

Appendix 5-4: Marine Megafauna Mitigation Plan





ORIEL WIND FARM PROJECT

Environmental Impact Assessment Report Appendix 5-4: Marine Megafauna Mitigation Plan

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ORIEL WIND FARM PROJECT – MARINE MEGAFUNA MITIGATION PLAN

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Acronyms

Term	Meaning
ADD	Acoustic Deterrent Device
CBRA	Cable Burial Risk Assessment
CTV	Crew Transfer Vessels
ECoW	Environmental Clerk of Works
EIAR	Environmental Impact Assessment Report
EMF	Electromagnetic Fields
EPA	Environmental Protection Agency
HWM	High Water Mark
IEF	Important Ecological Features
MEC	Maximum Export Capacity
MMMP	Marine Megafauna Mitigation Plan
MMO	Marine Mammal Observation
MPCP	Marine Protection Contingency Plan
NMPF	National Marine Planning Framework
NMFS	National Marine Fisheries Service (USA Federal agency within NOAA)
NPWS	National Parks and Wildlife Service
OSS	Offshore Substation
OWL	Oriel Windfarm Limited
PAM	Passive Acoustic Monitoring
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
SAM	Static Acoustic Monitoring
SEL	Sound Exposure Level
SPL	Sound Pressure Level
TSS	Temporary Threshold Shift
WTG	Wind Turbine Generator

1 MARINE MEGAFUNA MITIGATION PLAN

1.1 Introduction

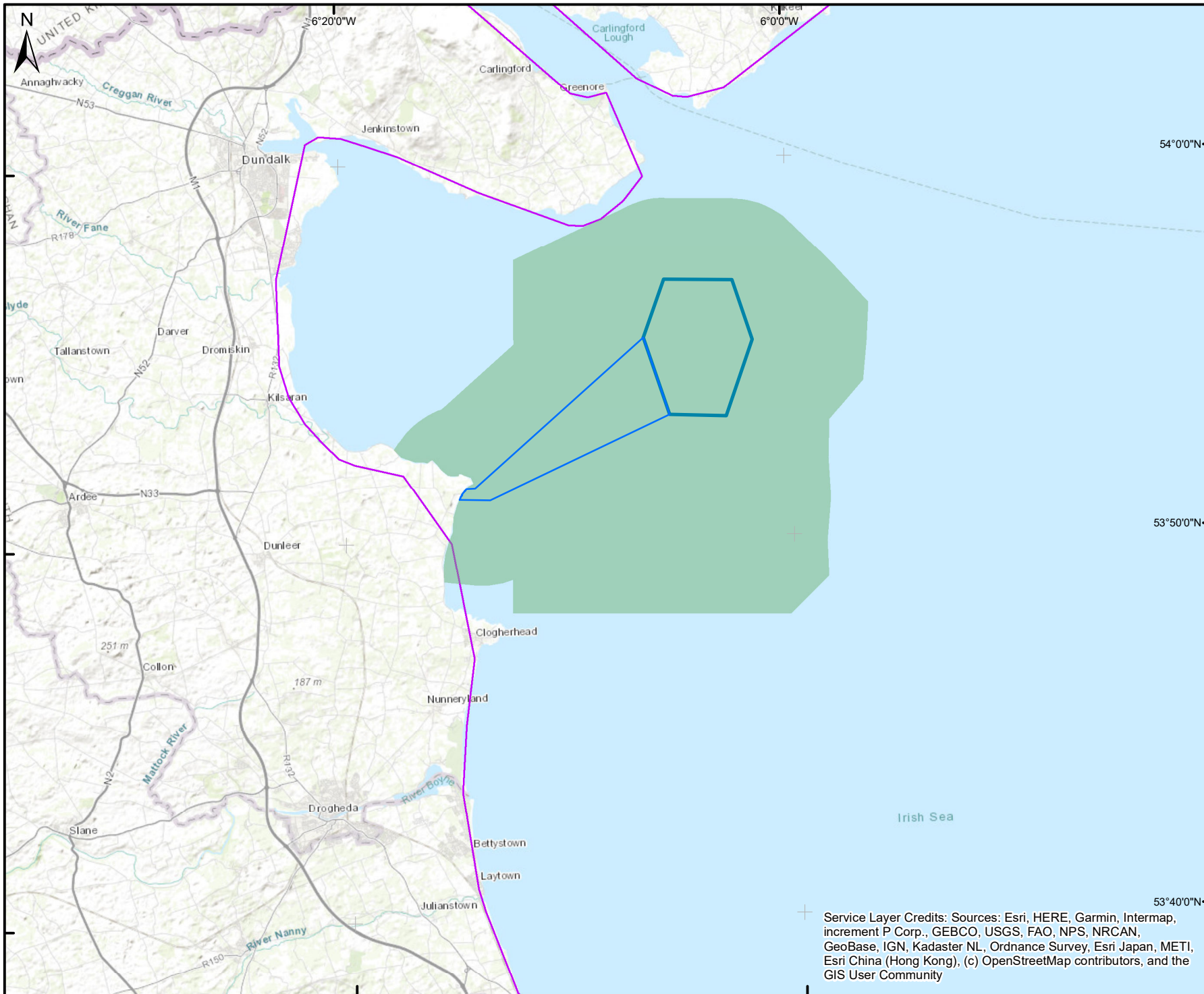
Oriel Windfarm Limited (OWL) (hereafter referred to as “the Applicant”), is promoting the development of the Oriel Wind Farm Project (hereafter referred to as “the Project”).

The Project is an offshore wind farm located in Dundalk Bay (Figure 1-1) located approximately 22 km east of Dundalk town centre and 18 km east of Blackrock. The closest wind turbine will be approximately 6 km from the closest shore on the Cooley Peninsula. The offshore cable corridor extends approximately 11 km southwest from the offshore wind farm area to the landfall south of Dunany Point. The offshore infrastructure of the Project, such as the wind turbines, Offshore Substation (OSS) and inter-array cables, will be located within the offshore wind farm area, which covers approximately 27.7 km², being broadly hexagonal in shape with a length of approximately 5.3 km west to east and 6.6 km north to south. The Project will have 25 wind turbine generators (WTGs) and one OSS located within the offshore wind farm area and will have a Maximum Export Capacity (MEC) of 375 MW.

The offshore cable corridor connects the offshore wind farm area with the landfall south of Dunany Point. The offshore cable corridor is contiguous to the High-Water Mark (HWM) at the landfall and to the southwestern boundary of the offshore wind farm area. The offshore cable corridor is approximately 11 km in length and covers an area of approximately 25.3 km², indicated in Figure 1-1. The WTGs will be connected to each other by a network of inter-array cables, which will also connect into the OSS. The offshore cable will transfer the electricity from the OSS to shore, where it will connect to the onshore infrastructure.

This Marine Megafauna Mitigation Plan (MMMP) presents a summary of findings as assessed in the Environmental Impact Assessment Report (EIAR) on the potentially injurious effects of underwater noise during pile-driving and geophysical surveys, on marine mammals and other megafauna (hereafter referred to collectively as ‘marine megafauna’). Pile-driving has the potential to impact marine mammals and megafauna during the construction phase, and geophysical acoustic surveys have the potential to cause an impact during the operational and maintenance phase. This MMMP is informed by the following sections of the EIAR:

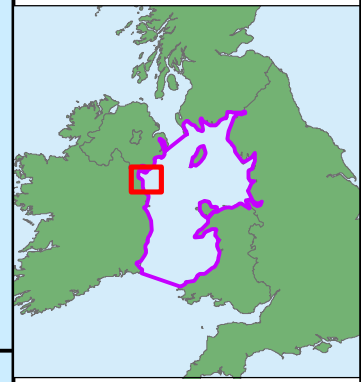
- Volume 2B, chapter 10: Marine Mammals and Megafauna;
- Volume 2B, appendix 10-1: Marine Mammals and Megafauna Technical Report; and
- Volume 2B, appendix 10-2: Subsea Noise Technical Report.



Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Marine Mammal and Megafauna Study Area
- Regional Marine Megafauna Study Area

Data Sources: Client.



Client



ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title **Figure 1-1
Marine Megafauna Study Area
and Regional Marine
Megafauna Study Area**



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1.2 Purpose of the MMMP

The purpose of this MMMP is to present the means by which the potentially injurious effects of underwater noise resulting from pile-driving activity and geophysical surveys on marine mammals, fish (basking shark) and sea turtles are to be mitigated during the construction and operational and maintenance phases of the Project. Information presented in this MMMP is based on volume 2B, chapter 10: Marine Mammals and Megafauna, which considers the potential impacts of the Project seaward of the HWM during the construction, operational and maintenance, and decommissioning phases. Only those impacts with the potential to cause auditory injury and for which specific measures have been proposed have been included in this MMMP.

The precautionary injury ranges for marine mammals established in the EIAR are based on the underwater noise modelling for the most sensitive species, the parameters for which are based on the project design parameters for the Project. It should be noted that this plan will be updated and finalised pre-construction following the refinement of the project design and refined marine mammal, fish and sea turtle injury ranges, with mitigation measures updated based on these refined ranges. Also any conditions of permission or updated guidelines or changes in industry best practice will be included. The project design parameters informing the assessment of potential impacts on marine mammals and megafauna as a result of underwater noise during pile-driving and geophysical site investigation surveys is presented in Table 1-1.

Table 1-1: Project design parameters used for the assessment of potential impacts on Marine Mammals and Megafauna.

Potential impact	Phase ¹			Project design parameters	Justification
	C	O	D		
Injury and/or disturbance to marine megafauna from underwater noise during pile-driving	✓	✗	✗	<ul style="list-style-type: none"> 26 monopiles (25 x WTGs and 1 x OSS) of 9.6 m diameter; Absolute maximum hammer energy of 3,500 kJ. On average, a maximum of 5 hours piling per pile across all WTG locations (no more than 8 hours at selected locations) with one pile expected to be installed in each 24-hour period. Maximum days piling = 26 days. 	<p>The spatial extent of noise impacts is driven by key parameters including monopile diameter and hammer size, as well as associated hammer energy required to pile a monopile of this size (see appendix 10-2: Subsea Noise Technical Report).</p> <p>The minimum number of piles within a 24-hour period is likely to lead to the maximum period (number of piling days) over which piling could occur and the maximum within 24 hours would lead to the longest duration on any one day.</p>
Injury and/or disturbance to marine megafauna from elevated underwater noise during site investigation surveys	✗	✓	✗	<p>Routine geophysical surveys of wind turbine foundations, inter-array cables and offshore cable:</p> <ul style="list-style-type: none"> Multibeam echosounder (MBES) expected to be the only method of geophysical survey to be employed; Survey campaigns estimated to occur once every five years for 40-year lifetime of Project; Surveys to be conducted using one survey vessel; Duration of 14 days per survey; 42-day duration per survey campaign (three surveys per campaign); 42 vessel round trips per survey campaign; and Maximum total of 294 survey vessel round trips for lifetime of Project. 	<p>First survey campaign expected to occur in year 5, and final campaign in year 35, equating to seven survey campaigns.</p> <p>Assumes daily vessel trip for every day of each 14-day survey window.</p>
Injury and/or disturbance to marine	✓	✓	✓	<p>Vessel types include jack-up barges, tug/anchor handlers, cable installation vessels, scour/cable protection installation</p>	<p>Greatest range of vessel types and greatest number of round trips.</p>

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Potential impact	Phase ¹			Project design parameters	Justification
	C	O	D		
megafauna from vessels and other construction activities including monopile driving				<p>vessels, guard vessels, survey vessels, Crew Transfer Vessels (CTVs).</p> <p>A maximum 475 vessel round trips during the construction phase, 352 vessel round trips per year during the operational and maintenance phase and 475 vessel round trips during the decommissioning phase.</p> <p>Other construction includes:</p> <ul style="list-style-type: none"> • Monopile drilling at each pile location following piling activity with 6 days drilling for each monopile = cumulative total of 156 days drilling over construction phase; • Cable trenching for inter-array and offshore cable; and • Cable laying for inter-array cables and offshore cable. <p>Offshore construction may take place over a period of 15 months. Operational and maintenance phase is 40 years. Decommissioning duration assumed to be similar to that for construction.</p>	
Changes in the fish and shellfish community affecting marine megafauna prey resources	✓	✓	✓	<p>Project design parameters as described in volume 2B, chapter 9: Fish and Shellfish Ecology for the following impacts:</p> <ul style="list-style-type: none"> • Temporary subtidal habitat loss/disturbance; • Injury and/or disturbance to fish from underwater noise during pile driving; • Increased suspended sediment concentrations and associated sediment deposition; • Long-term habitat loss; and • Electromagnetic Fields (EMF) from subsea electrical cabling. 	See volume 2B, chapter 9: Fish and Shellfish Ecology.
Electromagnetic Fields (EMF) from subsea electrical cabling may disrupt behaviour of basking shark (<i>Cetorhinus maximus</i>)	✗	✓	✗	<p>Presence of inter-array cables and offshore cable:</p> <ul style="list-style-type: none"> • Maximum 41 km of 66 kV inter-array cables; • Maximum 16 km of 220 kV offshore cable; • Burial depths of between 0.5 m to 3 m; • Maximum 50% of inter-array cable route and Maximum 50% of offshore cable may require cable protection. <p>Operational phase is 40 years.</p>	Maximum length of cables and minimum burial depth (greater the depth the more the EMF is attenuated).

1. C = Construction, O = Operation, D = Decommissioning

In addition to measures included in the Project (designed in and management measures (controls)) and mitigation proposed to reduce the injurious impacts on marine megafauna associated with pile-driving and geophysical surveying, a range of procedures will be applied to reduce other environmental impacts of the Project, including development and adherence to an Environmental Management Plan (EMP), which are summarised in Table 1-2.

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Table 1-2: Management plans developed to reduce environmental impacts.

Consents Management Plan	Relevance to MMMP	Where presented
Environmental Management Plan (EMP)	<p>The EMP provides the overarching framework for environmental management during the construction and operational and maintenance phases of the Project.</p> <p>The EMP also sets out the monitoring activities to be completed for the Project, as proposed in the EIAR, including proposed methodologies.</p>	Appendix 5-2

This MMMP has been prepared in accordance with the following guidance and it is considered that compliance with these will reduce the risk of injury to marine mammals and megafauna to negligible levels:

- National Parks and Wildlife Service (NPWS) (2014) Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters.
- National Marine Fisheries Service (NMFS) (2018) Revision to Technical Guidance for Assessing Effects of Anthropogenic Sound on Marine Mammal Hearing.

1.3 Target species

Marine mammals and megafauna species were characterised based on their abundance and densities at a regional scale (Regional Marine Megafauna Study Area) and local scale (Marine Megafauna Study Area), as detailed in EIAR (see volume 2B, chapter 10: Marine Mammals and Megafauna).

Boat-based visual surveys were conducted between March 2006 and August 2006, and between May 2018 and May 2020 (with the exception of February 2020 to April 2020 owing to COVID-19 restrictions), aerial digital surveys were carried out from April 2020 to September 2020, and Static Acoustic Monitoring (SAM) surveys were conducted between November 2019 and November 2020.

