The Sizewell C Project

6.3 Volume 2 Main Development Site

Chapter 22 Marine Ecology and Fisheries

Appendix 22N - Sizewell C Draft Marine Mammal Mitigation Protocol

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Cefas Report TR509

Sizewell C Marine Mammal Mitigation Protocol (MMMP)

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1 Introduction

1.1 Project background

EDF Energy proposes to construct and operate a new nuclear power station immediately to the north of the existing operational and decommissioned stations (Sizewell B and Sizewell A, respectively) at Sizewell on the Suffolk coast (Figure 1.1).

A draft Marine Mammal Mitigation Protocol (MMMP) was submitted as part of the original DCO submission Appendix 22N [APP-331] and is in fulfilment of the Deemed Marine Licence (Condition 40(2)(b)) [REP2-015] and Code of Construction Practice [APP-615].

Since DCO submission of the Application, further design work has been carried out which has identified that there may be potential for more material to be brought to the site by sea than is currently provided for in the original Application. As described in the ES Addendum [AS-181], this would be achieved by:

- enhancing the design of the permanent Beach Landing Facility (BLF); and
- providing a new temporary BLF.

The BLFs would be used to receive large deliveries into Sizewell C by sea. The enhanced permanent BLF would support construction of the power station by enabling delivery of abnormal indivisible loads (AILs) by sea. The primary role of the temporary BLF would be to receive aggregate deliveries and building materials from self-unloading vessels.

The permanent BLF would be longer (approximately 100m in total length) to better align the barge deck with the platform, making deliveries safer and more efficient. It would require approximately 28 permanent piles in total.

The temporary BLF would be up to approximately 505m in length. Approximately 114 piles would be required to construct the temporary BLF, of which approximately 12 would be located above Mean High Water Springs (MHWS).

Two piles would typically be driven every three days (for each BLF) to an embedment depth of approximately 20m, with hammering typically lasting approximately one hour per pile. Piling is assumed to occur simultaneously.

1.2 Purpose of this document

This document outlines the monitoring and mitigation requirements for minimising the impacts on marine mammals during the construction of the enhanced permanent BLF and temporary BLF. It aims to ensure, as far as practically possible, that marine mammals occurring around the proposed development site are not exposed to potentially damaging levels of underwater noise during piling operations, with its primary focus on avoiding, wherever possible, injurious impacts during piling.

The MMMP is based on the statutory advice on minimising the risk of injury to marine mammals from piling noise provided by the JNCC (2010). The protocol:

a) Identifies the area known as the mitigation zone (MZ);

b) Outlines the mitigation measures that will be implemented to limit potential impacts on marine mammals;

c) Describes the communication plan in place to implement the mitigation measures quickly and effectively;

d) Sets out the roles of the Marine Mammal Mitigation Team (MMMT) and the Designated Person (DP) in relation to piling activity (i.e., their authority in terms of pile driving activity).

This draft MMMP will be agreed upon in consultation with the relevant Statutory Nature Conservation Bodies (SNCBs). The protocol presented in the final MMMP must be followed for all piling operations during the piling activities for construction of BLFs in the marine environment. EDF Energy and its contractors are responsible for ensuring the agreed MMMP is implemented.

