

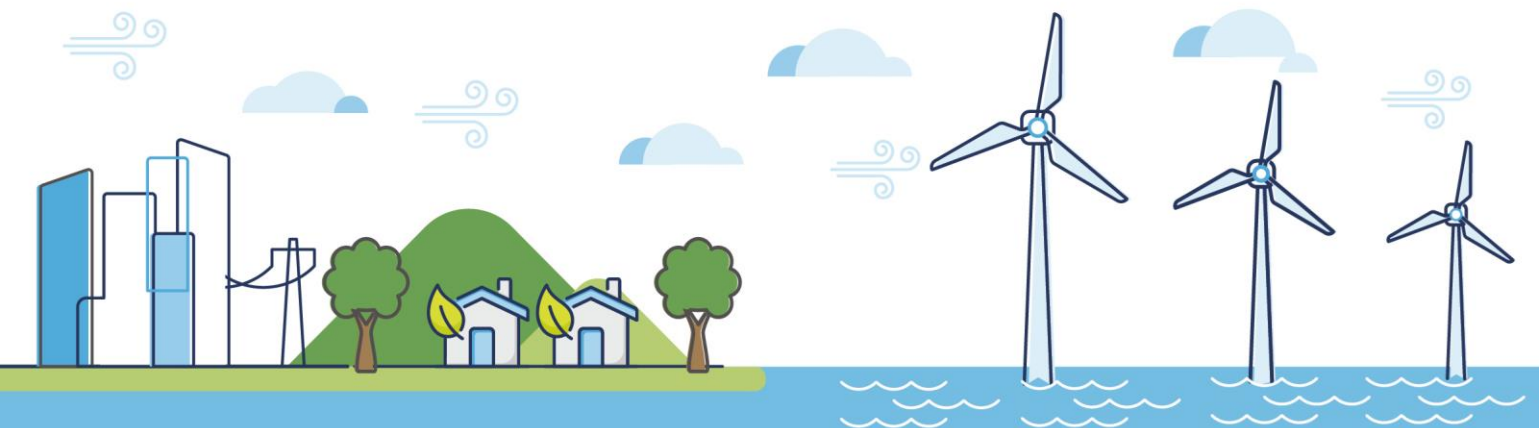
Morecambe Offshore Windfarm: Generation Assets Examination Documents

Volume 9

Outline Underwater Sound Management Strategy (Tracked)

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Glossary of Acronyms

ADD	Acoustic Deterrent Devices
CEA	Cumulative Effect Assessment
DCO	Development Consent Order
Defra	Department for Environment Food and Rural Affairs
dML	Deemed Marine Licence
EIA	Environmental Impact Assessment
EPS	European Protected Species
ES	Environmental Statement
JNCC	Joint Nature and Conservation Committee
MA	Monitoring Area
ML	Marine Licence
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MMObs	Marine Mammal Observers
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
PDE	Project Design Envelope
PEIR	Preliminary Environmental Information Report
SNCB	Statutory Nature Conservation Body
UWSMS	Underwater Sound Management Strategy
UXO	Unexploded Ordnance
WTG	Wind Turbine Generators

Glossary of Terminology

Applicant	Morecambe Offshore Windfarm Ltd
Agreement for Lease (AfL)	Agreements under which seabed rights are awarded following the completion of The Crown Estate tender process.
Generation Assets (the Project)	Generation assets associated with the Morecambe Offshore Windfarm. This is infrastructure in connection with electricity production, namely the fixed foundation wind turbine generators (WTGs), inter-array cables, offshore substation platform(s) (OSP(s)) and possible platform link cables to connect OSP(s).
High-order detonation	An explosive donor charge will be attached to or placed next to the unexploded ordnance (UXO) and will be detonated.
Inter-array cables	Cables which link the WTGs to each other and the OSP(s).
Low-order detonation	This is a method that usually uses a small charge to deflagrate or burn out the explosive material within an UXO, without detonating it.
Monitoring Area	The area around each pile location to be monitored in the pre-piling watch, and where possible during any breaks in piling or soft-start by either Marine Mammal Observers (MMObs) or Passive Acoustic Monitoring (PAM) Operator. This area is 700m from the pile location in all directions.
Offshore substation platform(s)	A fixed structure located within the windfarm site, containing electrical equipment to aggregate the power from the WTGs and convert it into a more suitable form for export to shore.
Platform link cable	An electrical cable which links one or more OSP(s).
Ramp-up	In the piling process, ramp-up forms the second part of the soft-start procedure and follows on from the initial low-energy blows. It comprises a 10-minute period of piling, starting at the low-energy blow level, and gradually increasing in hammer energy. The maximum hammer energy required (operational power for that specific pile) must not be reached within this 10-minute ramp-up period.
Soft-start	The procedure used to commence piling at a lower hammer energy. The soft-start procedure consists of low-energy blows for 10 minutes which are immediately followed by ramp-up for 10 minutes.
Windfarm site	The area within which the WTGs, inter-array cables, OSP(s) and platform link cables will be present.



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1 Introduction

1.1 Background

1. Morecambe Offshore Windfarm Generation Assets (hereafter referred to as the “Project”) is a proposed offshore windfarm located in the Eastern Irish Sea. The Project is being developed by Morecambe Offshore Windfarm Ltd (the Applicant).
2. A marine licence is required before carrying out any licensable marine activities under the Marine and Coastal Access Act 2009. The marine licence activities in relation to the Project will be deemed under the Development Consent Order (DCO). The deemed Marine Licence (dML) will cover works related to the offshore windfarm generation infrastructure (wind turbine generators (WTGs), offshore substation platforms (OSPs), inter-array cables and platform link cables).
3. The Environmental Statement (ES) has been submitted with the DCO Application and presents the findings of the Environmental Impact Assessment (EIA) process. The ES has been prepared in accordance with The Infrastructure Planning (EIA) Regulations 2017 (the 2017 EIA Regulations).
4. In response to the EIA, a direct request from Natural England was made in their in their Relevant Representation (RR-061) to provide an Outline Underwater Sound Management Strategy (UWSMS). The Applicant confirmed in The Applicant’s Response to Relevant Representations (PD1-011) that an Outline UWSMS would be provided at Deadline 2. The Outline UWSMS is applicable to the generation infrastructure and is secured within the dML in the revised Draft DCO (PD1-004 and PD1-005).

1.2 Purpose of the UWSMS

5. The UWSMS is a consent compliance document that provides a strategy to reduce the magnitude of impacts from elevated underwater sound from the Project and consequently controls the underwater noise contribution to potential cumulative impacts. The aim of the strategy is to reduce residual effects on sensitive marine mammal and fish receptors. The UWSMS is an overarching document that includes the mechanism to secure any further mitigation measures necessary to reduce the risk of both injury and disturbance to marine mammals and fish receptors due to elevated underwater sound from those activities assessed within the EIA including piling.
6. At this stage of the Project (Examination), the Outline UWSMS has been drafted to provide an overview of the information that will be detailed within

the Final UWSMS, which will be developed post-consent based on further refined Project design information. To this end, the Outline UWSMS will set out the process for investigating mitigation options (i.e. a strategic look at what ~~could-would~~ be considered) whilst the Final UWSMS will provide the detail of the approach as determined by the refined Project parameters.