Marine mammals which were sighted regularly in site-specific surveys included minke whale *Balaenoptera acutorostrata* and grey seal *Halichoerus grypus*, and the most common cetacean species in the vicinity of the Project was harbour porpoise *Phocoena phocoena*. Common dolphin *Delphinus delphis* and harbour seal *Phoca vitulina* were sighted occasionally during site surveys, and whilst bottlenose dolphin *Tursiops truncatus* were not sighted during these surveys, a review of published datasets indicates that bottlenose dolphin may also be occasionally present in the area. Risso's dolphin *Grampus griseus* are likely to occur in lower numbers.

Basking shark migrate through the Celtic Sea and Irish Sea during summer months, and during site-specific surveys, two basking sharks were sighted in the vicinity of the Project. Tagging studies have also shown that basking sharks have migrated through this area in previous years (Doherty *et al.*, 2017). Historical records show that three species of marine turtle are likely to regularly occur in Irish waters including leatherback (or 'leathery') turtle, loggerhead turtle *Caretta caretta* and Kemp's Ridley turtle *Lepidochelys kempii* (King and Berrow, 2009). Of these species, the leatherback turtle is distributed around the coast of Ireland, including the Irish Sea, and accounts for 80% of all sea turtle sightings (King and Berrow, 2009).

These species (particularly harbour porpoise, common dolphin and minke whale) use sound for many aspects of their lives and are sensitive to underwater noise. Pile-driving during the construction phase and geophysical surveys during the operational and maintenance phases has the potential to result in elevated levels of subsea noise that are detectable by marine mammals and megafauna above background levels, which could result in injurious or behavioural effects. A detailed account of the marine mammal and megafauna baseline, and the effects of underwater noise on the marine megafauna species presented in this MMMP, can be found in volume 2B, chapter 10: Marine Mammals and Megafauna.

All of the marine mammal and megafauna species which could potentially be affected by the Project are protected by international legislation and/or are important from a conservation perspective at an international

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or national context (see volume 2B, chapter 10: Marine Mammals and Megafauna). Therefore, the value of marine megafauna Important Ecological Features (IEF) was designated as International (Table 1-3).

Table 1-3: Marine mammal and megafauna IEFs and their importance within the Marine Megafauna Study Area.

IEF	Value	Justification
Harbour porpoise	International	Annex II species protected under international legislation and designated feature of Rockabill to Dalkey Island SAC, North Channel SAC, North Anglesey Marine/Gogledd Môn Forol SAC and West Wales Marine/Gorllewin Cymru Forol SAC. Regularly sighted within the Regional Marine Megafauna Study Area.
Bottlenose dolphin	International	Annex II species protected under international legislation and designated feature of Cardigan Bay/Bae Ceredigion SAC
Short-beaked common dolphin	National	Internationally protected species and Ireland Protected Species regularly sighted in the Regional Marine Megafauna Study Area.
Minke whale	National	Internationally protected species and Ireland Protected Species regularly sighted in the Regional Marine Megafauna Study Area.
Grey seal	International	Annex II species protected under international legislation and designated feature of Lambay Island SAC, Lley Peninsula and the Sarnau/Pen Llŷn a'r Sarnau SAC and Pembrokeshire Marine/Sir Benfro Forol SAC and is a qualifying feature of Cardigan Bay/Bae Ceredigion SAC. Regularly recorded in the Regional Marine Megafauna Study Area, with large haul-outs at Carlingford Lough, Clogherhead, the Skerries, Dublin Bay and Lambay Island.
Harbour seal	International	Annex II species protected under international legislation and designated feature of Lambay Island SAC and is a qualifying feature of Murlough SAC. Regularly recorded in the Regional Marine Megafauna Study Area, with large haul-outs at Carlingford Lough, Dundalk Bay, Clogherhead and the Skerries.
Basking shark	National	Internationally protected species/EPS listed on Ireland's Red List of Threatened Species (list No. 11) and UK BAP Species. Recorded migrating through Regional Marine Megafauna Study Area on an annual basis.
Leatherback turtle	National	Internationally protected species, listed on Ireland's Red List of Threatened Species (list No. 5) and UK BAP Species, reported regularly (largely stranded) in the Regional Marine Megafauna Study Area.

1.4 Measures included in the Project

A number of designed-in and management measures (controls) have been proposed as part of the project design process to reduce the potential for impacts on marine mammals and megafauna. These measures are considered standard industry practice for this type of development and, as there is a commitment to their implementation, are considered an inherent part of the design of the Project. Designed-in and management measures (in addition to this MMMP) have therefore been considered in the assessment of impacts presented in volume 2B, chapter 10: Marine Mammals and Megafauna and are summarised in Table 1-4.

The use of additional measures such as Acoustic Deterrent Devices (ADDs) will also be implemented and is further discussed in section 1.6, however these are mitigation measures and are not considered to be a measure included as part of the Project.

Table 1-4: Measures included in the Project, in addition to the MMMP.

Measures included in the Project	Justification
An Environmental Management Plan (EMP) (see volume 2A, appendix 5-2: Environmental Management Plan) will be implemented during the construction, operational and maintenance, and decommissioning phases of the Project. The EMP will include Project mitigation/monitoring	Measures will be included to ensure that the potential for release of pollutants from construction, operational and maintenance, and decommissioning plant is minimised.

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Measures included in the Project	Justification
<p>measures and commitments and a Marine Pollution Contingency Plan (MPCP) which will include key emergency contact details (e.g. Environmental Protection Agency (EPA)).</p> <p>The EMP will include mitigation such as designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds. In this manner, accidental release of contaminants from vessels will be strictly controlled, thus providing protection for marine life across all phases of the Project.</p>	
<p>During piling operations, soft starts will be used, following NPWS (2014) guidelines. This will involve the implementation of lower hammer energies (i.e. approximately 10-15% of the maximum hammer energy) at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels (also known as a soft-start).</p>	<p>The soft-start will provide an audible cue to allow marine mammals and megafauna to flee the area before piling at increased hammer energy commences. The soft/slow-start will help to mitigate any potential auditory injury.</p>
<p>A Marine Megafauna Vessel Code of Conduct (see appendix 5-5: Marine Megafauna: Vessel Code of Conduct) will be issued to all Project vessel operators, requiring them to:</p> <ul style="list-style-type: none"> • Not deliberately approach marine megafauna; • Keep vessel speed to a minimum; and • Avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride. <p>The Marine Megafauna Vessel Code of Conduct will be adhered to at all times.</p>	<p>To minimise the potential for collision risk, or potential injury to, marine megafauna.</p>
<p>Preparation and implementation of a Cable Specification and Installation Methodology by the appointed contractor prior to the construction phase will include a detailed cable laying plan, including geotechnical data and cable laying techniques.</p> <p>A Cable Repair Method Statement will also be prepared, including a Cable Burial Risk Assessment (CBRA) to inform cable burial depth. A Cable Repair Method Statement will be developed in advance of any cable repair or reburial activities setting out the parameters of the repair or reburial activities and the proposed methodology.</p>	<p>While burial of cables will not reduce the strength of EMF, it does increase the distance between cables and marine mammal and megafauna (and fish and shellfish) receptors, thereby potentially reducing the effect on those receptors.</p>

1.5 Summary of chapter 10: Marine Mammals and Megafauna

1.5.1 Pile-driving

Pile-driving during the construction phase of the Project has the potential to result in elevated levels of subsea noise that are detectable by marine mammals and megafauna above background levels and could result in injurious or behavioural effects on IEFs. A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammal, fish and sea turtle IEFs as a result of impulsive sounds from pile-driving (volume 2B, appendix 10-2: Subsea Noise Technical Report). The results of this modelling were drawn upon to inform the impact assessment presented in volume 2B, chapter 10: Marine Mammals and Megafauna.

