HORIZON
NUCLEAR POWER

WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

Horizon Deadline 4 responses to actions set in Issue Specific Hearing on 10 January 2019

PINS Reference Number: EN010007

17 January 2019

Revision 1.0
Examination Deadline 4

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Horizon Internal DCRM Number: WN0902-HZDCO-PAC-REP-00132

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Appendices

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1 Horizon Deadline 4 responses to actions set in Issue Specific Hearing on 10th January 2019

1.1 Introduction

1.1.1 This document contains Horizon Nuclear Power Wylfa Limited's ("Horizon's") responses to actions set in the Issue Specific Hearing on 10th January 2019 that were set for Deadline 4.

1.1.2 This document also contains details of other actions set at the Issue Specific Hearing on 10th January 2019 set for subsequent Examination Deadlines.

1.2 Summary of Deadline 4 action responses

Evidence of tern colony abandonment as presented in the NRWs Written Representation [REP2-235]

1.2.2 Contained in Appendix 1-1 is Horizon's response to the action to provide further information on the evidence presented in paragraphs 7.8.23 – 7.8.27 of National Resources Wales' (NRW's) Written Representation [REP2-325].

In-combination effects: North Wales Connection Project and the Cemlyn Bay SAC

1.2.3 Contained in Appendix 1-2 is Horizon's response to the action for Horizon to re-consider the in-combination effects between the Wylfa Newydd DCO Project and National Grid's North Wales Connection Project on the Bae Cemlyn / Cemlyn Bay Special Area of Conservation (SAC) in light of the latest environmental information available.

Breakwater design and options considered

1.2.4 In response to the request to provide information to National Trust on the breakwater design and options considered during the design process we refer to "Ecological Enhancements Mitigation Report" [WN0902-HZDCO-PAC-REP-00138] submitted into Examination at Deadline 4.

Additional National Marine Fisheries Service modelling results

1.2.5 Contained in Appendix 1-3 is Horizon's response to the request to provide additional NMFS modelling results in response to challenges from NRW at the ISH on 10th January 2019 and in paragraph 7.11.11 of NRW's Written Representation [REP2-325].

Update on other consents and licences

1.2.6 Horizon was requested to provide an update on other consents and licences at Deadline 4. Horizon has updated its Deadline 2 Submission "Other consents and licences" [REP2-005] and submitted into examination at Deadline 4.

1.3 Action responses planned for subsequent Examination Deadlines

1.3.1 Table 1-1 summarises the responses to actions set at the ISH on 10th January 2019 that Horizon is planning to submit at subsequent deadlines.

Table 1-1 Summary of planned action responses

Action / Deliverable	Planned deadline
Note on mercury contamination	Deadline 5
Note responding to comments by Dr Jones on impact of sediment from dredging	Deadline 5
Additional modelling examining marine works concurrent activities and underwater activities	Deadline 5
Note on effect of cooling water outfall on tidal vectors and velocity	Deadline 5
Additional information on new pathways and dewatering effects on Ynys Mon groundwater	Deadline 6
Phase 1 Validation report confirming why baseline data for A5025 is still considered robust	Deadline 5
Note on the establishment process/times and mechanisms for management of the ecological compensation sites	Deadline 6

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Horizon's response to NRW provided evidence on other Tern Colonies

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1 Horizon's response to NRW provided evidence on other Tern Colonies

1.1 Evidence of tern colony abandonment as presented in the NRWs Written Representation [REP2-235]

1.1.1 During the Issue Specific Hearing that covered Habitats Regulations Assessment (HRA) held on 10th January 2019, the Examining Authority requested that further information should be provided by the Applicant on the evidence presented in paragraphs 7.8.23 – 7.8.27 of NRW's Written Representation [REP2-325] regarding the evidence from other tern colonies on the role of disturbance in causing abandonment. The Examining Authority wished to understand whether this evidence had been addressed within the Applicant's assessment.