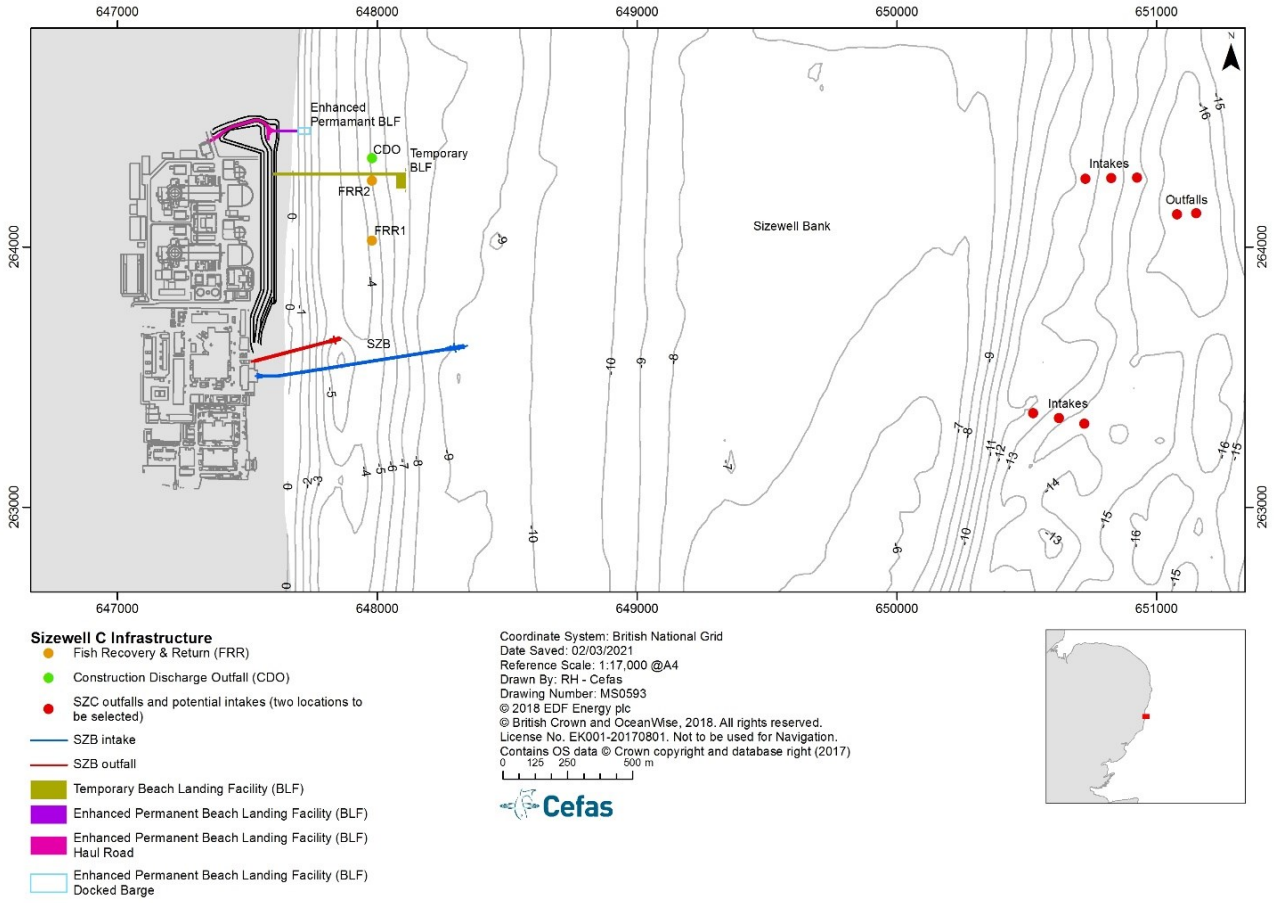

Figure 1.1: Schematic of the proposed location of development infrastructure in the marine environment with indicated locations of the BLFs. Background to pile driving and marine mammal mitigation.

1.3 Background to pile driving and marine mammal mitigation

Pile driving activities are performed to establish foundation support for different structures in the marine environment. Piles are driven into the seabed by means of a hydraulic hammer. The sounds from pile driving enters the water column directly because the impact of the hammer strike will create waves in the pile wall, which combine with the surrounding fluid (water) (Popper and Hastings, 2009). Furthermore, the pulse propagating down the pile may combine to the substrate at the bottom, causing waves to propagate outward through the seabed sediment (Popper and Hastings, 2009). Acoustic energy can radiate back into the water column from the seabed at some distance away from the pile (Erbe, 2012). The propagation of pile driving noise varies according to the seabed type (Hildebrand, 2009), pile characteristics (size, shape, length and

material), the size and energy of the hammer, water depth, bathymetry, temperature and salinity (Erbe, 2012). Pile driving activities are of particular concern as they generate loud, impulsive sounds, at low frequencies and high source levels (Hildebrand, 2009). Pile-driving operations have been identified as producing sufficiently high noise levels, capable of causing physical injury to marine mammals (Nedwell *et al.*, 2007).

The Joint Nature Conservation Committee (JNCC) '*Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise*' (2010) provides guidance on mitigation measures required during pile-driving operations. As per the protocol (JNCC, 2010), the best practice for mitigating the impacts of anthropogenic sound on marine mammals includes the following mitigation options:

a) Establishment of an appropriate mitigation zone around the sound source (standard is 500m), encompassing the area within which mitigation measures are applicable.

b) When possible, the implementation of a soft start procedure to build up the sound source slowly over time and permit marine mammals to leave the area prior to maximum exposure.

c) The use of dedicated personnel to undertake visual and/or acoustic monitoring in order to detect marine mammals and implement a suite of real-time mitigation measures.

Additional measures may also be considered including interrupting noise-generating activities if marine mammals are sighted within a designated mitigation zone during the operation (JNCC, 2010), or at the planning stage by imposing constraints on when and where noise emissions are permitted due to known sensitivities (e.g., a fish spawning area during a particular period, or bird breeding season).

Recently, noise abatement technologies have been given more consideration. Noise abatement can be achieved by making the noise sources quieter, such as by modifying or replacing technology (e.g., alternative piling foundations or technologies) or by operational interventions (e.g., bubble curtains around pile driving operations). Available noise abatement technologies have different constraints related to water depth and oceanographic conditions (Merchant and Robinson, 2020).

The marine mammal mitigation measures proposed for pile-driving activities for the proposed development follow the JNCC (2010) piling protocol and latest guidelines on the abatement of underwater noise pollution from pile-driving (Merchant and Robinson, 2020).

1.4 Piling during construction

Impact piling represents the primary construction impact for marine mammals for the Sizewell C project. Construction of the enhanced permanent and temporary BLFs requires pile driving[1]. The installation and mitigation measures summarised and described in the Construction Method Statement (Appendix 3D of Volume 2 Chapter 3) and detailed within this MMMP aim to minimise potential effects.

The enhanced permanent BLF would be located on the coast at the northern end of the sea defences (Figure 1.2). It would consist of 24 piles (12 below MHWS) and four fenders and mooring dolphins seaward of the terminus of the BLF. The total length of the BLF would be approximately 100m. Piles would be

[1] The temporary BLF would be dismantled after the construction phase. The full superstructure would be dismantled from seaward working back toward land. Piles would be removed by a combination of very short duration impact piling to loosen the pile, followed by vibropiling. In a similar fashion to installation, two piles would be removed per day followed by two days to dismantle the span. Piles and dolphins that are not possible to be removed by vibropiling would be cut off below the seabed. This MMMP is designed to fulfil the construction phase associated with conditions in the Deemed Marine Licence (Condition 40(2)(b) [REP2-015] and Code of Construction Practice [APP-615], thus it does not cover the mitigation during the decommissioning phase.

approximately 1m in diameter and embedded to a depth of approximately 29m into the seabed. Mooring dolphins and the fender would be approximately 2.5m in diameter and embedded approximately 22m into the seabed.