Auditory injury in marine mammals can occur as either a Permanent Threshold Shift (PTS), where there is no hearing recovery, or as a Temporary Threshold Shift (TTS), where recovery from tissue damage is possible. Irish guidance recommends that TTS is included as a potential injury risk as this could impair the ability of animals to use natural sounds, with potential consequences to fitness (NPWS, 2014). In basking sharks and

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sea turtles, injury is assessed as ‘mortality and mortal injury’ (immediate or delayed death) or ‘impairment’ (recoverable injury). This dual criteria approach was used to assess the potential for PTS and TTS in marine mammals and ‘mortality and mortal injury’ and ‘impairment’ in basking shark and sea turtles.

The most likely response of an animal exposed to noise levels that could induce TTS or impairment is, however, to flee the ensonified area. It is therefore considered that the behavioural response (disturbance) can overlap with potential injury ranges, and animals exposed to noise levels with the potential to induce TTS or impairment are likely to simply move away from the area.

Injury from PTS and disturbance from TTS were investigated with respect to two metrics over the entire piling sequence from hammer initiation to maximum hammer energy (3,500 kJ) based on one pile being installed within a 24-hour period (see project design parameters in Table 1-1). Peak Sound Pressure Level (SPL_{pk}) was used to determine ranges for instantaneous injury at the highest point over the piling sequence whilst cumulative Sound Exposure Level (SEL_{cum}) was modelled to estimate the injury range from cumulative exposure as an animal flees the area. The SEL_{cum} metric can lead to overestimates in effect ranges which means that subsea noise modelling results in a precautionary assessment due to the conservative assumptions adopted, namely:

- Maximum hammer energy (3,500 kJ) would be reached at all locations;
- Subsea noise would remain impulsive at all distances, and not transition to a non-impulsive character;
- The soft start procedure does not include short pauses in piling which would reduce the noise exposure that fleeing animals experience;
- Animals would swim away from the noise source at the onset of activity at a constant rate and in a straight line; and
- Time spent at the surface, where sound levels are reduced, was not considered.

Where insufficient data existed to determine a quantitative guideline value, the risk was categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres).

For all species, except minke whale, injury ranges based on the SPL_{pk} metric were greater, with the greatest distance being 236 m for harbour porpoise, for the first strike following ramp up. For minke whale the maximum injury range, based on the SEL_{cum} metric, was 394 m. Disturbance ranges were predominantly greater for SEL_{cum} across species (maximum 8,060 m for minke whale), except for bottlenose dolphin and common dolphin, which had a greater disturbance range of 59 m for SPL_{pk} . A summary of injury ranges for all IEFs is presented in Table 1-5.

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Table 1-5: Summary of marine mammal injury (PTS and TTS) onset acoustic thresholds (NMFS, 2018) and criteria for onset of injury to fish due to impulsive noise (Popper *et al.*, 2014) (N/E = threshold not exceeded). White rows indicate SPLpk, grey rows indicate SELcum, and blank cells indicate scenarios which were not modelled.

Species	PTS or 'Mortality and mortal injury'			TTS or 'Impairment'		
	Threshold	Range (m)		Threshold	Range (m)	
		Soft Start - First Strike	Max Energy		Soft Start - First Strike	Max Energy
Harbour porpoise	202 dB re 1 µPa	236	489	196 dB re 1 µPa	344	713
	155 dB re 1 µPa ² s	168	-	140 dB re 1 µPa ² s	5,980	-
Bottlenose dolphin	230 dB re 1 µPa	41	84	224 dB re 1 µPa	59	123
	185 dB re 1 µPa ² s	N/E	-	170 dB re 1 µPa ² s	12	-
Common dolphin	230 dB re 1 µPa	41	84	224 dB re 1 µPa	59	123
	185 dB re 1 µPa ² s	N/E	-	170 dB re 1 µPa ² s	12	-
Minke whale	219 dB re 1 µPa	81	168	213 dB re 1 µPa	118	245
	183 dB re 1 µPa ² s	394	-	168 dB re 1 µPa ² s	8,060	-
Grey seal	218 dB re 1 µPa	86	179	212 dB re 1 µPa	126	261
	185 dB re 1 µPa ² s	19	-	170 dB re 1 µPa ² s	1,330	-
Harbour seal	218 dB re 1 µPa	86	179	212 dB re 1 µPa	126	261
	185 dB re 1 µPa ² s	19	-	170 dB re 1 µPa ² s	1,330	-
Basking shark	>213 dB re 1 µPa	118	245	>213 dB re 1 µPa	118	245
	>219 dB re 1 µPa ² s	N/E	-	>186 dB re 1 µPa ² s	770	-
Leatherback turtle	>207 dB re 1 µPa	172	357	(Near) High		
	210 dB re 1 µPa ² s	17	-	(Intermediate) Low (Far) Low		

Therefore, even considering the conservative assumptions of the subsea noise modelling that estimated highly precautionary injury ranges, across all species, the maximum range over which injury could occur was predicted to be less than the standard 1,000 m mitigation zone for pile-driving proposed by NPWS (2014). A summary of the assessments for injury and disturbance to IEFs, considering measures included in the Project only, is presented in Table 1-6, and full details are presented in volume 2B, chapter 10: Marine Mammals and Megafauna.

Table 1-6: Significance of the effect to IEFs as a result of injury and disturbance from underwater noise during pile-driving with measures included in the Project (soft start and MMMP).

IEF	Magnitude of Impact	Sensitivity of Receptor	Significance of the effect	Significant / Not significant
Disturbance				
Harbour porpoise	Low	Medium	Slight adverse	Not significant
Bottlenose dolphin	Low	Medium	Slight adverse	Not significant
Common dolphin	Low	Medium	Slight adverse	Not significant
Minke whale	Low	Medium	Slight adverse	Not significant
Grey seal	Low	Medium	Slight adverse	Not significant
Harbour seal	Low	Medium	Slight adverse	Not significant

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IEF	Magnitude of Impact		Sensitivity of Receptor		Significance of the effect		Significant / Not significant
Basking shark	Low		Low		Imperceptible		Not significant
Leatherback turtle	Low		Low		Imperceptible		Not significant
Injury	PTS	TTS	PTS	TTS	PTS	TTS	
Harbour porpoise	Low	Medium	High	Low	Slight adverse	Slight adverse	Not significant
Bottlenose dolphin	Low	Medium	High	Low	Slight adverse	Slight adverse	Not significant
Common dolphin	Low	Medium	High	Low	Slight adverse	Slight adverse	Not significant
Minke whale	Low	Medium	High	Low	Slight adverse	Slight adverse	Not significant
Grey seal	Low	Medium	High	Low	Slight adverse	Slight adverse	Not significant
Harbour seal	Low	Medium	High	Low	Slight adverse	Slight adverse	Not significant
Basking shark	Negligible	Negligible	High	Low	Slight adverse	Slight adverse	Not significant
Leatherback turtle	Negligible	Negligible	High	Low	Slight adverse	Slight adverse	Not significant

Mitigation measures will be applied by use of an ADD to reduce the potential for injury, particularly to marine mammals. There are a number of ADDs on the market with different sound source characteristics (see McGarry *et al.*, 2022) and a suitable device will be selected based on the key species requiring mitigation for the Project. The selected device will typically be deployed from the piling vessel and activated for a pre-determined duration to allow animals sufficient time to move away from the sound source, whilst also minimising the additional noise introduced into the marine environment. The type of ADD and approach to deployment (including activation time and procedure) will be discussed and agreed with relevant stakeholders prior to construction.