7. The detailed Project design prior to construction will be shared with the licencing authority and mitigation will be agreed via the Final UWSMS if required. The Project is currently considering a range of foundation types (e.g. monopiles, pin piled jackets, suction buckets, gravity base foundations) and a range of foundation numbers (e.g. up to 37 foundations), however these could be reduced post consent (e.g. if a smaller number of bigger turbines were constructed). Maximum hammer energies are also set out as part of the Project Description (see Chapter 5 Project Description (APP-042), however reductions could be applied to hammer energies and durations of piling activity during detailed design and contracting processes.
8. There will also be further information incorporated, where available, on other nearby project construction timelines, such as piling schedules. For the purpose of the Cumulative Effects Assessment (CEA) for marine mammals in the ES (found within Volume 5, Chapter 11 Marine Mammals of the Environmental Statement (APP-048)), it was assumed a large number of projects and activities within the CEA screening areas ~~could-would~~ be constructed at the same time as the Morecambe Offshore Windfarm. The assessment of cumulative effects from other plans and projects was also based upon the respective design scenarios presented in the ESs for Tier 1 projects or Preliminary Environmental Information Reports (PEIR) for Tier 2 Projects. The assessment does not consider any further mitigation or reduced/refined Project Design Envelopes (PDEs) for other Tier 1 and/or Tier 2 projects that may be implemented post consent. However, if other projects are consented, it is reasonable to assume that they will each implement appropriate measures. It is also understood that, given the length time between consent and the start of construction, timescales of the projects considered for cumulative effects may change.
9. The Final UWSMS will be approved by the MMO in consultation with statutory nature conservation bodies (SNCBs) to agree, in detail, the necessary mitigation measures that will be implemented prior to commencement of and during offshore construction. Production of the Final UWSMS is secured within the dML in the draft DCO (PD1-004 and PD1-005).
10. The Final UWSMS will be in general accordance with the Outline UWSMS and agreed with the relevant authority prior to construction commencing. The Final UWSMS will gather all the relevant information and will allow the Applicant, regulators, and SNCBs to assess the risk (particularly to key receptors

highlighted in the ES) and secure further mitigation, if required at the time, based on the most up to date information available.

1.3 Linkage with the Marine Mammal Mitigation Protocol

11. As part of the DCO Application for consent, the Applicant has committed to a range of embedded mitigation measures adopted as part of the Project to reduce or eliminate the risk of injurious effects of underwater sound due to piling on marine mammals. A Draft Marine Mammal Mitigation Protocol (MMMP) (APP-149) has been produced and as described above for the UWSMS, a Final MMMP will be developed post-consent, in consultation with the licensing authority and SNCBs, in consideration of any refinements to the Morecambe Generation Assets project design. The Applicant's commitment to the Final MMMP is secured within the dML in the draft DCO (PD1-004 and PD1-005).
12. The draft MMMP also includes other additional mitigation options that ~~could~~ would be considered for the Project and includes measures for appropriate and early consultation to agree the final mitigation measures with stakeholders. However, in response to the Relevant Representation made by Natural England and the Marine Management Organisation (in relation to fish), this Outline UWSMS has been produced to provide a mechanism to agree and secure any final additional mitigation measures required for the Project post-consent. This is in relation to effects from underwater sound on marine mammals and fish (noting that fish are not directly considered in the MMMP). While the UWSMS cannot mitigate for other projects, it also creates an additional mechanism to review the cumulative underwater noise scenario closer to the point of construction when projects schedules are further defined.
13. Post consent, Project design refinements will be undertaken. The UWSMS will detail potential effects accounting for Project refinement and considering the application of appropriate embedded mitigation. ~~Should-if~~ the residual risk of injury and disturbance to marine mammals and fish cannot be suitably reduced, the UWSMS will describe the steps to be undertaken by the Applicant post-consent to apply additional mitigation which will be detailed and agreed through the Final UWSMS. The UWSMS also allows a mechanism for consultation with regulators outside of English waters where sound disturbance effects are possible (e.g. Isle of Man and Welsh Waters). The Final MMMP will align with the Final UWSMS in relation to marine mammals, with the UWSMS providing further detail, discussion and agreement around potential additional mitigation measures.
14. Separate marine licence applications will be made for geophysical surveys (where applicable) and unexploded ordnance (UXO) clearance (if required). As such, these are not covered within this document, noting the appropriate

mitigation for these activities would be agreed as part of the ir marine licence determinations.

1.4 Structure of the UWSMS

15. The Final UWSMS will contain the sections outlined in **Table 1.1**, as set out in this Outline UWSMS, and will be updated as a live document as more information is assembled on the Project design post consent.

Table 1.1.1.1 UWSMS document structure

Section	Title	Overview
1	Introduction	Introduction to the UWSMS. Background to the consent requirements; brief outline of the objectives, scope and purpose of the UWSMS, detailing how it will address the conditions in the dML and links to other relevant consent compliance plans.
2	Overview of Environmental Sensitivities	Environmental sensitivities in relation to sensitive marine mammals and fish receptors.
2	Consultation	A summary of the consultation undertaken with SNCBs with regard to marine mammals and fish for application to the UWSMS.
4	Responsibilities for the UWSMS	Responsibilities and ownership of the UWSMS, including details of key roles, organisation and change management systems.
5	Measures adopted as part of the Project	A summary of the embedded mitigation adopted by the Project
6	Project construction activities	Summary of activities likely to result in elevated sound and require further consideration
7	Refinements in Project design and updated effects review	Reduction in effects for key species due to refinements in Project design post-consent compared to the DCO Application.
8	Review of project timescales and timescales of cumulative projects	A review of projects included in the CEA and their latest times scales/project stage
9	Further management measures	Summary of steps to be undertaken to reduce magnitude where residual risk cannot be mitigated via embedded measures adopted as part of the Project.
10	Licences and legal requirements	A summary of additional licences which may be required for the construction activities.
11	Reporting	A summary of reporting mechanisms
12	References	List of cited references.

2 Overview of Environmental Sensitivities

16. This section will set out the sensitivities in relation elevated underwater sound as highlighted in the DCO Application for consent.
17. This section will also present an overview of the effects with respect to injury and disturbance on sensitive receptors.