1.1.2 The Applicant considers that it has addressed the available evidence for disturbance as a cause of abandonment in tern colonies. Specifically, the Applicant is unaware of any evidence for anthropogenic noise disturbance as a cause of abandonment of tern colonies, and the available evidence provides no suggestion that the noise levels predicted to occur from the Project construction activities would have any detrimental effects on the Cemlyn Bay tern colony.

1.1.3 Paragraph 7.8.23 of NRW's Written Representation [REP2-325] suggests that noise and visual disturbance from the construction activities will cause stress to the birds which breed at the Cemlyn Bay colony and that this, in turn, is likely to reduce breeding success and lead to potential abandonment of the colony by Sandwich terns. As detailed in paragraphs 7.31.7 to 7.31.11 of the Applicant's response to NRW's Written Representation [REP3-035], the evidence for such stress responses in terns (and other birds) was considered in the Shadow HRA [APP-050 and 051 – see paragraph 10.3.57]. The conclusion reached was that these stress responses are unlikely to be important because the evidence for such effects in birds relates to situations in which disturbance results from the direct presence of people, which are likely to be perceived as potential predators (and hence more likely to cause such responses than are noise and visual disturbance from construction activities).

1.1.4 Paragraph 7.8.27 (part C) of NRW's Written Representation [REP2-325] cites scientific papers which demonstrate that high rates of colony failure amongst least terns and common terns on the east coast of the USA were the result of anthropogenic disturbance (Burger 1984, Burger and Gochfield 1991). A number of the scientific papers concerning the effects of disturbance on terns by Burger and co-authors are cited within the Shadow HRA [APP-050 and 051]. The Shadow HRA also fully acknowledges that in certain situations anthropogenic disturbance (as a source of noise and visual disturbance) has been implicated as a cause of reduced breeding success and sometimes colony abandonment in tern populations (although the Shadow HRA also points out that not all of the evidence for such effects withstands scientific scrutiny).

1.1.5 In the case of the studies by Burger and co-authors (as cited in NRW's Written Representation [REP2-325]), the evidence for anthropogenic disturbance as a cause of high rates of colony failure is compelling (and possibly unequivocal). However, these studies deal with tern colonies which occur on sandy beaches or in sand-dune areas, where the birds are affected by the direct presence of people in frequent and close proximity to the colonies. The example of 45% of tern colony failures resulting from anthropogenic disturbance (as cited in NRW's Written Representation [REP2-325]) is in relation to birds breeding on ocean facing beaches, where the colonies are in direct conflict with people using these beaches for bathing, marinas, homes and docks. In this case, most of the loss is attributed to off-road vehicles and people passing directly through the colonies whilst, in some cases, the colony failures are from direct habitat loss.

1.1.6 Burger (1984) also points out that *"much of this destruction can be prevented by education and adequate posting or patrolling"*. This is evident in the UK at Chesil Beach, where the numbers of birds using the little tern colony has increased since the Dorset Wildlife Trust introduced 24-hour wardens to remove direct on beach disturbance. For the Cemlyn lagoon colony, during the breeding season in particular (when wardens cordon off the colony), access to the colony by people (and dogs) is restricted.

1.1.7 As such, the evidence for anthropogenic disturbance in causing colony failures in terns derives from radically different situations to that which would result from the construction activities associated with the Project.

1.2 References

1.2.1 Burger, J. (1984). Colony stability in least terns. *The Condor*, 86, 61-67.

1.2.2 Burger, J. and Gochfield, M. (1991). *The common tern: Its breeding biology and social behaviour.* Columbia University Press, New York.