The temporary BLF would be constructed approximately 165m south of the enhanced permanent BLF (Figure 1.2). The temporary BLF would consist of a trestle pier, fitted with a covered aggregate conveyor, with an unloading platform at the seaward terminus. The temporary BLF would be in place during the construction phase before being decommissioned. The temporary BLF would be approximately 505m in length and extend approximately 440m seaward of MHWS. The trestle pier would require 68 piles to be installed below MHWS. Piles would be approximately 1.2m in diameter and embedded to a depth of approximately 19m. The unloading platform would consist of 30 piles. Four mooring dolphins with a diameter of approximately 2.5m would be installed at the seaward end of the temporary BLF.

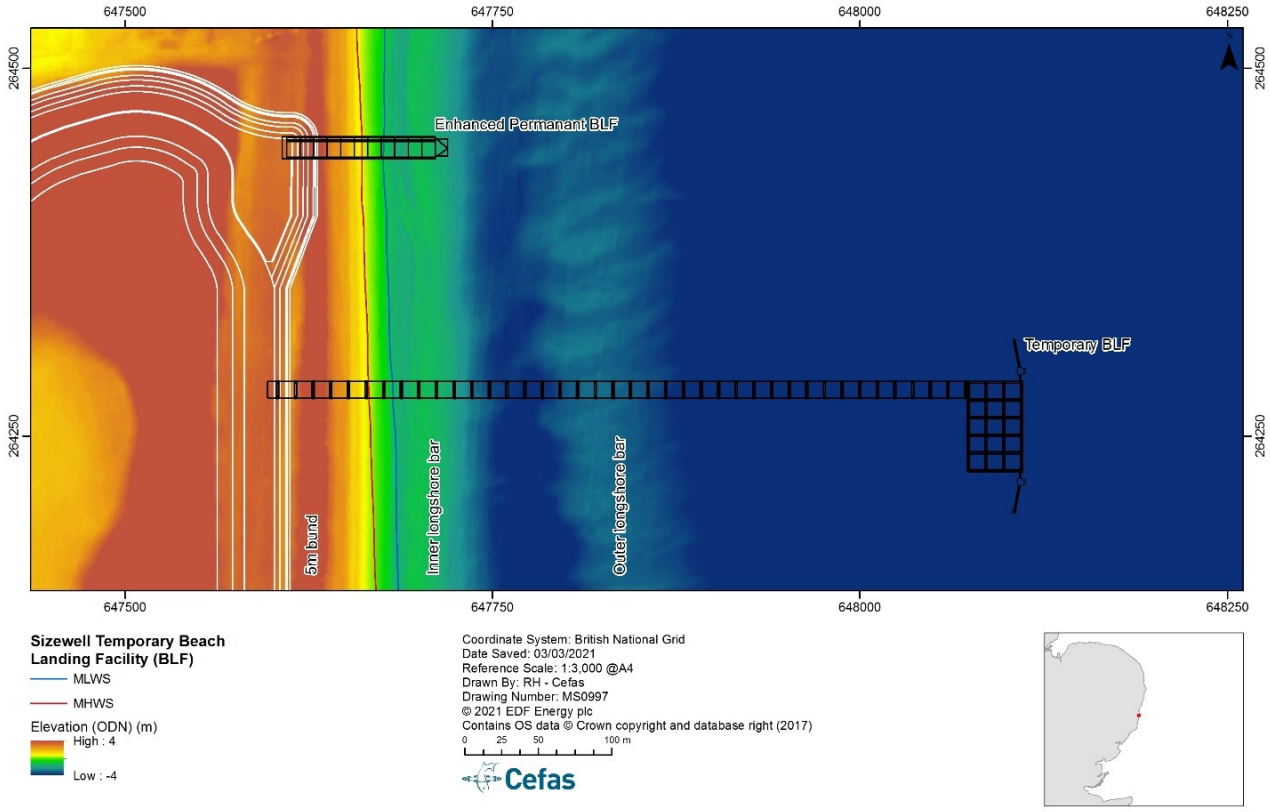

Figure 1.2: The location of enhanced permanent and temporary Beach Landing Facilities (BLFs) showing the pile locations relative to local bathymetry.

Impact piling to install piles is anticipated to require 120kJ hammer energies. Installation of mooring dolphins is anticipated to require 280kJ hammer energies. Where technically feasible, noise reduction systems are proposed in the Construction Method Statement (Appendix 3D of Volume 2 Chapter 3). The noise reduction as a result of changes to the hammer employed and would be implemented through the use of measures such as a hydrohammer that has hydraulic plungers filled with water designed to dampen the impact and reduce the source noise of impact piling. For the purposes of this MMMP the application of a hydrohammer is included as part of the suite of piling mitigation measures that also includes marine mammal observers, soft start procedures and seasonal piling restrictions, detailed in Section 6.

Construction of the enhanced permanent BLF would require the use of land based/shallow water plant and/or jack-up barges to install the piles. Up to two piles would be installed per day followed by laying of the platform.

In the case of the temporary BLF, a Cantitravel system will be used (where the piles are installed from landward and the crane/plant advances seaward across the newly installed piles and platform). Up to two piles may be installed per day for the trestle and three piles per day may be installed during the installation of the unloading platform. A maximum of two mooring dolphins per day would be installed by a jack-up barge both for the permanent and temporary BLF.

Piling parameters are provided in Table 1.1 and Table 1.2.

Installation of the enhanced permanent BLF is anticipated to last six months. Installation of the temporary BLF is anticipated to last nine months. Installation is assumed to start in August in year 1 for both BLFs and be completed by April of year 2 (i.e., 2023) of the construction phase. No piling would occur in the months of May to August inclusive to minimise the potential for effects on designated breeding birds. Assuming no temporal overlap of piling activities, a total of 54 days piling would occur during this period. If piling for the enhanced permanent BLF and temporary BLF occurred simultaneously, a total of 48 days of piling would be required. No consecutive piling at each BLF would occur when the mooring dolphins are installed.