Noise modelling was carried out for the SEL_{cum} metric to determine the potential efficacy of using an ADD to deter marine mammals from the injury zone (see volume 2B, appendix 10-2: Subsea Noise Technical Report). The modelled scenario included the activation of an ADD for a period of 15 minutes prior to initiation of piling and was compared to the scenario with measures included in the Project only (i.e. initiation + soft start + ramp up) to determine whether deployment of an ADD was of potential benefit to reducing the risk of injury to marine mammals. There is no evidence for the effectiveness of ADDs as a tool to deter basking shark and sea turtle and therefore this was not considered in the modelling for these species.

Results of modelling the use of an ADD suggest that the risk of injury occurring in marine mammal receptors would be reduced. For example, based on the SEL_{cum} metric, ADD use would avoid thresholds for PTS being exceeded in all species as animals would flee beyond the injury zones prior to the start of piling. In particular, minke whale, for which modelled SEL_{cum} injury ranges were greatest (Table 1-5) have been shown to make directed movements and increase their net swim speed at distances of greater than 1,000 m (which coincides with the mitigation zone for pile-driving proposed by NPWS) from an ADD (Boisseau *et al.*, 2021).

The use of an ADD will also reduce the risk of TTS occurring in marine mammals. With an ADD deployed the range at which the SEL_{cum} threshold for TTS would be reduced to 5,980 m for minke whale, 4,620 m for harbour porpoise and for mid-frequency cetaceans and pinnipeds the TTS thresholds would not be exceeded (Table 1-7). These ranges are likely to be highly conservative overestimates, although this subsea noise modelling illustrates that the use of an ADD can reduce the risk of temporary auditory impairment.

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Table 1-7 Changes in range of injury (PTS) and disturbance (TTS) from unmitigated piling (including designed-in and management measures) and mitigated piling (including use of ADD).

Species	Threshold (Weighted) SEL _{cum}	Measures	Range (m)
Harbour porpoise	PTS - 155 dB re 1 µPa ² s	Soft start	168
	TTS - 140 dB re 1 µPa ² s		5,980
	PTS - 155 dB re 1 µPa ² s	Soft start + ADD	N/E
	TTS - 140 dB re 1 µPa ² s		4,620
Bottlenose dolphin	PTS - 185 dB re 1 µPa ² s	Soft start	N/E
	TTS - 170 dB re 1 µPa ² s		12
	PTS - 185 dB re 1 µPa ² s	Soft start + ADD	N/E
	TTS - 170 dB re 1 µPa ² s		N/E
Common dolphin	PTS - 185 dB re 1 µPa ² s	Soft start	N/E
	TTS - 170 dB re 1 µPa ² s		12
	PTS - 185 dB re 1 µPa ² s	Soft start + ADD	N/E
	TTS - 170 dB re 1 µPa ² s		N/E
Minke whale	PTS - 183 dB re 1 µPa ² s	Soft start	394
	TTS - 168 dB re 1 µPa ² s		8,060
	PTS - 183 dB re 1 µPa ² s	Soft start + ADD	N/E
	TTS - 168 dB re 1 µPa ² s		5,980
Grey seal	PTS - 185 dB re 1 µPa ² s	Soft start	19
	TTS - 170 dB re 1 µPa ² s		1,330
	PTS - 185 dB re 1 µPa ² s	Soft start + ADD	N/E
	TTS - 170 dB re 1 µPa ² s		N/E
Harbour seal	PTS - 185 dB re 1 µPa ² s	Soft start	19
	TTS - 170 dB re 1 µPa ² s		1,330
	PTS - 185 dB re 1 µPa ² s	Soft start + ADD	N/E
	TTS - 170 dB re 1 µPa ² s		N/E

A summary of the assessments for injury and disturbance to IEFs, considering measures included in the Project and the use of an ADD, is presented in Table 1-8, and full details are presented in volume 2B, chapter 10: Marine Mammals and Megafauna.

Table 1-8: Significance of the effect to IEFs as a result of injury and disturbance from underwater noise during pile-driving with measures included in the Project (MMMP and soft start) plus mitigation (ADD).

IEF	Magnitude of Impact	Sensitivity of Receptor	Significance of the effect	Significant / Not significant
Disturbance				
Harbour porpoise	Low	Medium	Slight adverse	Not significant
Bottlenose dolphin	Low	Medium	Slight adverse	Not significant
Common dolphin	Low	Medium	Slight adverse	Not significant
Minke whale	Low	Medium	Slight adverse	Not significant
Grey seal	Low	Medium	Slight adverse	Not significant
Harbour seal	Low	Medium	Slight adverse	Not significant
Basking shark	Low	Low	Imperceptible	Not significant

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IEF	Magnitude of Impact		Sensitivity of Receptor		Significance of the effect		Significant / Not significant
	PTS	TTS	PTS	TTS	PTS	TTS	
Leatherback turtle	Low		Low		Imperceptible		Not significant
Injury							
Harbour porpoise	Negligible	Medium	High	Low	Slight adverse	Slight adverse	Not significant
Bottlenose dolphin	Negligible	Negligible	High	Low	Slight adverse	Imperceptible	Not significant
Common dolphin	Negligible	Negligible	High	Low	Slight adverse	Imperceptible	Not significant
Minke whale	Negligible	Medium	High	Low	Slight adverse	Slight adverse	Not significant
Grey seal	Negligible	Negligible	High	Low	Slight adverse	Imperceptible	Not significant
Harbour seal	Negligible	Negligible	High	Low	Slight adverse	Imperceptible	Not significant
Basking shark	Negligible	Negligible	High	Low	Slight adverse	Imperceptible	Not significant
Leatherback turtle	Negligible	Negligible	High	Low	Slight adverse	Imperceptible	Not significant

It is also important to highlight the potential magnitude of effect and sensitivity of marine mammals to the ADD itself. Whilst ADDs deployed for such short durations are unlikely to lead to injury there may be some trade-off with an increase in disturbance during the period of activation. Depending on the device employed, ADDs may elicit a strong behavioural response and lead to displacement over potentially large ranges (a kilometre or more) for periods of time longer than the activation of the device itself. Whilst this is useful for reducing the risk of injury to marine mammals there needs to be a balance to ensure that ADDs do not lead to significant additional disturbance themselves. This can be achieved by optimising both ADD source signals and deployment schedules (Thompson *et al.*, 2020). Since the effect of ADDs on marine mammals is likely to be a short-term disturbance response over a relatively localised area (within a maximum of few kilometres) and animals are likely to quickly recover to baseline levels (within a few hours) the magnitude of disturbance is not considered to be significant.

1.5.2 Geophysical acoustic surveys

Site investigation surveys to facilitate the inspection of offshore infrastructure foundations, inter-array cables and offshore cable during the operational and maintenance phase of the Project have the potential to cause direct or indirect effects (including injury or disturbance) on marine megafauna IEFs. An underwater noise modelling assessment was carried out to investigate the potential for injurious and behavioural effects as a result of geophysical surveys using the latest criteria (volume 2B, appendix 10-2: Subsea Noise Technical Report), which is drawn upon in the information below.

