming speed of 3.25m/s (Blix and Folkow, 1995).

75. For high-order clearance, an ADD would be activated for a maximum of 80 minutes, during which harbour porpoise, 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 and Folkow, 1995).

76. The magnitude of effect for ADD activation prior to UXO clearance has been assessed as negligible for all marine mammal species (Table 1.12).

77. 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 1.12 Estimated number of marine mammals that could potentially be disturbed during ADD activation for UXO clearance

Species	Low-order clearance [up to 14 minutes]		High-order detonation [up to a maximum of 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	14.1 (0.004% NS MU)	Negligible	459.6 (0.13% NS MU)	Negligible
Minke whale	0.47 (0.002% CGNS)	Negligible	15.4 (0.076% CGNS)	Negligible
Grey seal	0.90 (0.003% SE E MU; 0.001% wider population)	Negligible	29.3 (0.085% SE E MU; 0.049% wider population)	Negligible
	0.84 (0.002% SE E MU; 0.001% wider population)	Negligible	27.4 (0.079% SE E MU; 0.045% wider population)	Negligible
Harbour seal	0.48 (0.01% SE E MU & wider population)	Negligible	15.8 (0.33% SE E MU & wider population)	Negligible
	0.02 (0.0003% SE E MU & wider population)	Negligible	0.6 (0.011% SE E MU & wider population)	Negligible

1.4.4.5 Effect significance

78. Taking into account the medium sensitivity of marine mammals to disturbance from UXO clearance and the magnitudes of effect (Table 1.7 & Table 1.8), the temporary disturbance during UXO clearance has been assessed as minor adverse for all marine mammals (Table 1.13).

Table 1.13 Assessment of effect significance for disturbance of marine mammals during UXO clearance

Species	Sensitivity	Magnitude	Effect significance	Mitigation	Residual effect significance
Disturbance effect based on TTS / fleeing response					
See Table 1.8.					
Disturbance effect (26km EDR for high-order clearance)					
Harbour porpoise	Medium	Low	Minor adverse	None required.	**Minor adverse**

Species	Sensitivity	Magnitude	Effect significance	Mitigation	Residual effect significance
Disturbance effect (5km disturbance for low-order clearance)					
Harbour porpoise, minke whale, grey seal, and harbour seal	Medium	Negligible	Minor adverse	None required.	**Minor adverse**
Disturbance from ADD activation					
Harbour porpoise, minke whale, grey seal, and harbour seal	Medium	Negligible	Minor adverse	None required.	**Minor adverse**

1.4.4.6 Mitigation

79. No mitigations are required for disturbance to marine mammals due to UXO clearance.

1.4.5 Impact 3: Changes to prey availability as a result of underwater noise from UXO clearance activities

1.4.5.1 Sensitivity

80. As outlined in Appendix 12.1 (Volume III), 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.

81. 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 Appendix 12.1, Volume III). Therefore, minke whale are considered to have a low to medium sensitivity to changes in prey resource.

82. 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 Appendix 12.1, Volume III). Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources.

1.4.5.2 Magnitude of effect

83. Chapter 11 Fish and Shellfish Ecology 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.

84. 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.

1.4.5.3 Effect of significance

85. Taking into account the low sensitivity of 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 grey seal and harbour seal; and negligible to minor adverse for harbour porpoise and minke whale.

1.4.5.4 Mitigation

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

1.5 Summary

87. The potential effects on marine mammals from UXO clearance at North Falls are summarised in Table 1.14.

Table 1.14 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	High	Low to medium	Major adverse	MMMP for UXO Clearance.	Minor adverse
	Minke whale, grey seal and harbour seal	High	Negligible to medium	Minor to major adverse		Minor adverse
TTS for UXO high-order detonation with no mitigation	Harbour porpoise, minke whale and harbour seal	Medium	Negligible to low	Minor adverse	MMMP for UXO Clearance.	Minor adverse
	Grey seal	Medium	Negligible	Minor adverse		Minor adverse
Impact 2: Disturbance from underwater noise associated with UXO clearance						
Disturbance from UXO clearance	Harbour porpoise, minke whale and harbour seal	Medium	Negligible to low	Minor adverse	None required.	Minor adverse
	Grey seal	Medium	Negligible	Minor adverse		Minor adverse
Disturbance from ADD activation	Harbour porpoise, minke whale and grey seal	Medium	Negligible	Minor adverse		Minor adverse
	Harbour seal	Medium	Low to negligible	Minor adverse		Minor adverse
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,	Low to medium	Low	Negligible to minor adverse	None required	Negligible to minor adverse
	Grey seal and harbour seal	Low	Low	Negligible		Negligible

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