2.1 Marine mammals

18. In the ES, harbour porpoise, minke whale and grey seal were identified as being potentially sensitive to auditory injury arising from elevated underwater sound from piling for the Project alone without mitigation.
19. All marine mammal species were identified as being potentially sensitive to disturbance arising from the elevated underwater sound from piling during the CEA, but no significant effects were identified through the population modelling undertaken. Further details are provided in Volume 5, Chapter 11 Marine Mammals of the ES (APP-048) including a high-level summary of the baseline ecology of these species and the potential effect from elevated underwater sound.
20. Potential effects will be reviewed when the Project design has been finalised and mitigation measures confirmed post consent.

2.2 Fish

21. In the ES, no fish species were identified as potentially being significantly affected by elevated underwater sound during piling from the Project alone. In their relevant representations (RR-047), the Marine Management Organisation (MMO) have provided feedback stating that they do not agree with the conclusions of the ES, specifically in the case of spawning Atlantic cod (*Gadus morhua*). Atlantic cod have physiological hearing adaptations (namely swim bladders involved in hearing) which elicit high sensitivity to sound, particularly impulsive sound during piling. Atlantic cod spawning grounds within the Irish Sea overlap with the Project area (see Figure 10.8a and b of APP-094). Further details are provided in Volume 5, Chapter 10 Fish and Shellfish Ecology of the ES (APP-047).

3 Consultation

3.1 Post-application consultation

22. This section details the consultation undertaken post-application to develop the Outline UWSMS, with the licensing authority and relevant statutory advisors. It clearly sets out how the Applicant has engaged with SNCBs on the development of the Outline UWSMS (Table 3.1).

Table 3.13.1 Consultation responses received post-application consultation in relation to UWSMS and how these have been addressed.

Consultee	Reference	Comment	Response/where addressed
Natural England	REP3-091	We welcome The Applicant's proposal to limit piling activity on days where UXO clearance is being carried out, to reduce area of effect for species displacement. Natural England advises that in order to fully resolve this issue more information is required regarding what is going to be limited, and in what way, and how this will be secured as a commitment and conditioned.	This commitment is secured in the UWSMS, which has been clarified in Section 9.2 . Further information on the potential reduction in impact ranges will <u>are</u> be supplied as an <u>in Appendix A</u> Appendix at Deadline 5 .
		Natural England notes that the Outline Underwater Sound Management Strategy submitted by The Applicant at Deadline 2 does not address the need for additional mitigation measures. We reiterate that the UWSMS should contain a commitment to the use of Noise Abatement Systems to mitigate residual impacts.	In line with the latest joint position statement (Joint Nature Conservation Committee (JNCC), <i>et al.</i> , 2025) and the marine noise policy paper (UK Government and Defra, 2025), the Applicant has committed to primary and/or secondary noise reduction measures (e.g. Noise Abatement System (NAS)) and commits to implement NAS for its worst case scenario (i.e., maximum strike rate and maximum hammer energy) and to review the final mitigation requirements based on the final Project design.
		2.2 Detailed comments - Longform i. Sufficiency of mitigation measures Natural England advises the mitigation measures proposed must be sufficient to mitigate for the project as it is consented. Additional design refinements confirmed post consent may reduce the overall impact of the project (and thus the level of mitigation actually needed), but this cannot be considered in the level of mitigation required for consent. The mitigation requirements must be based on current available evidence on the maximum design scenario and potential impacts i.e. the worst-case scenario. It is not clear that the current mitigation measures proposed will be adequate for the final consented project design.	This commitment and the agreement of required measures is included in Section 9.1 . Further information on the potential reduction in impact ranges will be <u>are</u> supplied in Appendix A, as an Appendix at Deadline 5 .
		ii) High strike rate scenario mitigation The Applicant has stated that the Outline Underwater Sound Management Strategy would include information on the	

Consultee	Reference	Comment	Response/where addressed
		residual impacts to Harbour Porpoise resulting from the higher strike rate scenario, as our relevant reps state that the proposed mitigation is insufficient and further assessment of this residual impact is required to inform additional mitigation. The Applicant has not included an assessment of this residual impact in the UWSMS. Natural England notes that the Applicant refers to potential refinements to the project design in the UWSMS, as well as potential mitigation which may be required depending on the final project design. We reiterate that as there is a residual impact to harbour porpoise under the higher strike rate scenario, further mitigation such as the use of Noise Abatement Systems is required and should be committed to at this stage. Furthermore, recently announced policy guidance indicates that the UK government will “<i>expect that all offshore wind pile driving activity across all English waters will be required to demonstrate that they have utilised best endeavours to deliver noise reductions through the use of primary and/or secondary noise reduction methods in the first instance</i>”.	
Natural Resource Wales (NRW)	REP3-094	WR-099-48: NRW (A) welcomes, in principle, the commitment to develop an Underwater Sound Management Strategy (UWSMS), and that it will identify all potential noise sources associated with the project with further detail provided in associated mitigation plans. Whilst NRW (A) acknowledge that further significant detail cannot be populated at this time, we agree that the UWSMS should reduce the magnitude of impacts to an acceptable level. NRW (A) agree that the UWSMS should be conditioned through both the deemed Marine Licence (dML) and standalone Marine Licence (ML). NRW (A) welcomes the	Noted. Potential management measures have been included in Section 9 and it is agreed that this document would be further developed and agreed post-consent.

Consultee	Reference	Comment	Response/where addressed
		opportunity to engage with the Applicant on developing the UWSMS during the examination and post-consent.	
		WR-099-51: With reference to the applicant's response to WR-099-51, NRW (A) acknowledge and welcome the Applicant's commitment to use all appropriate tools and up-to-date information when evaluating the potential effects of the Project post-consent, considering the final project design and the mitigation requirements for the development of the final UWSMS, the final MMMP for piling and European Protected Species (EPS) Licence requirements. NRW (A) advise that the mitigation method recommended via the Offshore Renewables Joint Industry Programme's (ORJIP) Range dependent nature of impulsive noise (RaDIN) project is included as a mitigation option within the final UWSMS and MMMP.	Noted. The Applicant will take in to account all available guidance in the final development of the UWSMS. The strike rate profile will be reviewed post consent based on the final project design and all appropriate measures will be taken to reduce impacts where practicable.
		WR-099-73 - WR-099-74; WR-099-89 - WR-099-91; WR-099-101: NRW (A) welcomes the applicant's response and acknowledges that the Applicant commits to using all appropriate tools and up-to-date information when evaluating the potential effects of the Project post-consent. NRW (A) also note that potential mitigation options, including NAS, are listed within the Draft MMMP (APP-149) and outline UWSMS which would be finalised post-consent in line with the final design of the Project.	The Applicant welcomes the response and notes that further commitments around the use of noise mitigation have been made in the submissions of the Draft MMMP (Document Reference: 6.5) and UWSMS (this document) in respect of the new guidance.
		WR-099-104: NRW (A) acknowledge and welcome the commitment of the applicant to an outline UWSMS which also includes a commitment to consider the use of NAS. NRW (A) also welcome the inclusion of condition 30 in the dML. NRW (A) welcomes the opportunity to engage with the Applicant on developing the UWSMS during the examination and post-consent.	