Table 1.1 Piling parameters for the enhanced permanent BLF.

Parameter	Piles	Mooring dolphins
Number (below MHWS).	12	4
Pile diameter.	1m	2.5m
Modelled depth of deepest pile (depth includes +1.4m chart datum to encompass a range of tidal conditions).	5.1m	5.1m
Hammer energy.	120kJ	280kJ
Strike rate.	44 blows / minute.	44 blows / minute.
Piling duration.	45 minutes (+ 20-minute ramp-up).	45 minutes (+ 20-minute ramp-up).
Acoustic conversion efficiency.	0.5%	1%
Maximum piles installed in 24-hour period.	2	2
Minimum piling interval (worst-case).	15 minutes.	15 minutes.

Table 1.2 Piling parameters for the temporary BLF.

Parameter	Piles	Mooring dolphins
Number (seaward of MHWS).	98 (30 unloading platform piles) (68 trestle piles).	4
Pile diameter.	1.2m	2.5m
Modelled water depth of deepest pile. (depth includes +1.4m chart datum to encompass a range of tidal conditions).	8.5m at the unloading platform at the seaward end. 5.3m within the outer longshore sand bar (trestle pier).	8.5m
Hammer energy.	120kJ	280kJ
Strike rate.	44 blows / minute.	44 blows / minute.
Piling duration.	45 minutes (+ 20-minute ramp-up).	45 minutes (+ 20-minute ramp-up).
Acoustic conversion efficiency.	0.5%	1%
Maximum piles installed in 24-hour period.	2 for trestle - (34 days of piling). 3 for the unloading platform (10 days of piling).	2 (2 days of piling).
Minimum piling interval (worst-case).	15 minutes.	15 minutes.

2 Marine mammals in the area

BEEMS Technical report TR324, Appendix 22E of [APP-317] characterised the marine mammals in the area. Three species of marine mammal are known to occur in the Great Sizewell Bay (GSB). These include one cetacean species: harbour porpoise (*Phocoena phocoena*) and two pinniped species: harbour seal (also known as common seal) (*Phoca vitulina*) and grey seal (*Halichoerus grypus*). Other species of cetaceans are present in the southern North Sea, although, these species are infrequently observed within the GSB (BEEMS 2019a).

Effects on marine mammal receptors (including underwater noise) are considered in the Environmental Statement (ES) in Section 22.9 of [APP-317] and in the cumulative effects assessment in Appendix 4C of [APP-579]. Effects on designated sites with marine mammal features are considered in the shadow Habitats Regulations Assessment [APP-145]. Updated assessments for the revised marine freight management strategy are provided in Section 2.17 of the ES Addendum [AS-181] and detailed modelling results are provided in BEEMS Technical Report TR538 (BEEMS, 2021b).

2.1 Harbour porpoise

The harbour porpoise is the only cetacean species regularly present in the GSB with the majority of acoustic detections occurring during winter months (i.e., between October and March). Their presence is more pronounced in offshore waters (10-20km from the coast) with lower detection rates in inshore waters (1-2km from the coast) (BEEMS, 2014).

The area of open sea adjacent to the eastern boundary of the proposed development is located within the Southern North Sea Special Area of Conversation (SAC) designated for the purpose of aiding the

management of the Annex II[2] species harbour porpoise. The designated area is of high importance to harbour porpoise in both the summer and winter months. The conservation objectives of the site are to ensure that site integrity is maintained, and that it makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for harbour porpoise in UK water (JNCC & NE, 2019). In the context of natural change, this will be achieved by ensuring that:

- harbour porpoise is a viable component of the site;
- there is no significant disturbance of the species; and
- the condition of supporting habitats and processes, and the availability of prey is maintained.

Due to harbour porpoise sensitivity to anthropogenic noise, special attention has been given to assessing the significance of noise disturbance against the conservation objectives of the harbour porpoise SACs (JNCC, 2020). The noise disturbance within an SAC from a plan/project, individually or in combination, is considered to be significant if it excludes harbour porpoises from more than:

- 20% of the relevant area[3] of the site in any given day; or
- an average of 10% of the relevant area of the site over a season.

The guidance therefore recommends that 'significant disturbance'[4] should be interpreted as a reduction of the range of the species within the site or a reduction in the access to available habitat within the site, not changes in species abundance in the site. This is due to the fact that harbour porpoises are highly mobile and wide-ranging thus density and abundance both within and outside the sites vary considerably by season and year (JNCC, 2020).

2.2 Harbour seal

The harbour seal is found around the UK coast but is more widespread around the west coast than in the North Sea. The nearest sites of relevance to the proposed development area are The Wash and North Norfolk Coast Special Area of Conservation (SAC) (harbour seal is an Annex II species and the primary reason for selection of this site) to the north and the Thames Estuary to the south. Tagging studies have revealed that harbour seals do transit along the coastline between the Thames and north Norfolk (Sharples *et al*., 2012; Barker *et al*., 2014; Russell *et al*., 2017) suggesting a certain level of at-sea usage of the area close to the proposed development area. Generally, habitat use is considered to be low to moderate in the proposed development area with low haul out usage (SCOS, 2019).

2.3 Grey seal

Previous surveys conducted in the wider area suggest that grey seals are present reasonably regularly around the proposed development area (Kowalik *et al*, 2008; Galloper Wind Farm Limited, 2011; Fugro EMU, 2015). However, they do not utilise the area heavily and appear present mostly during winter and spring (Fugro EMU, 2015). The nearest SAC to the proposed development that includes grey seal as a qualifying feature is the Humber Estuary, circa 220km to the north.