Underwater noise modelling for geophysical surveys has been undertaken based upon the likely parameters of the equipment expected to be employed. Here, the Kongsberg EM710 MBES unit has been modelled operating at 105 kHz, 231 dB re: 1µPa @ 1 m (rms) (see Table 1-9 below), although this equipment can typically work at a range of signal frequencies, depending on the distance to the seabed and the required resolution. For sonar-like sources the signal is highly directional, acting like a beam, and is emitted in pulses. Sonar-based sources are considered as continuous (non-impulsive) because they generally comprise a single (or multiple discrete) frequency as opposed to a broadband signal with high kurtosis, high peak pressures and rapid rise times (see volume 2B, appendix 10-2: Subsea Noise Technical Report, wherein a full description of the source sound levels for geophysical survey activities is provided).

Table 1-9: Typical Sonar-based survey equipment parameters used in assessment.

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Survey Type	Unit	Frequency (kHz)	Source Level (dB re 1 μ Pa (rms))	Pulse Rate (s ⁻¹)	Pulse Width (ms)	Beam Width (degrees)	Swathe Beam Width (degrees)
MBES	Kongsberg EM710	105	231	30	0.2	2	140

Noise modelling was undertaken only for MBES surveying methods and did not consider non-impulsive sources to be a key potential impact for basking shark and sea turtles. These species were subsequently screened out, and the focus of the assessment was on marine mammal species only. As for the impact of pile-driving, the potential effect upon marine mammals was either auditory injury (PTS or TTS) or behavioural disturbance.

Potential impacts of site investigation surveys depend on the characteristic of the sound source, survey design, frequency bands and water depth. Sonar-based sources have very strong directivity which effectively means that there is only potential for injury when a marine mammal is directly underneath the sound source. Once the animal moves outside of the main beam, there is no potential for injury.

Based on underwater noise modelling presented in volume 2B, appendix 10-2: Subsea Noise Technical Report, PTS has the potential to occur out to a maximum of 227 m for harbour porpoise (Table 1-10), up to 124 m for dolphin species and up to 12 m for minke whale. and in pinniped species the maximum range for PTS to occur is out to 34 m from the sound source. TTS has the potential to occur out to a maximum of 449 m in harbour porpoise, 172 m for dolphin species, and up to 107 m for minke whale. In pinniped species this range is predicted out to 123 m from the sound source.

Table 1-10: PTS and TTS onset thresholds and potential impact ranges for marine mammal species during non-impulsive MBES geophysical site investigation surveys, based on comparison to Southall *et al.* (2019) SEL thresholds.

Species	Hearing group (NMFS, 2018)	Injury type	SEL threshold (dB re 1 μ Pa ² s)	Impact range (m)
Minke whale	LF	PTS	199	12
		TTS	179	107
Bottlenose dolphin	MF	PTS	198	124
		TTS	178	172
White-beaked common dolphin	MF	PTS	198	124
		TTS	178	172
Harbour porpoise	HF	PTS	173	227
		TTS	153	449
Harbour seal	PCW	PTS	201	34
		TTS	181	123
Grey seal	PCW	PTS	201	34
		TTS	181	123

The number of marine mammals with the potential to be injured within the modelled ranges for PTS and TTS presented in Table 1-10 was estimated using the most up to date species-specific density estimates. Due to low predicted injury ranges, for all marine mammal species, it is predicted that no more than one animal has the potential to experience PTS or TTS as a result of geophysical site investigation surveys.

Mitigation for injury during geophysical site investigation surveys from a conventional vessel will involve the use of MMOs and PAM to ensure that the risk of injury over the defined mitigation zone is reduced in line with NPWS guidance (NPWS, 2014). A soft start will also be implemented where this is within technical capabilities of the survey equipment.

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The estimated maximum range for onset of disturbance is based on underwater noise levels being greater than a threshold of 120 dB re 1 μ Pa (rms) for all marine mammals (see volume 2B, appendix 10-2: Subsea Noise Technical Report). The disturbance range as a result of geophysical site-investigation surveys will be higher than those presented for injury, so the predicted range beyond which no marine mammals are expected to experience disturbance is approximately 1,410 m. Considering the high degree of variation between studies relating to the onset of behavioural effects due to non-impulsive sound, it is recommended that any predicted disturbance ranges are viewed as probabilistic, and potentially over-precautionary.

There is likely to be a proportional response in those animals experiencing disturbance, and not all individuals will be disturbed to the same extent. Similarly, the life history of an individual, and the context of the reception of sound, will also influence the likelihood for an aversive response. These impacts will not be continuous over the entire operational and maintenance phase: site investigation surveys will instead be carried out over a period of days within any given survey window. Therefore, given the limited quantitative information available, any simplified calculation is likely to produce an overestimation of the number of animals potentially disturbed, particularly given the intermittent and highly directional nature of sound from sonar-based survey methods like MBES. Nonetheless, an estimate of the number of animals for each species with the potential to be disturbed is presented in Table 1-11.

Table 1-11: Maximum number of animals potentially affected by disturbance arising from geophysical site investigation surveys.

Species	Hearing group (NMFS, 2018)	Estimated density (animals per km ²)	Number of animals within zone of disturbance	Percentage of population (%)
Minke whale	LF	0.040 – 0.260 ¹	2	0.007
Bottlenose dolphin	MF	0.008 – 0.036 ²	<1	0.057
White-beaked common dolphin	MF	0.008 ³	<1	0.001
Harbour porpoise	HF	0.570 – 1.330 ¹	9	0.008
Harbour seal	PCW	0.010 – 0.610 ⁴	4	0.068
Grey seal	PCW	0.090 – 0.210 ¹	2	0.008

A summary of the assessments for injury and disturbance to marine mammal IEFs, considering measures included as part of the Project, is presented in Table 1-12, and full details are presented in volume 2B, chapter 10: Marine Mammals and Megafauna.

Table 1-12: Significance of the effect to marine mammal IEFs as a result of injury and disturbance from underwater noise during routine geophysical surveys.

IEF	Effect	Magnitude	Sensitivity	Significance	Significant/Not significant
All marine mammal species	PTS	Low	High	Slight adverse	Not significant
	TTS	Low	Medium	Slight adverse	Not significant
	Disturbance	Low	Medium	Slight adverse	Not significant

¹ Mean monthly average and mean monthly maximum recorded during site-specific boat-based surveys (2018 -2020)

² SCANS-III Block E (western Irish Sea) data collected summer 2016 (Hammond *et al.*, 2017)

³ Insufficient records of common dolphin in block E during SCANS-III surveys therefore these data are from SCANS-II for Block O (Irish Sea) collected summer 2005 (Hammond *et al.*, 2013)

⁴ SMRU at-sea densities

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1.6 Mitigation methods and procedures

The mitigation measures presented below include designed-in and management measures (measures included in the Project) and mitigation measures to reduce the risk of injury to marine mammals as described in volume 2B, chapter 10: Marine Mammals and Megafauna.

1.6.1 Pile-driving

As per the NPWS (2014) guidance, a 30-minute constant effort pre-piling search will be undertaken by at least two accredited and experienced marine mammal observers (MMO) using binoculars and a range finding stick as required and a Passive Acoustic Monitoring (PAM) operator to monitor the specified 1,000 m radial mitigation zone in order to minimise the likelihood of marine mammals being present within this range.

In addition to visual and acoustic monitoring, an ADD will be deployed at the start of the pre-piling search in close proximity to the pile to be installed. The ADD will be activated for a minimum period of 15 minutes to allow animals sufficient time to disperse, while also minimising the additional noise produced by the device and emitted into the marine environment. Visual and acoustic monitoring will continue throughout the ADD deployment to ensure that marine mammals have left the mitigation zone prior to the start of piling.

Pile driving activities will only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. Where effective visual monitoring, as determined by the MMO, is not possible (including in circumstances in which poor visibility prevents the 1,000 m mitigation zone from being visually monitored) the sound-producing activities will be postponed until effective visual monitoring is possible.