Consultee	Reference	Comment	Response/where addressed
MMO (and Cefas)	RR-047	Cefas and the MMO do not support the conclusions made in the CIA (Cumulative Impact Assessment). The UWN modelling presented in Figures 10.8a and 10.8b present the piling noise impact range noise contours which overlap the spawning grounds of Atlantic cod. The modelling uses the hearing thresholds in Group 3 fish for piling of 207, 203 and 186 dB SELcum for mortality and potential mortal injury, recoverable injury and temporary threshold shift (TTS), respectively. Results of the underwater noise modelling presented in Table 10.25 (Chapter 10 Fish and Shellfish Ecology) quantify the area of impact to eggs and larvae during mono- and pin-piling, which is limited to an area of 0.32km² for monopiling and 0.19km² for pinpiling, though the impact range for this impact is not shown in Figures 10.8a and 10.8b. Figures 10.8a and 10.8b show that piling noise overlaps the spawning grounds of cod for all impairments, i.e. mortality and potential mortal injury, recoverable injury and especially for TTS. Whilst suitable UWN modelling has been undertaken in respect of cod, it is disappointing to see that the assessment of impacts from UWN has assessed cod under the generic Group 3 fish in Section 10.245. The assessment seems to be missing the link between the cod as a Group 3 fish and the spawning activity they engage in at their spawning grounds. Meanwhile, the assessment of impacts from noise on spawning grounds in Sections 10.211 – 10.220, only considers impacts to the eggs and larvae, rather than the spawning fish. In our advice for PEIR we highlighted that piling works could have potential to significantly impact cod at a population level if piling was to occur during their spawning season (January – April inclusive). This is of particular importance, given ICES' latest advice on cod for the Irish Sea which states that 'when the maximum sustainable yield	The Applicant is mindful of the MMO's position and understands that either a piling restriction in the peak cod spawning season or <u>noise impacts reduced through design and/or</u> noise management measures could be employed is required. It is also noted that in light of the new underwater guidance released in January 2025, the Applicant has further updated the UWSMS at Deadline 4 (Outline Underwater Sound Management Strategy_Rev 02). The Applicant considers that the updated UWSMS aligns with the MMO's position and is sufficient to control noise mitigation and that a condition on the face of the DCO would duplicate this mechanism and is not therefore necessary. See Table 2.2 for a response.

Consultee	Reference	Comment	Response/where addressed
		(MSY) approach and precautionary considerations are applied, there should be zero catch in 2023' and that 'Fishing pressure on the stock is below FMSY, and spawning-stock size is below MSY Btrigger, Bpa, and Blim' (ICES 2022). We also pointed to Fox et al. (2000) which reports high site fidelity in cod spawning grounds in the Irish Sea. For these reasons, the MMO and Cefas would have expected you to consider this information, and potentially other sources of data to inform their assessment such as data from the Northern Irish ground fish trawl survey which has been ongoing since 2009 and has several survey stations within the eastern Irish sea (data are available from ICES: http://datras.ices.dk/). In the absence of any data to suggest that this part of the cod spawning ground is of lower importance than other areas, and in consideration of ICES advice on the cod population in the Irish sea, the MMO and Cefas recommend that piling is not permitted during the cod spawning season and recommend that the following restriction is conditioned on the deemed marine licence: No piling of any kind shall take place during the cod spawning period from 1st January to 30th April (inclusive) of any year. Reason: To prevent disturbance to adult spawning cod during their spawning season.	
		As per our advice on the PEIR, you may wish to consider the use of noise abatement measures such as big as big bubble curtains (BBC) or double BBC during piling, to reduce the noise levels emitted during piling (see Würsig et al. (1999)). UWN modelling incorporating the use of noise abatement measures has been shown to reduce the range of effect for disturbance with sensitive habitats such as spawning grounds	
		Cefas and the MMO do not support the conclusions made in the CIA that that the cumulative effects of piling noise are	

Consultee	Reference	Comment	Response/where addressed
		deemed to be no greater than project-alone effects 'minor adverse'. We would also add that recent advice for Morgan OWF (DCO/2022/00003) which is located entirely in the Irish sea cod spawning ground we highlighted the likelihood that a seasonal piling restriction to protect spawning adult cod and their eggs and larvae will be necessary during the spawning season (January – April inclusive). Whilst we have raised a number of points requiring further clarification on their UWN modelling, the modelling that was presented suggests that an extensive overlap of noise disturbance will occur at the spawning ground.	

3.2 Post-consent consultation

23. This section will detail consultation undertaken post-consent with the licensing authority and relevant statutory advisors on the Final UWSMS. It will clearly set out how the Applicant has engaged with the licencing authority and SNCBs on the development of the Final UWSMS.

4 Responsibilities for the UWSMS

4.1 Key roles

24. The key roles and responsibilities for implementing the various measures detailed in the Final UWSMS will be described in this section, alongside how communication between the responsible parties involved in construction activities that generate elevated underwater sound will be managed. The roles and titles may change as the Project progresses, but the Applicant will be responsible for the live management and consultation on the draft document prior to formal submission, after which the MMO will lead on consultation on the Final UWSMS to discharge the relevant dML condition.
25. Key contractors for foundation installation will be detailed in this section and the responsibility for ensuring the day-to-day implementation of the documented measures in the Final UWSMS will lie with the relevant installation contractors and the mitigation team (including the Acoustic Deterrent Devices (ADD) operator/Marine Mammal Observers (MMObs) and Passive Acoustic Monitoring (PAM) personnel).
26. Indicative key roles may include:
27. A Project Manager (construction phase) (or equivalent) responsible for ensuring that sufficient resources and processes are in place to deliver/comply with the documented measures.
- A Project Manager for Offshore Installations (or equivalent) who will ensure that provision is made for matters relating to the delivery of the documented measures and that construction personnel and contractors are fully briefed. The Project Manager for Offshore Installations (or equivalent) will provide reporting to the Project Manager and where necessary address any non-compliances in relation to the Final UWSMS.
28. Consents Team (or equivalent) who are responsible for monitoring ongoing compliance with the documented measures. Key responsibilities include being the primary contact for the licensing authority, and other statutory bodies or stakeholders and will be responsible for managing and reporting on compliance with dML consent conditions to the licencing authority.

29. Mitigation team (ADD operator, MMObs, PAM) which will be responsible for deployment of mitigation measures, and communication with the full distribution team including the Consents Team.
30. An organisational chart of the identified roles for the implementation of the Final UWSMS during construction will be provided in this section.

4.2 Change management

31. The Final UWSMS will set out the proposed methods for piling at the Project windfarm site and procedures to mitigate the effects of piling if required on the sensitive marine mammal and fish species identified in the relevant consent conditions. It will be a live document, that will be updated at relevant milestones in the light of any new significant information related to operations.
32. Therefore, ~~should-if~~ it ~~is~~be necessary to update the Final UWSMS, a change management process as detailed here will be described and used.