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Wylfa Newydd Project

In-combination effects: North Wales Connection Project and the Cemlyn Bay SAC

PINS Reference Number: EN010007

17 January 2019

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1 Horizon's response on in-combination effects between the Project and North Wales Connection Project

1.1 Introduction

1.1.1 At the Issue Specific Hearing (ISH) on 10th January 2019 concerned with biodiversity and Habitats Regulations Assessment (HRA), the Examining Authority requested that the potential for in-combination effects to arise between the Wylfa Newydd DCO Project and National Grid's North Wales Connection Project on the Bae Cemlyn/Cemlyn Bay Special Area of Conservation (SAC) be re-considered using the latest environmental information available. The North Wales Connection Project was considered in the in-combination assessment included within the Shadow HRA for the Wylfa Newydd DCO Project but, at the cut-off date for identification of other plans and projects relevant to the in-combination assessment, only preliminary environmental information was available.

1.1.2 The North Wales Connection Project was accepted for examination by the Planning Inspectorate on 4 October 2018 (Application Reference EN020015).

1.1.3 The Screening stage of the HRA for the North Wales Connection Project (reported in [APP-300] for EN020015) considered the potential for the proposed development to have a likely significant effect (LSE) on European Designated Sites with regard to the following topics:

- Habitat loss or fragmentation.
- Predation.
- Collision risk.
- Disturbance.
- Pollution.
- Hydrological alteration.
- Invasive non-native species and biosecurity.
- Electromagnetic fields.

1.1.4 As part of this assessment, Table 6.2 of the HRA Report for the North Wales Connection Project assesses whether an effect pathway exists between the proposed development and any European Designated Sites. For the Bae Cemlyn/Cemlyn Bay SAC, the HRA concludes that the SAC contains no transient interest features, is outside of the Project's zone of influence for deposition and there are no hydrological linkages between the Project and the site. Consequently, the applicant's HRA concludes that no pathway exists for the North Wales Connection Project to affect any of the interest features of the SAC (i.e. the potential for a likely significant effect does not exist) and the Bae Cemlyn/Cemlyn Bay SAC was screened out of further assessment.

1.1.5 Given the conclusion of the HRA for the North Wales Connection Project, it can be concluded that there is no potential for an in-combination affect to arise between it and the Wylfa Newydd Project in respect of the Bae Cemlyn/Cemlyn Bay SAC.

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WYLFA NEWYDD

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Wylfa Newydd Project

Marine Works Noise Modelling based on US National Marine Fisheries Services Criteria

PINS Reference Number: EN010007

17 January 2019

Revision 1.0
Examination Deadline 4

Planning Act 2008
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Horizon Internal DCRM Number: WN0902-HZDCO-PAC-REP-00158

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Appendices

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1 Introduction

1.1.1 In paragraph 7.11.11 of the National Resources Wales (NRW) Written Representation (WR) [REP2-325], NRW note that, since the Shadow Habitat Regulations Assessment (HRA) was written, the accepted underwater noise criteria for marine mammal injury and disturbance have changed. The Southall *et al*. 2007 noise criteria, used to inform the Shadow HRA, were the accepted industry standard until April 2018, when updated criteria were published by the National Marine Fisheries Service (NMFS) (2018). These latest criteria have now been adopted by the appropriate nature conservation bodies as the preferred criteria to use in noise assessments.

1.1.2 Consequently, NRW proposed that, although it does not consider that the conclusions regarding impacts from noise will change based on these new criteria, it may be beneficial to demonstrate this, since, especially for harbour porpoise, the distance from the sound source where it is predicted that hearing injury (Permanent Threshold Shift (PTS)) can occur can be much greater using the new NMFS criteria compared to the Southall *et al.* 2007 criteria.

1.1.3 In response, a Technical Note on the Shadow HRA's marine mammal PTS noise modelling was prepared for Deadline 3 (18 December 2018) [REP3-035, Appendix D] which describes the implications of using the NMFS criteria (2018) for the conclusions of the Shadow HRA [APP-050] based on a comparison with recent noise modelling undertaken for similar activities for a different site. This demonstrated that the conclusions of the Shadow HRA would not change based on the use of the new criteria.