[2] Annex II species require designation of SACs under the Habitat Directive (92/43/ECC).
[3] The relevant area is defined as that part of the SAC that was designated on the basis of higher persistent densities for that season (summer defined as April to September inclusive, winter as October to March inclusive).
[4] The results of underwater noise modelling and Cumulative Ecology Assessment (CEA) show that there is no significant disturbance from this project alone or in-combination with other plans/projects (Appendix 4C of [APP-579]).

3 Assessment of potential impacts and underwater noise modelling

Underwater noise modelling was undertaken to determine the potential effects of piling on marine mammals and fish (BEEMS, 2019b; BEEMS, 2021a; BEEMS 2021b). For each noise generating activity, the underwater noise effects assessment presents:

- Instantaneous auditory effects – To account for exposure to a single strike. Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) thresholds are formulated using the peak sound pressure level (SPLpeak) and presented in linear distance.
- Cumulative (24-hour) auditory effects – To account for accumulated exposure, over the duration of the activity within a 24-hour period. PTS and TTS thresholds are formulated using the weighted cumulative sound exposure level (SELcum) and presented in area (linear distance is also provided for context).

For activities with the potential to occur simultaneously (i.e., piling for both BLFs simultaneously and associated vessel traffic) the underwater noise effects assessment presents:

- Combined effects - PTS and TTS thresholds which are formulated using the weighted cumulative sound exposure level (SELcum) and presented as an area of effect (linear distance cannot be provided as there are two source locations).

The modelling considered the indicative piling specifications provided (as outlined in Section 1.4). Modelling was conducted with and without the use of a hydrohammer to illustrate the potential effectiveness of the mitigation measure being proposed. The results presented herein reflect the application of a hydrohammer to mitigate noise exposure (Table 3.1). Using the proposed hydrohammer reduces all the piling effect zones for marine mammals by between approximately 30 and 80% (BEEMS Technical Report TR538; BEEMS, 2021b) Results presented in BEEMS Technical Report TR538 includes acoustic contours displayed in GIS with a higher spatial resolution than directly generated from the model. The higher spatial resolution and subtle differences in the shape of the coastline result in minor differences in calculated area in BEEMS Technical Report TR538; however, these have no bearing on the outcome of the assessment and the raw model outputs reported in the ES Addendum [AS-181] and below in Tables 3.1 and 3.2 are typically larger, therefore marginally more precautionary.

The low energy impact piling is predicted to result in no instantaneous TTS and permanent hearing damage (PTS) for harbour porpoise or seals outside the standard 500m mitigation zone at the onset of piling in any of the modelled scenarios (BEEMS, 2021b). As such instantaneous impacts from piling are considered minimal. Therefore, compliance with standard mitigation procedures is predicted to be effective in negating the risk of instantaneous auditory damage in marine mammals.

Cumulative (24-hour) exposure assessments incorporated fleeing behaviours, which assume that marine mammals would flee from the source location at the onset of piling. Cumulative sound exposure was predicted for pile driving two consecutive piles within 24-hours using 120kJ and 280kJ hammer energy for piles and mooring dolphins, respectively. No cumulative (24h) auditory effect zones were predicted for seal species. For harbour porpoise no PTS was predicted and the largest TTS effect zones (associated with the mooring dolphins) were predicted to occur within 5,230ha for the enhanced permanent BLF and 3,734ha for the temporary BLF (BEEMS, 2021b).

An additional scenario was modelled whereby piling occurs at both BLFs simultaneously, the results of the fleeing model show that there would be no PTS for harbour porpoise or seals. The largest TTS effect zones were predicted to occur within 128ha for harbour porpoise using a noise reduction system on the hammer (i.e., a hydrohammer) (Table 3.2). Simultaneous piling would only occur with piles (not mooring dolphins). Therefore, the auditory effect zones in the simultaneous piling scenario are smaller than in the case of the

mooring dolphins for the individual BLF scenarios which require a larger hammer energy. There is no PTS predicted in the cumulative assessment for marine mammals in response to piling.

EDF Energy conducted an assessment of potential impacts of underwater noise during construction of BLFs to marine mammals as part of the Environmental Impact Assessment (EIA) (Chapter 22, Section 22.9 Marine Mammals of [APP-317]) and Environmental Statement (ES) Addendum ([AS-181] BEEMS, 2021a). Considering the predicted impact ranges of the underwater noise modelling, it was concluded that the impact of increased underwater noise due to the piling activities would have a minor negative effect on marine mammals. Effects are therefore not significant and are predicted to be short-lived and return to baseline conditions after piling activity ceases.

Table 3.1 Marine mammal auditory effect zone for piling activities associated with the enhanced permanent BLF and temporary BLF with a noise reduction system on the hammer (i.e., use of hydrohammer).

Piling Type		**Threshold**	**Instantaneous**		**Fleeing Cumulative**	
			Harbour porpoise	Phocid seals	Harbour porpoise	Phocid seals
Enhanced permanent BLF	**Pile**	PTS	11m	2m	0ha (<25m).	0ha (<25m).
		TTS	24m	4m	95ha (1,051m).	0ha (<25m).
	Mooring dolphin	PTS	33m	5m	0ha (25m).	0ha (<25m).
		TTS	55m	10m	1,878ha (4,589m).	0ha (<25m).
Temporary BLF	**Unloading platform pile**	PTS	9m	2m	0ha (25m).	0ha (25m).
		TTS	20m	4m	90ha (774m).	0ha (25m).
	Mooring dolphin	PTS	31m	5m	0ha (25m).	0ha (25m).
		TTS	68m	8m	1,435ha (4,203m).	0ha (25m).

Table 3.2 Marine mammal auditory effect zone for piling activities associated with the enhanced permanent BLF and temporary BLF occurring simultaneously. Effect zones are based on fleeing animals using a noise reduction system on the hammer (i.e., a hydrohammer).