5 Measures adopted as part of the Project

33. This section will summarise the commitments made as part of the design of the Project and construction sequence. This will include the commitment to no concurrent piling and a limit of 4 pin piles or three monopiles installed in a 24hr period.
34. This section will also summarise mitigation measures committed to, including those outlined in the MMMP:
- Establishment of a monitoring area (MA) with a minimum 500m radius;
 - The observation of the MA would be conducted by trained, dedicated and experienced MMObs during daylight hours and when conditions allow suitable visibility (visibility of entire MA; sea state 3 or less).
 - Deployment of PAM devices in the MA during poor visibility or at night.
 - The activation of the ADD;
 - Soft-start and ramp-up procedures; and
 - Procedure for breaks in piling.
35. The Applicant would ensure that the mitigation measures are adequate to minimise the risk of marine mammals being present within the MA prior to piling activity commencing, to reduce the risk of any physical or auditory injury.
36. The methods for establishing the MA and reducing the potential impacts of piling operations would be agreed with the licencing authority, in consultation with relevant stakeholders, and would be secured as commitments within the Final MMMP.

37. The Project is committed to deploying a NAS for its worst-case scenario (i.e., maximum strike rate with maximum hammer energy) and to ensure there is no residual PTS after the ADD use. All requirements for noise mitigation shall be determined following confirmation of the final project design. The Project will also ensure all ADD use is within the recommended maximum duration stipulated by SNCB's (currently set at 80 minutes).

6 Construction activities

38. This section will summarise the activities that are covered in the Final UWSMS, with the potential for underwater sound effects.
39. An overview of piling will be presented in this section in the Final UWSMS based on the refined Project design. Final wind turbine numbers and OSPs will be detailed alongside the piling methodology and construction programme.

7 Refinements in Project Design and updated effects review

40. The Department for Environment Food and Rural Affairs (Defra) Policy Paper on Reducing Marine Noise was published on 21st January 2025 (UK Government and Defra, 2025) as part of Defra's Marine Noise Package. In line with this policy, projects will deliver noise reductions, where applicable, through the use of primary and / or secondary noise reduction based on the final project design.
41. This section will describe any Project design refinements based on further information available post consent. At application stage a project must consider the worst-case scenario using a project design envelope, however, experience of other constructed projects in UK waters demonstrates that additional data and detail design work can be used to refine the design such that anticipated pile diameters and/or hammer energies may be reduced. Post-consent this section will identify whether there is a sufficient reduction in the Project design envelope such that no further mitigation is required or conversely, whether additional measures are needed due to potential residual effects.
42. The following parameters will be subject to potential refinement, and as such this section will include a review of the following parameters and describe any reduction in effects as a result:
- Foundation type, pile type, number and size and construction sequence;
 - Maximum hammer energies, strike rate, soft start and ramp up procedures and piling duration;

- Construction programme.

43. During the refinement of the project requirements, all updated legislation and guidance (such as any determined noise limit if available when writing) will be reviewed and incorporated as necessary. Any further guidance for mitigation through Primary measures to be built into the Project's design (such as outlined in the RaDIN report) or additional measures through a potential update to the JNCC piling guidance (current guidance was published in 2010 and an update is anticipated) or other relevant documents will be applied where applicable.

8 Review of Project timescales and timescales of cumulative projects

43.44. This section will provide a review of the projects included in the CEA and evaluate overlap of activities based on more up to date project information. While the effects of other projects cannot be mitigated by the Project, this section will be used to feed into consideration of the mitigation measures required for the Project, in its ability to reduce contribution to cumulative effects.

9 Further management measures

44.45. This section will detail any further management measures required to reduce the magnitude of any residual effects that remain following the refinement of the Project Design and updated effects review to a non-significant level. If none are required, then it will be acknowledged in this section of the Final UWSMS.

45.46. This Outline UWSMS provides a summary of measures currently available or likely to be available in the future, which ~~could be~~ applicable to reducing residual effects from underwater sound from pile driving. The need for these measures will be considered as part of the finalisation of the UWSMS.

9.1 Noise management options

46.47. In line with the Defra Policy Paper on Reducing Marine Noise (UK Government and Defra, 2025), projects will deliver noise reductions, where applicable, through the use of primary and / or secondary noise reduction based on the final project design.

47.48. Noise mitigation systems or other secondary measures are continually being developed and improved across the industry that enable a reduction of pile driving noise (decibels) at source. These methods currently include various types of bubble curtain, hydro-sound dampers, screens or tubes, vibro- and hydro-hammers.

~~48-49.~~ A reduction in the noise at source would reduce the total area of potential disturbance to marine mammal and fish species. However, it should also be noted that many of these measures may increase the total duration of disturbance from underwater noise during foundation installation and this ~~should~~ would be a consideration in an assessment of their efficacy.

~~50.~~ The mitigation measure(s) (or suite of measures including NAS) ~~that may~~ to be implemented during the construction of the Project will be determined in consultation with the regulator and relevant SNCBs. The Project is committed to deploying a NAS for its worst-case scenario (i.e., maximum strike rate with maximum hammer energy) and to ensure there is no residual PTS after the ADD use. The Project will also ensure all ADD use is within the recommended maximum duration stipulated by SNCB guidance's (currently set at 80 minutes). All requirements for noise mitigation shall be determined following confirmation of the final Project design (See **Section 7**) including refinement of final hammer energies and foundation types, collection of any necessary additional survey data (e.g. geotechnical data), the update of location specific noise model(s) including information on maturation of emerging technologies. The most recent guidance and research on marine mammal and fish behaviour will be applied to the assessment of potential mitigation measures.

~~49-51.~~ Where noise management measures (including the potential use of NAS) are considered in the UWSMS, full site-specific underwater noise modelling will be undertaken, beyond that preliminary indicated and presented in Appendix A, to demonstrate the noise reductions that can be achieved in relation to an un-mitigated piling scenario. The results of the noise modelling will be interpreted with regard to relevant marine mammal and fish receptors (including Irish Sea cod spawning grounds) to assess the efficacy of the proposed mitigation and whether any additional measures would be required to reduce impacts on relevant receptors.

— It should be noted that suitability of any noise mitigation system would be dependent on a number of factors including pile diameter and length, ground conditions, environmental conditions, and water depth. These factors will be considered in any assessment of the efficacy of the measure. The information to inform this selection would be contingent on the selection of the chosen foundation type and installation contractor, which will only be available once contracts are being finalised post consent.

~~50.~~ —

9.2 Spatial phasing

~~51-52.~~ As stated in **Section 5** the Project is committed to no concurrent piling, which would reduce the total area of significant disturbance at any one time. is the Project has also committed to ensuring there is no high order UXO clearance

at the same time as piling at the Project. Given the size of the windfarm site it is not expected that further spatial phasing would be required, however a combination of spatio-temporal planning is considered below for fish.