1.1.4 Further to this, the underwater noise modelling undertaken for the Shadow HRA has now been updated using the NMFS (2018) criteria and the results of this work are presented in appendix 2-1. Section 2 below summaries the outcomes in the context of the Shadow HRA for marine mammals.

2 Outcome of NMFS modelling

2.1.1 The results presented in appendix 2-1 correlate with those presented in the Technical Note [REP3-035, Appendix D] and Shadow HRA [APP-050].

2.1.2 That is, based on the use of the National Marine Fisheries Service (2018) criteria - for rotary drilling, dredging, rock cutting and vessel movements - the range to PTS for all assessed species (namely harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus* and grey seal *Halichoerus grypus*) remains below 100m[1].

2.1.3 For percussive drilling, the range at which a Temporary Threshold Shift (TTS) may occur in harbour porpoise has increased from a maximum of 17m to 250m as a result of using the updated criteria. However, the effect in relation to the population remains negligible, with 0.0002% of the harbour porpoise reference population anticipated to be exposed to the temporary effect (based on the worst-case density estimate at the Wylfa Newydd Development Area (WNDA)).

2.1.4 Similarly, for cutter-suction dredging, the range at which TTS onset may occur in harbour porpoise has increased from 4m to 260m in the updated modelling (at the south-west modelling location). However, as for percussive drilling, the effect in relation to the population remains negligible, with 0.0005% of the reference population anticipated to be exposed to the effect (based on the worst-case density for the proposed Holyhead North disposal site).

2.1.5 As for percussive drilling and cutter-suction dredging described above, the range at which TTS may occur in harbour porpoise for rock-cutting has increased from <1m to 130m; this also remains a negligible impact at the population level, with 0.00006% of the reference population anticipated to be affected.

2.1.6 For rock breaking, the area at which PTS onset could occur has increased for high frequency cetaceans; that is, 25m extends to 380m (using the SEL_{cum} threshold criteria). However, the effect in terms of population remains negligible; for example, it would permanently affect 0.0005% of the harbour porpoise reference population (based on the worst-case density estimate at WNDA). For TTS onset, the range has increased from 22m to a worst-case of 3.3km for harbour porpoise, however, as for PTS, the effect on the population would remain negligible, with 0.04% of the reference population expected to be temporarily affected.

2.1.7 For rock breaking, modelling was also undertaken using the SPL_{peak} criterion for PTS and TTS. The results of this modelling show a significantly larger impact range for harbour porpoise; with ranges of 2.0km for PTS and 6.1km for TTS (using the SPL_{peak} unweighted criteria), leading to 0.015% and 0.14% of the reference population anticipated to be permanently (PTS) (which

[1] It should be noted that all of the impacts described herein are based on the area of a circle (in relation to the impact range) and, as the WNDA is located adjacent to the coastline, this will significantly over-estimate the numbers of marine mammals that are expected to be exposed to each impact.

reduces to 0.008% of the reference population when taking into account the coastline) or temporarily (TTS) affected from the underwater noise associated with rock breaking respectively.

2.1.8 For the potential onset of TTS, this remains of negligible significance for the population. However, for the potential onset of PTS, this would have an effect of 'medium' significance on the population when using the full area of a circle based on the impact range for 2km, and of 'low' significance when taking into account the coastline. It is important to note in this context that these criteria are unweighted (i.e. do not take into account marine mammal hearing abilities) and are, therefore, considered to overestimate the potential effect. In addition, significantly, the Marine Mammal Mitigation Scheme will ensure that no marine mammals are within the PTS range of rock-breaking prior to commencement and, therefore, the potential effect of PTS onset will be negated.

2.1.9 Consequently, any potential effect from underwater noise during construction is not predicted to result in an adverse effect on the integrity of European Designated Sites, for which marine mammals are an interest feature, in relation to their conservation objectives.