Piling Type	**Threshold**	**Cumulative (24 hour) fleeing**	
		Harbour porpoise	Phocid seals
Enhanced permanent BLF piles (2 piles) and temporary BLF piles (2 piles) within the longshore bar.	PTS	0ha	0ha
	TTS	128ha	0ha

4 Marine mammal monitoring

Both visual and acoustic monitoring methods are generally considered as standard mitigation tools for piling projects.

The efficacy of both visual and acoustic monitoring methods varies depending on the species being monitored. Visual detection of marine mammals can vary with species depending on their size, surfacing behaviour, group size and weather conditions. Species such as harbour porpoise are particularly difficult to detect visually in poorer weather conditions due to their small size and often elusive surfacing behaviour (Palka, 1996). However, harbour porpoise can be detected acoustically using passive acoustic monitoring system (PAMS) but due to the ultrasonic nature of their clicks and rapid attenuation in water, the maximum likely range of their detection is 300m in good acoustic propagation conditions and minimal background noise (Goodson and Sturtivan, 1996). Harbour and grey seals are unlikely to be detected acoustically. Therefore, it has been considered that these two monitoring techniques complement each other and enhance likelihood of detections when used in synergy.

For this project, however, visual monitoring is deemed as a more practical and effective monitoring method in the relatively sheltered waters with low wave heights[5] inshore of the Sizewell-Dunwich Bank especially given the precautionary nature of the assessment, the limited instantaneous impact ranges and the logistical difficulties in deployment of an effective PAMS at the site. It has been agreed during the consultation process with Natural England that acoustic monitoring is not a practicable option for the construction of the BLFs due to the very shallow waters and thus inability to deploy the PAMS effectively.

4.1 Summary of mitigation measures

The following mitigation measures will be in place, as described in the Construction Method Statement (Appendix 3D of Volume 2 Chapter 3):

- Marine mammal observation – a visual inspection for local marine mammals prior to and during the piling.
- Use of a noise reduction system on the hammer, where feasible (i.e., a hydrohammer). A hydrohammer has hydraulic plungers filled with water designed to dampen the impact and reduce the source noise of impact piling.
- Soft start procedure (ramp-up).
- No pile driving between May and August (inclusive).

[5] For the decade 2008–2018, wave heights greater than 1.5m occurred 7.87% of the time (BEEMS, 2020).

5 Role and responsibilities

5.1 Marine Mammal Mitigation Team (MMMT)

The Marine Mammal Mitigation Team (MMMT) (consisting of MMOs for the piling of the enhanced permanent BLF and temporary BLF) will ensure that monitoring commences in good time to conduct a minimum of 30 minutes pre-piling monitoring and continue monitoring throughout the entire piling process in order to avoid unnecessary operational delays.

The maximum duration of each observer's shift will be 12 hours in any 24-hour period, including time needed for reporting requirements.

The MMMT should give effective briefings on the marine mammal mitigation requirements to crew members at the start-up meeting and provide continuous advice throughout the project and tool-box talks.

5.2 Visual monitoring

Visual methods using trained[6] and experienced Marine Mammal Observers (MMOs) are likely to be most effective during daylight hours, good visibility and calm (Beaufort Sea state <4) weather conditions. Therefore, visual monitoring for piling activities for both BLFs would be conducted during daylight hours in favourable weather conditions[7] by dedicated[8] MMOs. The MMOs would be observing from a suitable vantage point[9] allowing a clear and unobstructed view of the mitigation zone (MZ).

The MMOs will conduct diligent observations focusing on the area around the pile scanning with the naked eye and using binoculars to focus on points of interest where required. The MMOs will have field experience of detecting and identifying marine mammals in UK Continental Shelf (UKCS) waters. The MMOs will be equipped with a range-finder stick for measuring the distance as well as with binoculars, digital camera and field guides to aid species identification. Additionally, the MMO will be provided with a VHF radio to enable clear communication with the designated person (DP).

The JNCC protocol provides standardised data recording forms for 'Operations', 'Effort' and 'Sightings'[10], and these will be used to record data on marine mammal monitoring carried out, the time that pile-driving operations start and cease, and any sightings observed.

5.3 Designated person

A designated person (DP) will be assigned who will be situated on the piling vessel and will be responsible for liaising with the MMMT. The DP will have authority, based on the advice of the MMMT, to delay/stop piling if it is deemed necessary in accordance with the requirements of the MMMP. The contractor responsible for piling activity will be made aware of the jurisdiction of the DP during the start-up meeting.

[6] A trained MMO is defined as one who has attended a JNCC-approved MMO course.
[7] Weather conditions allowing a clear view of minimum 500m around the pile are considered as 'favourable'.
[8] A dedicated MMO is defined as one whose only role on board is to conduct visual watches for marine mammals.
[9] The exact location of the MMO will be established once piling platform is confirmed.
[10] Recording forms can be found at http://jncc.defra.gov.uk/page-1534

The DP will be briefed at the beginning of the project on the mitigation protocol to ensure the requirements are clear.

Communications between the MMMT and DP will be conducted via VHF radios. The radios should be tested prior to the commencement of the survey as clear communication is essential.

6 Mitigation principles

The mitigation principles outlined below and described in the Construction Method Statement (Appendix 3D of Volume 2 Chapter 3) and detailed aim to minimise potential effects on marine mammals from impact piling.

6.1 Mitigation zone

The mitigation zone (MZ) refers to the radius around the pile-driving source where primary visual monitoring effort should be focused. This area is also the area in which mitigation procedures should be implemented if marine mammals are observed within.