9.3 Temporal (~~seasonal~~) ~~phasing~~/restrictions

~~52.53.~~ Seasonal ~~scheduling-restrictions~~ could be used as a measure to reduce the duration of any continuous disturbance within a given time period (month, season or year). However, it is noted that temporal restrictions are not considered to be required in addition to noise abatement if impact ranges are demonstrated to be effectively reduced. The MMO noted in their Relevant Representation (RR-047) that *UWN modelling incorporating the use of noise abatement measures has been shown to reduce the range of effect for disturbance with sensitive habitats such as spawning grounds*.

~~53.54.~~ The site-specific surveys for the Project showed a high presence of harbour porpoise throughout the year (further information in Volume 5, Appendix 11.2 Marine Mammal Information and Survey Data (APP-066). Howe (2018) suggested bottlenose dolphin presence in Manx waters is highly temporal and they have only been recorded in winter months (between late August and March) when the waters provide a vital habitat. Minke whale have been sighted regularly in Manx waters in the summer and they were highly seasonal, with 97.2% being reported between May and November (Howe, 2018).

~~54.55.~~ For marine mammals, the variable seasons for peak species abundance means seasonal scheduling at the Project would not produce a reduction in potential effects. Management would include the limiting of piling on the same day as Project high order clearance of UXO without mitigation (if required) as outlined in **Section 9.2**. This would reduce the area of the effect that may displace species from the area at any one time.

~~55.56.~~ As outlined in **Section 2.2**, cod spawning grounds within the Irish Sea overlap with the Project area. Whilst the Applicant maintains the findings of the ES of no significant effect on spawning grounds, the MMO recommend a seasonal restriction on piling (see **Section 3.1**), if impacts cannot be mitigated by refinements in project design (**Section 7**), or through other measures (explored in **Sections 9.1, 9.2, and 9.4**). For fish, cod spawning occurs January – April (inclusive) with peak spawning during February and March. In a temporal sense, spatio-temporal ~~planning-restrictions for~~ piling could be implemented if required to avoid piling (using the maximum modelled hammer energy as assessed in the ES) in the ~~w~~Windfarm ~~s~~Site during the peak spawning period, or consideration of spatial piling whereby locations in the deepest sections of the windfarm site (with the largest impact) are avoided in the cod spawning season. This would also represent a reduced impact magnitude cumulatively, by reducing the potential for contributing to

cumulative ensouffication of Irish Sea cod spawning grounds during the reported spawning period.

~~56-57.~~ Peer reviewed studies have sought to further understand the timing of peak cod spawning within the Irish Sea. Maxwell *et al.* (2012) analysed data from fish larvae and egg surveys across the Irish Sea from January to the end of April in 2008, thereby covering the entire known cod spawning period. Surveys for planktonic fish eggs were undertaken during each month over the following periods: Survey 1: 28/1-6/2; Survey 2: 18/2-28/2; Survey 3: 5/3-15/3; Survey 4: 25/3-3/4, and Survey 5: 14/4-22/4. In general, cod egg abundance was concentrated in two distinct areas, indicating the presence of two separate spawning sites in the west and east of the Irish Sea. The west Irish Sea spawning ground contained the most spawning activity and is beyond the worst-case noise impact ranges for the Project, whilst the east Irish Sea is within the range of impact from Project piling noise. Maxwell *et al.* (2012) was able to identify that cod spawning peaked in both west and east spawning grounds over the period 23/02 – 10/03. The entire spawning period (including low intensity non-peak spawning) occurred over the period 18/02 – 03/04. It should be noted that the Maxwell *et al.* (2012) study relied on 2008 survey data, so didn't assess the potential for inter-annual variation in the timing of spawning. Armstrong *et al.* (2012) built on the same 2008 survey data utilised by Maxwell *et al.*, (2012), and also assessed additional annual datasets covering the period 1995-2010, thereby clarifying the extent to which peak cod spawning varied inter-annually. Peak cod spawning occurring in the mid-February to mid-March period over the 2006-10 period. There was a slight delay of approximately a week noted in the peak of the west spawning population in 2010 compared to the east spawning population, but both still spawned within the same mid-February to mid-March period. Consistency of peak cod spawning from mid-February to mid-March across years has therefore been demonstrated (Armstrong *et al.*, 2012).

~~57-58.~~ On the basis of the evidence set out above, a temporal piling restriction, if determined to be necessary through further development and agreement of the UWSMS post-consent, would be effective if targeted to mid-February to mid-March. However, this measure would not be considered in the event that sufficient noise abatement was employed or if the design parameters were refined sufficiently to reduce the impact range to an acceptable level, which would be agreed with the MMO.

9.4 Other potential measures

~~58-59.~~ Given the time lag between consent and the start of offshore construction, it is possible that new measures would become available. As such, the Final UWSM~~SP~~ would not be restricted only to potential measures outlined above. Rather, the UWSM~~SP~~ allows the consideration and assessment of other

relevant technologies or methodologies that may have emerged by the time of offshore construction. This would ensure that any new technologies or methods that may be developed could be used during construction of the Project.

10 Licences and legal requirements

10.1 Marine wildlife licence application

~~59-60.~~ The European Commission Habitats Directive (92/43/EEC) lists all cetaceans in Annex IV, i.e. species for which a system of strict protection needs to be established. There is a requirement to consider European Protected Species (EPS) through the Habitats Directive which is transposed into UK law by the Conservation (Natural Habitats) Regulations 1994 (as amended) (out to 12 nm).

~~60-61.~~ The Conservation of Habitats and Species 2017 (2017 No. 1012) (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (2017 No. 1013) (as amended) are the principal pieces of secondary legislation which, prior to the UK's departure from the EU, transposed the terrestrial and offshore marine aspects of the EU Habitats Directive (Council Directive 92/43/European Economic Community (EEC)) into the domestic law. This became known as the 'Habitats Regulations'.

~~61-62.~~ The Conservation of Habitats (Amendment) (EU Exit) Regulations 2019 (2019 No. 579) set out the changes that apply since the UK left the EU. These confirmed that:

~~62-63.~~ All protected sites and species retain the same level of protection

~~63-64.~~ Unless the UK government implements further legislative changes, the obligations, process and terminology of the Habitats Regulations will, for the purposes of this document, remain as set out in existing legislation and regulations. The role of the European Commission is now exercised by UK Ministers.

~~64-65.~~ A Marine Wildlife Licence application would be made for all activities that have the potential for injury or disturbance on EPS (cetaceans). The application would only be submitted after initial round(s) of consultation on the draft UWSMS and on the separate MMMP for piling and any required MMMP for UXO clearance based on the final Project requirements and design. The activities that may require an EPS licence are:

- Piling (if required)
- UXO clearance (if required)

~~65.66.~~ Prior to these activities taking place, an EPS risk assessment would be undertaken, following the staged approach as outlined in 'The protection of Marine European Protected Species from injury and disturbance' (JNCC *et al.*, 2010). If it is deemed that an EPS licence is required for any activity, an EPS Risk Assessment document would be produced, and a Marine Wildlife Licence applied for.