Appendix 2-1 Underwater Noise Assessment – Additional NMFS Modelling Results

Project title	**Wylfa Newydd Generating Station: Underwater noise assessment – additional modelling results**
Project number	P251
Author(s)	REDACTED
Company	Subacoustech Environmental Ltd.
Report number	P251IR0101
Date of issue	21 December 2018

Introduction

Subacoustech Environmental previously undertook an underwater noise modelling study using RAMSGeo, in order to assess the possible noise impacts to marine fauna resulting from the various activities planned during construction at the Wylfa Newydd Generating Station (Subacoustech Report Reference: E522R0704). Since the issue of the report, additional RAMSGeo noise modelling has been undertaken to assess noise from the construction activities using the NMFS (2018)[1] criteria for injury and TTS to marine mammals. All parameters used for the additional modelling are identical to those used in the original modelling.

This report presents the additional modelling results for the construction noise sources considered in the original reporting using the NMFS (2018) criteria. The noise sources considered are:

- Two different rotary drilling rigs (242 kW and 570 kW);
- Percussive drilling;
- Cutter-suction dredging;
- Rock breaking (peckering);
- Rock cutting; and
- Vessel noise (using the SPEAR model).

The three drilling scenarios include the possibility of two identical rigs operating simultaneously. Also considered is a worst-case scenario where rotary drilling (570 kW), percussive drilling, cutter-suction dredging and rock breaking (peckering) are all operational at the same time.

NMFS criteria

The NMFS guidelines, first issued in 2016 and revised in 2018, are based on the best available research on the effects of noise on marine mammals.

The NMFS (2018) guidance groups marine mammals into functional hearing groups and applies filters to the noise level to approximate the hearing response of the receptor. The hearing groups given in the NMFS (2018) guidance are summarised in Table 1.

The auditory weighting functions for each hearing group relevant to this study are provided in Figure 1.

[1] National Marine Fisheries Service (NMFS) (2018). 2018 Revisions to: Technical guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer, NOAA. NOAA Technical Memoranda, NMFS-OPR-59.

Hearing group	Example species	Generalised hearing range
Low Frequency (LF) Cetaceans	Baleen Whales	7 Hz to 35 kHz
Mid Frequency (MF) Cetaceans	Dolphins, Toothed Whales, Beaked Whales, Bottlenose Whales (including Bottlenose Dolphin)	150 Hz to 160 kHz
High Frequency (HF) Cetaceans	True Porpoises (including Harbour Porpoise)	275 Hz to 160 kHz
Phocid Pinnipeds (PW) (underwater)	True Seals (including Harbour Seal)	50 Hz to 86 kHz

Table 1 Marine mammal hearing groups (from NMFS, 2018)