After the 30-minute pre-piling search and ADD activation period has elapsed, the piling initiation, soft start and ramp up designed-in measures will commence with hammer initiation at the lowest hammer energy and strike rate (525 kJ). The ADD will be turned off immediately after the piling activity has commenced. The soft start is the gradual, incremental increase of piling power over a minimum of 20 minutes. This allows time for marine mammals or megafauna to move away from the noise source, thereby reducing the risk of exposing animals to noise levels which can cause injury.

The initiation and soft start stages allow for alignment piles and for marine megafauna to leave the area and involve a hammer energy of 525 kJ. The ramp up stage is a progressive increase in hammer energy following the soft start and involves an initial hammer energy of 525 kJ which builds 2,500 kJ over the 9-minute period. The maximum hammer energy proposed for the Project is 3,500 kJ. However, the actual energy used when piling will be significantly lower for the majority of the time and the driving energy will be raised to 3,500 kJ only when absolutely necessary. A summary of the piling stages and associated strike energies is presented in Table 1-13.

Table 1-13: Piling scenario for monopile installation using a maximum hammer energy of 3,500 kJ.

Stage	Energy (kJ)	SEL per strike (dB re 1 $\mu\text{Pa}^2\text{s}$)	SPL _{pk} (dB re 1 μPa)	Duration (mins)	Strike rate (strikes per minute)	Number of strikes
Initiation	525	205	246	1	6	6
Soft start	525	205	246	20	30	600
Ramp up	525 to 2,500	205 - 212	246 - 255	9	30	270
Standard operation	2,500	212	255	150	30	4500
Full power	3,500	213	258	120	30	3600
Total	-	-	-	300	-	8,976

These above activities were included in subsea noise modelling (with the inclusion of an ADD for 15 minutes prior to commencement of any piling activity) in volume 2B, appendix 10-2: Subsea Noise Technical Report. The ADD itself was assumed to not contribute towards any injury to marine megafauna.

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If marine megafauna are detected within the mitigation zone during the pre-piling search of soft-start, piling will not commence or at least the hammer energy should not be further increased until at least 30 minutes after the last visual or acoustic detection of the animal. The MMOs and PAM operative will track any marine megafauna detected and ensure that they have left the mitigation zone before piling commences or the soft start continues. Once the ramp up procedure commences there is no requirement to halt or discontinue the pile-driving if marine mammals are detected within the mitigation zone. Likewise, if marine megafauna are detected in the mitigation zone during piling at full power, there will be no requirement to cease piling. It may also not be possible to stop piling at full power due to engineering restrictions. Figure 1-2 illustrates the sequence of events and lines of communication required to implement the MMMP.

If for any reason there is a break in piling activity for greater than 10 minutes, then the pre-piling search and ADD activation, and a full soft start and ramp up procedure should be repeated before piling recommences.

The designed-in and mitigation measures detailed in this MMMP reduce the risk of auditory injury to an acceptable level in terms of PTS. With mitigation in place, the potential effect of piling (auditory injury) on marine megafauna is considered to be of **imperceptible or slight significance**, which is not significant in EIA terms.

Marine Mammal Observer

During daylight hours at least two dedicated and qualified Marine Mammal Observer (MMO) will conduct a visual search of the mitigation zone and conduct the pre-start searches from a vessel prior to the start of the piling (see section 1.6 for details). Visual monitoring for marine mammals will be conducted from a suitable platform on the vessel such as the ship's bridge, that allows 360-degree visualisation, and full coverage of the mitigation zone. MMOs must concentrate their efforts on the measures to be taken in advance of and during commencement, breaks in and resumption of the sound-producing activity (NPWS, 2014).

The MMO will be equipped with reticule binoculars and Marine Mammal Reporting forms and will be capable of determining the extent of the mitigation zone in relation to their viewing platform. A range stick may be used to aid the estimation of distance of the sighting from the survey vessel. The lead MMO should also be equipped with a two-way radio to ensure communication with both the vessel crew and the PAM operator. This is to allow any visual or acoustic detections of marine mammals or megafauna in the mitigation zone and any subsequent delay required to the commencement of piling to be communicated quickly and effectively between all parties. The MMO will be responsible for recording all marine mammal sightings in the appropriate format, along with other environmental data. Together with the PAM Operator, the MMO will be responsible for compiling all the data on marine mammal observations and mitigation activities for reporting to NPWS.

The MMO must be experienced and familiar with the Irish regulatory procedures pertaining to managing risk to marine mammals from underwater sound and must be provided with full details of all licence/consent conditions relevant to the performance of their role in advance of activity commencement, to ensure compliance. The MMO will have the necessary authority (or support by Works Superintendent) to implement the plan and stop works if necessary.

PAM Operator

PAM will be undertaken during pre-start, ramp-up and piling activities. A vertical PAM system will be used, as opposed to a towed system as the vessels are likely to use dynamic positioning rather than transiting during the pre-start monitoring phase.

Two dedicated and qualified PAM Operators will be responsible for deployment, maintenance and operation of the PAM hydrophone, including spares. Both PAM Operators will be suitably trained in PAM and the use of PAMGuard, with training having been provided by an appropriate organisation (e.g. Seiche). PAM Operators will also have an appropriate level of field experience (i.e. a minimum of one-year PAM experience on offshore projects).

PAM Operators will be based on the vessel together with the MMO. PAM Operators will be responsible for recording all acoustic marine mammal detections in the appropriate format, and together with the MMO, will be responsible for compiling all the data on marine mammal observations and mitigation activities for reporting to NPWS. The PAM operator should also be equipped with a two-way radio to ensure communication with both the vessel crew and the lead MMO. This is to allow any visual or acoustic

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detections of marine mammals or megafauna in the mitigation zone and any subsequent delay required to the commencement of piling to be communicated quickly and effectively between all parties.

PAM Operators must be experienced and familiar with the regulatory procedures pertaining to managing risk to marine mammals from underwater sound, and to ensure compliance, must be provided with full details of all licence/consent conditions relevant to the performance of their role in advance of activity commencement. PAM Operators will have the necessary authority (or support by Works Superintendent) to implement the plan and stop works if necessary.

ADD Operator

A trained and dedicated ADD operator will be responsible for ADD maintenance, operation and reporting. The ADD Operator will be responsible for deploying the ADD from the installation vessel, verifying the operation of the ADD before deployment, operating the ADD, ensuring that batteries are fully charged and that spare equipment is available.

The ADD Operator will also record and report to the Works Superintendent/MMO/PAM on all ADD and piling activity so the details of any ADD used (see section 1.6), and any relevant observations on their efficacy can be reported as a part of the Operational/Marine Mammal Observer/Passive Acoustic Monitoring Report (see section 1.8).