~~66.67.~~ Mitigation would be put in place for piling (and UXO clearance as part of a separate Marine Licence), as per the JNCC guidelines. Where ADDs are required, these would also be considered within the risk assessments. The EPS licence can require all piling operations, UXO clearance and ADD operations to be carried out in accordance with the Final UWSMS and the Final MMMPs.

10.2 UXO clearance marine licence

~~67.68.~~ A separate marine licence for UXO clearance would be sought, with the necessary information (including the final MMMP for UXO clearance), being provided through the marine licensing process. Proposed measures to mitigate potential impacts from UXO clearance have been provided within the draft MMMP (APP-149) for information purposes only, consistent with Natural England's advice that the DCO Application should include a high-level assessment of potential UXO clearance.

~~68.69.~~ As such, a separate MMMP for UXO clearance would be developed for the Project at the pre-construction stage. The final MMMPs would take account of the most suitable mitigation measures and up to date scientific understanding at the time of construction. These measures would be consulted upon with the MMO and SNCBs.

~~69.70.~~ The final MMMP for UXO clearance would be submitted to the MMO for approval prior to the start of relevant works, in consultation with the relevant SNCBs.

~~70.71.~~ The methods for reducing the potential impacts of any UXO clearance would be agreed with the MMO in consultation with relevant stakeholders including SNCBs and would be secured as commitments within the Final MMMP. UXO clearance methods would follow a hierarchy of measures including:

- UXO would be avoided and left in situ;
- If the UXO appears structurally sound and there is an acceptably low health and safety risk of detonation in transit, the UXO could potentially be relocated to a location within the DCO boundary that is not in a sensitive area (e.g. away from a designated site or existing or planned infrastructure) for subsequent long term storage or clearance if required, subject to consultation with relevant sea users

- Low-order disposal techniques, this would be the preferred method for all in-situ UXO clearance where possible
- The potential use of bubble curtains if high-order UXO detonation is required, taking into account the environmental conditions within which they could be effective.

10.2.1 Clustering of UXO devices

~~71.72.~~ The ability to cluster UXO devices would limit the total potential area of disturbance and the potential cumulative noise exposure that would otherwise result from successive detonations of UXO devices in discrete areas. If it is possible (and safe to do so), UXO could be detonated together in one area, once they have been clustered. This will be considered as an option if a UXO clearance Marine Licence is needed.

11 Reporting

11.1 Overview

~~72.73.~~ This section will set out how data gathered will be used and reported on for the Final UWSMS, in line with the requirements of the dML conditions.

~~73.74.~~ Members will report via the appropriate chain of command on completion and/or compliance with the mitigation measures.

11.2 Field records

~~74.75.~~ This section will detail commitments to reporting in field records in the Final UWSMS.

~~75.76.~~ Reports are likely to include, but not limited to, the following:

- Location and piling activity;
- Weather conditions during ADD or NAS deployment, including visibility;
- Start and end times of soft start piling;
- Details of soft-start procedures and hammer energy employed at each piling location, including the duration of full-power piling;
- Confirmation that the ADD or NAS has been tested and is functioning as per specifications;
- Time and duration of ADD or NAS deployment prior to piling events;
- Observations of marine mammals during the testing and deployment of the monitoring and mitigation options.

~~76.77.~~ The Project will collate and issue relevant data to relevant parties (e.g. Consents Team) and report to the licensing authority.

11.3 Compliance reporting

~~77.78.~~ This section will detail compliance reporting for the Final UWSMS.

~~78.79.~~ This ~~could~~would include an UWSMS compliance report and provision of marine mammal observations and other additional files (such as hydrophone records) if required.

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13 APPENDIX A Additional Preliminary Modelling

80. The Applicant has conducted additional underwater noise modelling using INSPIRE Light 5.1 to demonstrate how the use of NAS can effectively reduce sound levels. The modelling, which uses a maximum reduction of 10 dB, showed that for minke whales, harbour porpoises, and seals, the PTS ranges for one or for 3 sequential monopiles being installed were drastically reduced by over 80% (Table 13.1). For dolphins, the impact ranges were originally already below 100 m without NAS, and thus no overall change was detected as this is the nearest value that can be modelled to. This is also the case for single strike SPL_{peak} unweighted modelling where the ranges were modelled down to 50 m for unmitigated impact results but only down to 100 m for mitigated impact results, therefore, no overall change was detected.
81. -The reduction in impact areas for the installation of one or three sequential monopiles at the SW location, was up to 99% for harbour porpoise, meaning that with the use of NAS, the PTS impact area could be reduced from 150 km² to 1.6 km².
82. For minke whale, -a 97% reduction in impact area could be achieved, for any installation scenario, meaning that with the use of NAS, the PTS impact area could be reduced from 330 km² to 9.9 km².
83. The PTS impact area for seals could be reduced from 2 km² to 0.1 km², indicating a 95% area reduction if NAS with the ability to achieve a noise reduction of 10 dB can be applied at the Project.
84. The required duration of an Acoustic Deterrent Device (ADD) would also be significantly reduced (Table 13.2). In the ES, the ADD duration was estimated to be 90 minutes to cover potential PTS distances (noting that Natural England states 80 minutes is the effective maximum limit) for harbour porpoise, which would have also deterred minke whale. With the updated modelling, including the 10dB noise reduction from NAS, ADD is still required but for a much shorter duration. For minke whale, the ADD activation would only be required for a maximum of 14 minutes (initially it was approximately 67 minutes of ADD activation time), during which the animal would travel 2.73 km, assuming a swimming speed of 3.25 m/s. At the same time, but with a slower swimming speed of 1.5 m/s, harbour porpoise would be beyond their PTS injury range of 900 m (at 1.26 km).