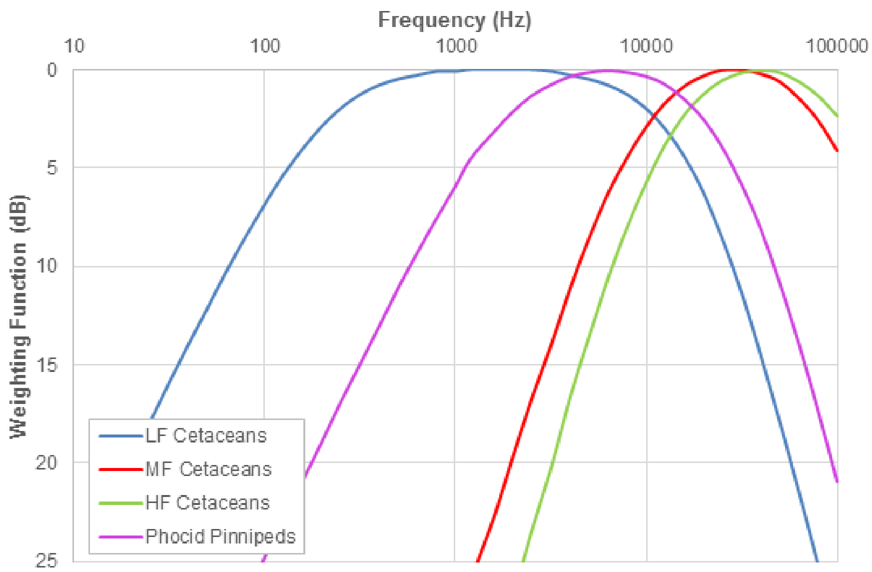

Figure 1 Auditory weighting functions for low frequency (LF) cetaceans, mid frequency (MF) cetaceans, high frequency (HF) cetaceans, phocid pinnipeds (PW) (underwater) (from NMFS, 2018)

For non-impulsive (i.e. continuous) noise, NMFS (2018) presents cumulative weighted sound exposure criteria (SEL_{cum}) for both permanent threshold shift (PTS), where unrecoverable hearing damage may occur, and temporary threshold shift (TTS), where a short-term, recoverable effect on hearing sensitivity may occur in individual receptors. Table 2 and Table 3 summarise the NMFS (2018) criteria for onset of risk of PTS and TTS for each of the key marine mammal hearing groups for impulsive and non-impulsive noise.

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

Table 2 NMFS (2018) noise exposure criteria for impulsive noise

Non-Impulsive noise	PTS criteria	TTS criteria
Hearing group	**Weighted SEL_{cum} (dB re 1 μPa²s)**	**Weighted SEL_{cum} (dB re 1 μPa²s)**
LF Cetaceans	199	179
MF Cetaceans	198	178
HF Cetaceans	173	153
PW Pinnipeds	201	181

Table 3 NMFS (2018) noise exposure criteria for non-impulsive noise

For the SEL_{cum} modelling a worst-case static animal models have been assumed, as per the modelling previously carried out at the Wylfa site. This assumes that the animal remains at a fixed distance from the noise source throughout, which in this case is a 24-hour period.

Weighted source levels

Table 4 presents the predicted NMFS (2018) weighted source levels used for modelling, in terms of single strike SELs (SEL_{ss}). These can be cross-referenced with the unweighted source levels given in the original modelling report.

Noise source	Predicted NMFS (2018) weighted source level (dB re 1 μPa²s @ 1 m) (SEL_{ss})			
	LF Cetacean	**MF Cetacean**	**HF Cetacean**	**Phocid Pinniped**
Rotary drilling (242 kW)	153.3	116.9	110.1	139.6
Rotary drilling (570 kW)	157.0	120.6	113.8	143.3
Percussive drilling	181.4	146.5	139.9	167.5
Cutter-suction dredging	171.7	150.2	144.7	163.4
Rock breaking (peckering)	183.2	154.8	148.7	173.6
Rock cutting	167.6	146.1	140.6	159.3
Large vessel movements	162.8	133.9	129.7	164.9
Medium vessel movements	155.0	126.1	121.9	157.1
All concurrent noise sources	185.9	156.5	150.6	174.7

Table 4 Summary of the predicted NMFS (2018) weighted source levels used for RAMSGeo modelling

Modelling outputs

The following sections present the noise modelling for construction noise relating to the Wylfa Newydd Generating Station using the NMFS (2018) criteria for marine mammals. As per the original report impact ranges have been presented along three transects. Details of these and all the parameters used for modelling can be found in the original modelling report.

Drilling

Table 5 to Table 10 present the impact ranges using the non-impulsive NMFS (2018) criteria for the various proposed drilling operations, assuming a stationary animal remaining in the vicinity over a 24-hour period. These include rotary drilling (Table 5 and Table 6), percussive drilling (Table 7), and scenarios where two drilling rigs are operating simultaneously (Table 8 to Table 10).