The results of the underwater noise modelling indicate that the instantaneous impacts from piling are considered minimal (BEEMS, 2019b; BEEMS, 2021a; BEEMS 2021b) and well within the standard MZ prescribed within the JNCC piling protocol (JNCC, 2010). Thus, the MZ for this project is established to be a precautionary 500m from the centre of the pile (Figure 6.1).

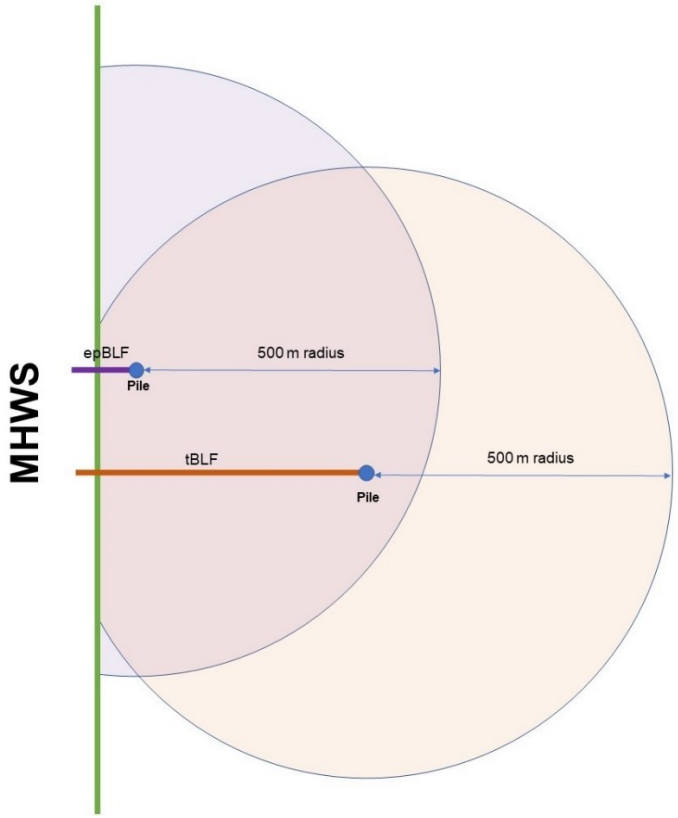

Figure 6.1 Schematic illustration of the mitigation zones for the enhanced permanent BLF and temporary BLF in relation to the MHWS (please note, the pile positions were located at the furthest point from MHWS i.e., radius has been applied from the terminus of the BLFs).

6.2 Pre-piling monitoring

The MMMT should be notified at least one hour prior to the commencement of piling operations. Visual monitoring will be conducted for at least 30 minutes in advance of piling. At the completion of pre-piling monitoring, if no marine mammals are observed within the MZ, the MMMT will inform the DP that piling (with a soft start) can commence.

6.3 Delay procedures

Should marine mammal/s be observed within the MZ during the pre-piling monitoring period, the MMMT will immediately alert the DP who will then ensure that a delay of the piling occurs.

The piling (with a soft start) will commence only if: a) the animal(s) have left the MZ and MMO are fully confident that they are outside of the MZ; or b) at least 20 minutes have passed since the last sighting within the MZ.

6.4 Soft start

Soft start is a gradual increase of hammer energy at the onset of piling. The purpose of soft start approach is to allow animals to move away from the noise source before full power is reached thus reducing the likelihood of exposing the animals to injurious sound levels.

If operationally feasible, a full 20-minute soft start (in line with JNCC protocol, 2010) will be undertaken for all piling events during the construction of the BLFs. However, it must be noted that the planned hammer energies during this project are expected to be 120kJ for piles and 280kJ for mooring dolphins. Such energy is lower than usual energy levels for piling of offshore windfarms reaching up to 4000kJ. It is best practice to commence soft start with 10% of the maximum hammer energy, which in this case would be 12kJ and 28kJ, respectively. If such low energy is not operationally feasible or if a gradual increase of energy throughout the full duration of soft start is not possible, then an alternative soft start method will be applied whereby there is a linear ramp-up in hammer strike rate from 1 blow per minute to full strike rate, during the first 20 minutes of piling (slow start).

The exact methodology will be confirmed by the piling contactor when final technical and operational capabilities are considered.

Each soft start or slow start will be carried out in a consistent manner and timings will be logged by the MMMT. A hammer energy report will be produced by a piling contractor and provided to the MMMT post-piling for inclusion in the mitigation report.

6.5 Marine mammals within mitigation zone during soft start

Marine mammal monitoring will continue throughout the soft start procedure. If a marine mammal is detected/observed within the MZ during the soft start, then the MMO will inform the DP and the power and

frequency will not be further increased until: a) the animal(s) have left the MZ and the MMO is fully confident that they are outside of the MZ; or b) at least 20 minutes have passed since the last sighting within the MZ.

6.6 Breaks in piling

The DP will inform the MMMT immediately if breaks in pile-driving operations occur. Following a pause in pile-driving of less than 10 minutes, operations may resume immediately at required power if no marine mammals have been observed within the MZ during the time of no piling activity. However, if any marine mammals are observed during the break in piling, then piling operations may only resume following the agreed soft start procedure if: a) the animal(s) have left the MZ and MMO is fully confident that they are outside of the MZ; or b) at least 20 minutes have passed since the last sighting within the MZ.

As per JNCC protocol (2010) pauses in pile-driving operations of more than 10 minutes in duration require full pre-piling monitoring period of 30 minutes followed by a full soft start procedure. However, if continuous monitoring has been undertaken for the previous 30 minutes, and no marine mammals have been seen within the MZ, the soft start may resume immediately as long as MMMT has given 'All clear'. If marine mammals have been observed, then the delay and soft start procedures described above should be implemented.