Table 13.1 Predicted PTS impact ranges (and areas) at the Project from the unmitigated and mitigated weighted PTS SEL_{cum} Monopile (maximum strike rate scenario)

<u>Species</u>	<u>Impact</u>	<u>Criteria and threshold (Southall et al., 2019)</u>	<u>Monopile (single)</u>			<u>Monopile (sequential piling)</u>		
			<u>Maximum impact range (km) and area (km²)</u>			<u>Maximum impact range (km) and area (km²)</u>		
			<u>Maximum hammer energy (6,600kJ)</u>			<u>Maximum hammer energy (6,600kJ)</u>		
			<u>Unmitigated</u>	<u>Mitigated (-10dB)</u>	<u>Reduction</u>	<u>Unmitigated</u>	<u>Mitigated (-10dB)</u>	<u>Reduction</u>
<u>Harbour porpoise (VHF)</u>	<u>PTS from single strike (without mitigation)</u>	<u>SPL_{peak} Unweighted (202 dB re 1µPa) Impulsive</u>	<u>0.69 km (1.5 km²)</u>	<u>0.2 km (0.1 km²)</u>	<u>Range:71% Area:93%</u>	<u>n/a</u>	<u>n/a</u>	<u>n/a</u>
	<u>PTS from cumulative SEL (including soft-start and ramp-up)</u>	<u>SEL_{cum} Weighted (155 dB re 1µPa²s) Impulsive</u>	<u>8.1 km (150 km²)</u>	<u>0.9 km (1.6 km²)</u>	<u>Range:89% Area: 99%</u>	<u>8.2 km (150 km²)</u>	<u>0.9 km (1.6 km²)</u>	<u>Range:89% Area: 99%</u>
<u>Dolphin species (HF)</u>	<u>PTS from single strike (without mitigation)</u>	<u>SPL_{peak} Unweighted (230 dB re 1µPa) Impulsive</u>	<u><0.05 km (<0.01 km²)</u>	<u><0.1 km (<0.1 km²)</u>	<u>No change</u>	<u>n/a</u>	<u>n/a</u>	<u>n/a</u>
	<u>PTS from cumulative SEL (including soft-start and ramp-up)</u>	<u>SEL_{cum} Weighted (185 dB re 1µPa²s) Impulsive</u>	<u><0.1 km (<0.1 km²)</u>	<u>No change</u>	<u>No change</u>	<u><0.1 km (<0.1 km²)</u>	<u>No change</u>	<u>No change</u>

<u>Species</u>	<u>Impact</u>	<u>Criteria and threshold</u> <u>(Southall et al., 2019)</u>	<u>Monopile (single)</u> <u>Maximum impact range (km) and area (km²)</u>			<u>Monopile (sequential piling)</u> <u>Maximum impact range (km) and area (km²)</u>		
			<u>Maximum hammer energy (6,600kJ)</u>			<u>Maximum hammer energy (6,600kJ)</u>		
			<u>Unmitigated</u>	<u>Mitigated (-10dB)</u>	<u>Reduction</u>	<u>Unmitigated</u>	<u>Mitigated (-10dB)</u>	<u>Reduction</u>
<u>Minke whale (LF)</u>	<u>PTS from single strike (without mitigation)</u>	<u>SPL_{peak} Unweighted (219 dB re 1μPa) Impulsive</u>	<u><0.05 km (0.01 km²)</u>	<u><0.1 km (<0.1 km²)</u>	<u>No change</u>	<u>n/a</u>	<u>n/a</u>	<u>n/a</u>
	<u>PTS from cumulative SEL (including soft-start and ramp-up)</u>	<u>SEL_{cum} Weighted (183 dB re 1μPa²s) Impulsive</u>	<u>13 km (330 km²)</u>	<u>2.6 km (9.9 km²)</u>	<u>Range:80% Area: 97%</u>	<u>13 km (330 km²)</u>	<u>2.6 km (9.9 km²)</u>	<u>Range:80% Area: 97%</u>
<u>Grey and harbour seal (PCW)</u>	<u>PTS from single strike (without mitigation)</u>	<u>SPL_{peak} Unweighted (218 dB re 1μPa) Impulsive</u>	<u>0.06 km (0.01 km²)</u>	<u><0.1 km (<0.1 km²)</u>	<u>No change</u>	<u>n/a</u>	<u>n/a</u>	<u>n/a</u>
	<u>PTS from cumulative SEL (including soft-start and ramp-up)</u>	<u>SEL_{cum} Weighted (185 dB re 1μPa²s) Impulsive</u>	<u>0.95 km (1.9 km²)</u>	<u><0.1 km (<0.1 km²)</u>	<u>Range:89% Area: 95%</u>	<u>0.98 km (2.0 km²)</u>	<u><0.1 km (0.1 km²)</u>	<u>Range:90% Area: 95%</u>

Table 13.2 ADD Duration Times

<u>Species</u>	<u>Unmitigated ADD times</u>	<u>Mitigated (-10dB) ADD times</u>
<u>Harbour porpoise (VHF)</u>	<u>90 minutes</u>	<u>10 minutes</u>
<u>Dolphin species (HF)</u>	<u>2 minutes</u>	<u>2 minutes</u>
<u>Minke whale (LF)</u>	<u>67 minutes</u>	<u>14 minutes</u>
<u>Grey and harbour seal (PCW)</u>	<u>11 minutes</u>	<u>2 minutes</u>

85. Through the use of noise mitigation measures, the area of noise exposure to marine mammals can be significantly decreased (Koschinski & Lüdemann, 2020). Several parameters influence the resulting noise levels such as pile diameter, water depth, soil structure and blow energy.
86. NAS are typically categorised into one of three types, bubble curtains (BBC), pile isolation casings and alternative hammers. Within these categories there are many different types of NAS.
87. With regard to bubble curtains, the effectiveness of these has been well established through use on European offshore wind projects. For example, DanTysk offshore wind farm used a small bubble curtain (Dahne *et al.*, 2017), Borkum West II useding BBC, and Alpha Ventus (2009) and Baltic II (2014) OWF useding a layered bubble curtain. A single BBC is expected to reduce received sound levels at 750m by approximately 7 – 15dB SEL (subject to water depth and other conditions) (Verfuss *et al.*, 2019; Bellmann *et al.*, 2020). The application of a BBC was used by Borkum West II at depths up to 33m, it was recorded the BBC hadcaused a noise reduction of up to 15dB (SEL) (Bellman, 2012). The use of a double bubble curtain (DBBC) has been recorded to haveareduce underwater sound reduction between 8 – 18 dB (SEL) (Bellmann *et al.*, 2020).
88. IHC IQIP NMS is an example of an isolation casing mitigation system, it was founddeployed across 450 installations using various designs, and resulted in a sound reduction between 13 – 17 dB (SEL)–was seen. The IHC-NMS8000 used on at least 65 installations hadresulted in a sound reduction of 15 – 17 dB SEL (Bellmann *et al.*, 2020).
89. Another noise reduction system is Hydro Sound Dampers (HSD), these have been shown to have a sound reduction between 10 – 12 dB in up to 40m depths when measured over 340 installations (Bellmann *et al.*, 2020). OffNoise-Solutions GmbH provides HSD technology and has demonstrated a sound reduction between 11 – 14 dB (SEL) at 750 m. They also demonstrated the HSD combined with DBBC had a noise reduction of between 19 – 25 dB (SEL) at 750m.
90. There are other technologies such as AdBm Technologies that have demonstrated attenuation of up to 20 dB was-measured when used with a single BBC and attenuation of 8 dB when the AdBm system was used alone (Wochner, 2019).
91. To estimate the potential reduction in impact area and ranges due to noise reduction mitigation the additional indicative underwater noise modelling assumed a 10 dB reduction in source level. Based on the examples provided above, the 10 dB sound reduction provides a conservative estimate to cover different noise mitigation options.

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