NMFS (2018) (Rotary drilling [242 kW])	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	2 m	2 m	1 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	20 m	20 m	28 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	4 m	4 m	2 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	5 m	5 m	3 m

Table 5 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from rotary drilling (242 kW) operations

NMFS (2018) (Rotary drilling [570 kW])	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	4 m	4 m	3 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	40 m	50 m	60 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	6 m	6 m	3 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	7 m	7 m	5 m

Table 6 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from rotary drilling (570 kW) operations

NMFS (2018) (Percussive drilling)	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	100 m	110 m	120 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	9 m	9 m	8 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	9 m	9 m	8 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	960 m	1.5 km	440 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	10 m	10 m	10 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	220 m	230 m	250 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	190 m	230 m	240 m

Table 7 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from percussive drilling operations

NMFS (2018) (2 rotary drilling rigs [242 kW])	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	4 m	4 m	2 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	40 m	40 m	51 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	5 m	5 m	3 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	6 m	6 m	4 m

Table 8 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from two rotary drilling rigs (242 kW) operating concurrently

NMFS (2018) (2 rotary drilling rigs [570 kW])	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	6 m	6 m	4 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	90 m	80 m	90 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	7 m	7 m	6 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	8 m	8 m	7 m

Table 9 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from two rotary drilling rigs (570 kW) operating concurrently

NMFS (2018) (2 percussive drilling rigs)	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	190 m	180 m	210 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	1 m	1 m	1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	10 m	10 m	10 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	10 m	10 m	10 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	1.2 km	2.1 km	440 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	10 m	10 m	20 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	320 m	280 m	280 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	320 m	280 m	280 m

Table 10 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from two percussive drilling rigs operating concurrently

Cutter-suction dredging

Table 11 presents the impact ranges along the three calculated transects using the non-impulsive NMFS (2018) criteria for cutter-suction dredging noise, assuming a stationary animal over a 24-hour period.

NMFS (2018) (Cutter-suction dredging)	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	10 m	10 m	10 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	1 m	1 m	1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	9 m	9 m	10 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	9 m	9 m	3 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	270 m	270 m	280 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	5 m	5 m	10 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	240 m	250 m	260 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	40 m	40 m	70 m

Table 11 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from cutter-suction dredging operations

Rock breaker / cutter

Table 12 to Table 14 present the impact ranges using the NMFS (2018) criteria for rock breaker (peckering) and rock cutting operations. Table 12 and Table 13 present the impulse criteria for SEL_{cum} and SPL_{peak} respectively. Table 14 presents the results for rock cutting operations. As with the other noise sources, all the SEL_{cum} criteria assume a stationary animal over a 24-hour period.

NMFS (2018) (impulse SEL_{cum}) (Rock breaking)	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 183 dB re 1 µPa²s Weighted SEL_{cum}	730 m	790 m	430 m
Range to PTS is Mid Freq. Cetaceans 185 dB re 1 µPa²s Weighted SEL_{cum}	9 m	9 m	10 m
Range to PTS in High Freq. Cetaceans 155 dB re 1 µPa²s Weighted SEL_{cum}	330 m	380 m	340 m
Range to PTS in Phocid Pinnipeds 185 dB re 1 µPa²s Weighted SEL_{cum}	190 m	250 m	250 m
Range to TTS in Low Freq. Cetaceans 168 dB re 1 µPa²s Weighted SEL_{cum}	4.3 km	9.9 km	440 m
Range to TTS is Mid Freq. Cetaceans 170 dB re 1 µPa²s Weighted SEL_{cum}	110 m	100 m	120 m
Range to TTS in High Freq. Cetaceans 140 dB re 1 µPa²s Weighted SEL_{cum}	1.2 km	3.3 km	440 m
Range to TTS in Phocid Pinnipeds 170 dB re 1 µPa²s Weighted SEL_{cum}	830 m	1.1 km	440 m

Table 12 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for impulsive sounds, based on noise from rock breaking operations