As such, it is recommended that the MMO remains on watch during the entire duration of the piling operations.

6.7 Poor visibility

JNCC guidelines recommends that piling should not commence during periods of darkness or poor visibility (such as fog or sea state associated with Beaufort wind force 4). Therefore, piling should not occur during times of reduced visibility affecting effective observation of the entire 500m MZ.

6.8 Hydrohammer

It is proposed that a noise reduction system is used on the hammer, where feasible (i.e., hydrohammer). This can be considered as reducing the amount of noise pollution (noise abatement), through mitigation measures (Merchant and Robinson, 2020). The hydrohammer is positioned between the piling hammer and the sleeve; two hydraulic plungers filled with water are designed to dampen the impact and reduce the source noise associated with impact piling. Hydrohammers can reduce the sound exposure levels (SEL) by 3 to 6dB and peak sound pressure levels (SPL) by 9 to 12dB.

6.9 Temporal exclusions

To mitigate the potential for impacts on breeding birds, no piling would occur in May to July inclusive. This period of the year also coincides with the spawning of some of the marine mammal prey species (e.g., European sprat, whiting, seabass, sand gobies, anchovies) thus this measure would mitigate the potential for indirect effects thorough avoidance of disturbance to prey species. Further to this, it is considered that implementation of the measures such as soft start (Section 6.4) could effectively mitigate the impacts of underwater noise on fish in the area (further information is provided within the underwater noise modelling report and ES addendum ([AS-181] BEEMS, 2021b)).

7 Communication protocol

The communication protocol (as outlined in Figure 7.1) will be introduced at a start-up meeting with the DP, MMOs, and construction team representatives in attendance, to ensure that everyone understands the communication channels and their specific roles and responsibilities.

Quick and effective communications are crucial to the success of the mitigation programme. Key aspects are:

- To convey information quickly and clearly, mitigation-related communications will be between the DP and the MMMT.
- The DP and MMMT will be confident at utilising VHF radios.
- Appropriate working channels for communications will be determined prior to commencing the first pile-driving operation.
- The DP will have a clear and direct communication with the construction team.
- The DP will notify the MMMT of planned times for piling activities.
- The DP will notify the MMMT prior to commencement of piling (soft start) and request the 'All Clear' to commence operations.
- The MMMT will maintain communications with the DP throughout visual monitoring, alerting them to any marine mammal sightings.
- Once piling has commenced, the DP will notify the MMMT of any breaks in operations.
- Hammer logs (including information on the time of start of operations, time taken to reach full power, duration of the soft start, duration of piling, number of blows, energy of each blow and number of blows per minute) will be provided to the MMMT at the end of the piling operations.

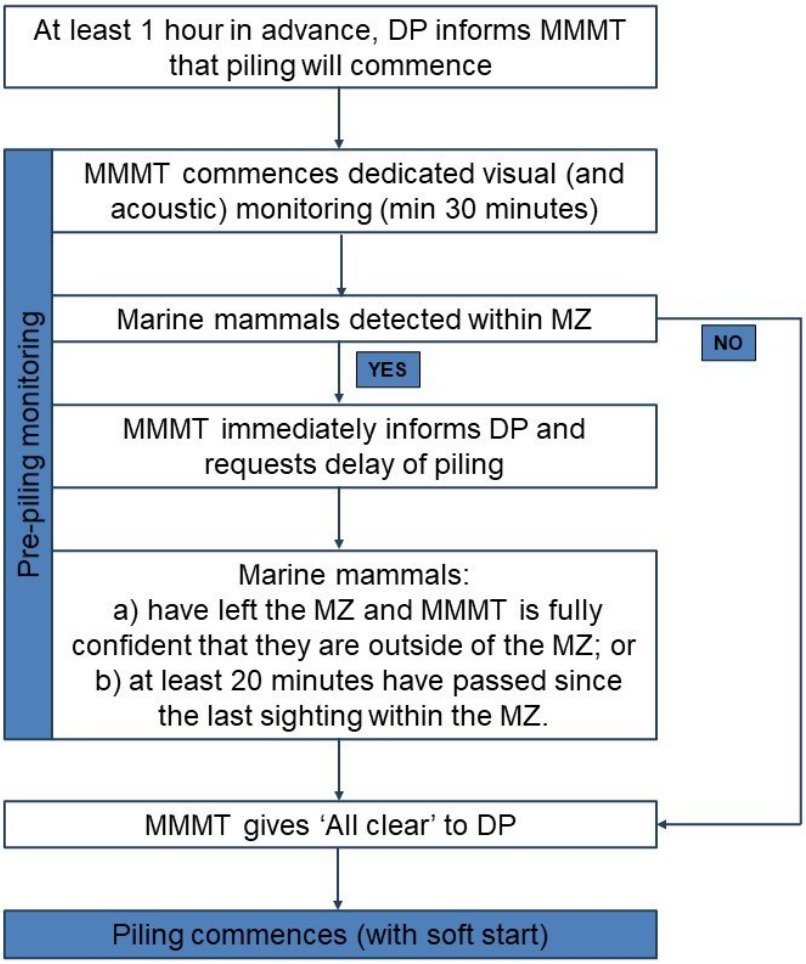

Figure 7.1 Communication and monitoring plan.

8 Reporting

The JNCC data recording forms will be completed throughout the survey, recording details of the visual monitoring carried out, any marine mammal sightings and pile-driving operations.

The data collected will be presented within the final report. This report will detail methods, monitoring effort, weather conditions, marine mammal sightings, pile-driving events, compliance with soft-start procedures, communications, mitigation measures taken and any recommendations. The completed JNCC survey forms will be included as Appendices. The final report will be submitted within an agreed period to the client and the relevant Statutory Nature Conservation Bodies (SNCBs).

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