NMFS (2018) (impulse SPL_{peak}) (Rock breaking)	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 219 dB re 1 µPa Unweighted SPL_{peak}	270 m	260 m	250 m
Range to PTS is Mid Freq. Cetaceans 230 dB re 1 µPa Unweighted SPL_{peak}	40 m	40 m	50 m
Range to PTS in High Freq. Cetaceans 202 dB re 1 µPa Unweighted SPL_{peak}	1.1 km	2.0 km	440 m
Range to PTS in Phocid Pinnipeds 218 dB re 1 µPa Unweighted SPL_{peak}	270 m	270 m	270 m
Range to TTS in Low Freq. Cetaceans 213 dB re 1 µPa Unweighted SPL_{peak}	530 m	500 m	340 m
Range to TTS is Mid Freq. Cetaceans 224 dB re 1 µPa Unweighted SPL_{peak}	110 m	110 m	120 m
Range to TTS in High Freq. Cetaceans 196 dB re 1 µPa Unweighted SPL_{peak}	3.2 km	6.1 km	440 m
Range to TTS in Phocid Pinnipeds 212 dB re 1 µPa Unweighted SPL_{peak}	540 m	560 m	350 m

Table 13 Summary of the predicted unweighted SPL_{peak} impact ranges from NMFS (2018) for impulsive sounds, based on noise from rock breaking operations

NMFS (2018) (Rock cutting)	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	8 m	8 m	6 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m	< 1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	7 m	7 m	5 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	4 m	4 m	1 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	140 m	150 m	160 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	8 m	8 m	6 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	120 m	120 m	130 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	20 m	20 m	40 m

Table 14 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from rock cutting operations

Vessel noise

Noise from vessel movements have been calculated using a simple modelling approach rather than RAMSGeo; this is the same approach as used in the original report. The results for large and medium sized vessels are given in Table 15.

NMFS (2018) (Vessel movements)	**Large vessels**	**Medium vessels**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	10 m	3 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	4	< 1 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	< 1 m	< 1 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	480 m	130 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	3 m	< 1 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	140 m	30 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	40 m	9 m

Table 15 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on noise from vessel movements

Concurrent noise sources

Table 16 presents the impact ranges using the NMFS (2018) criteria assuming that the rotary drilling (570 kW), percussive drilling, cutter-suction dredging, and rock breaking operations from the previous sections happen concurrently. It should be noted that this uses the non-impulsive criteria. Rock breaking (peckering) is the only impulsive source, as such the ranges in Table 12 and Table 13 can be used to apply in reference to these stricter thresholds.

NMFS (2018) (Concurrent noise sources)	**North East (038°)**	**North West (332°)**	**South West (156°)**
Range to PTS in Low Freq. Cetaceans 199 dB re 1 µPa²s Weighted SEL_{cum}	140 m	160 m	180 m
Range to PTS is Mid Freq. Cetaceans 198 dB re 1 µPa²s Weighted SEL_{cum}	2 m	3 m	2 m
Range to PTS in High Freq. Cetaceans 173 dB re 1 µPa²s Weighted SEL_{cum}	30 m	30 m	30 m
Range to PTS in Phocid Pinnipeds 201 dB re 1 µPa²s Weighted SEL_{cum}	20 m	20 m	20 m
Range to TTS in Low Freq. Cetaceans 179 dB re 1 µPa²s Weighted SEL_{cum}	920 m	1.8 km	360 m
Range to TTS is Mid Freq. Cetaceans 178 dB re 1 µPa²s Weighted SEL_{cum}	40 m	40 m	40 m
Range to TTS in High Freq. Cetaceans 153 dB re 1 µPa²s Weighted SEL_{cum}	610 m	660 m	330 m
Range to TTS in Phocid Pinnipeds 181 dB re 1 µPa²s Weighted SEL_{cum}	460 m	340 m	270 m

Table 16 Summary of the predicted weighted SEL_{cum} impact ranges from NMFS (2018) for non-impulsive sounds, based on the combined noise from noise from rotary drilling, percussive drilling, cutter-suction dredging, and rock breaking operations occurring simultaneously

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