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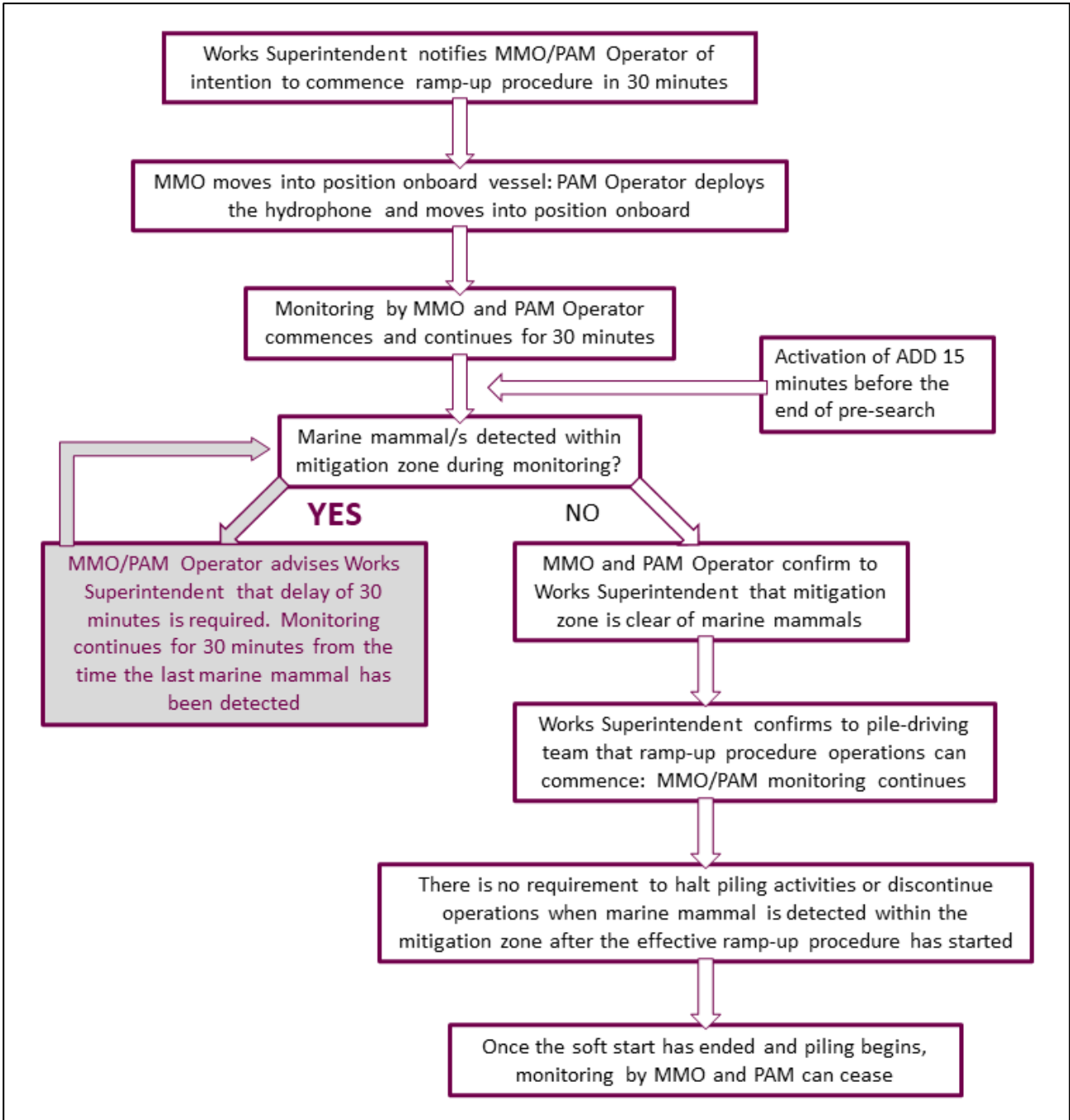


Figure 1-2: Task and communication plan for piling procedures start-up.

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1.6.2 Field records during pile-driving

Operations report

As per NPWS guidelines (2014) the Operations report will be provided to NPWS on completion of pile-driving activities as outlined below and must include use of the standard data forms provided in annex A.1:

- Details of the Client/Contractor involved in the plan/project;
- Details of the Platform/Vessel type(s) participating in the plan/project;
- Survey reference number supplied by the Regulatory Authority or other statutory body;
- Date and location of the plan/project;
- Latitudes, longitudes or grid references for the area of operations;
- Specifications and acoustic characteristics of all sound-producing equipment used;
- A daily log of how and when the sound-producing equipment was used; and
- Information on any technical problems encountered during pre-start-up procedures or during full scale operation/activity.

Marine Mammal Observer/PAM Report

The Marine Mammal Observer/Passive Acoustic Monitoring Report will include:

- An Executive Summary: a concise text at the beginning of the report highlighting the MMO/PAM work undertaken and summarising in turn:
 - All marine mammal detections made during the piling;
 - All detections made prior to the commencement of the piling activity (pre-search and ramp-up procedures);
 - All operational responses to the presence of animals in the area and the associated outcomes;
 - All occurrences of night-time operation/activity, continuation into poor weather and stoppages;
 - Any and all problems arising during implementation of the prescribed mitigation;
 - Any recommendations based on the project and any marine mammal sightings/behaviour encountered during the piling operations which could benefit future projects; and
 - A concluding statement regarding the operational efficacy of the mitigation measures performed.
- Date and location(s) of the plan/project;
- Name, address and qualifications of the MMO, PAM and ADD operators on the Platform/Vessel;
- Name of any other Platform/Vessel involved in the operation/activity;
- Latitudes, Longitudes or Grid references for the area(s) of operations monitored by the MMO;
- Details of the observation platform used for marine mammal monitoring, including its height above sea level;
- Details of all sound-producing operations/activities undertaken during the period of survey;

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- Details of monitoring watches conducted for marine mammals;
- Details of all marine mammal sightings recorded during monitoring watches;
- Details of all marine mammal sightings recorded outside monitoring watches (e.g. incidental observations), including records from additional personnel on board;
- Details of any problems encountered during marine mammal monitoring, start-up procedures or during full scale operation/activity; and
- Details of any instances of non-compliance with NPWS guidelines.

1.6.3 Geophysical acoustic surveys

As per the NPWS (2014) guidance, a constant effort pre-survey search will be undertaken by at least two accredited and experienced MMOs (using binoculars and a range finding stick as required) and a PAM Operator to monitor the specified 500 m radial mitigation zone to minimise the likelihood of marine mammals being present within this range. In waters up to 200 m deep (which includes the offshore array area and offshore cable corridor), the MMO shall conduct pre-start-up visual monitoring at least 30 minutes before the sound-producing activity is due to commence. Sound-producing activity shall not commence until at least 30 minutes have elapsed with no marine mammals detected by the MMO within the mitigation zone.

Sound-producing activities will only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. Where effective visual monitoring, as determined by the MMO, is not possible (including in circumstances in which poor visibility prevents the 500 m mitigation zone from being visually monitored) the sound-producing activities shall be postponed until effective visual monitoring is possible.

An agreed and clear on-site communication signal must be used between the MMO and the Works Superintendent as to whether the relevant activity may or may not proceed, or resume following a break (see below). It shall only proceed on positive confirmation with the MMO.

This prescribed pre-survey monitoring shall subsequently be followed by a ramp-up procedure (i.e. a soft-start) which should include continued monitoring by the MMO.

In commencing a geophysical acoustic survey operation, the following soft-start procedure must be used, including during any testing of acoustic sources, where the output peak SPL from any source exceeds 170 dB re: 1 μ Pa @ 1 m:

- Where it is possible according to the operational parameters of the equipment concerned, the device's acoustic energy output shall commence from a lower energy start-up (i.e. a peak SPL not exceeding 170 dB re 1 μ Pa @ 1 m) and thereafter be allowed to gradually build up to the necessary maximum output over a period of 20 minutes;
- This controlled build-up of acoustic energy output shall occur in consistent stages to provide a steady and gradual increase over the ramp-up period; and
- Where the acoustic output measures outlined in steps (a) and (b) are not possible according to the operational parameters of any such equipment, the device shall be switched "on" and "off" in a consistent sequential manner over a period of 20 minutes prior to commencement of the full necessary output.

In all cases where a soft-start is employed the delay between the end of the soft-start and the necessary full output must be minimised to prevent unnecessary high-level sound introduction into the environment.

Once the soft-start commences, there is no requirement to halt or discontinue the procedure if weather or visibility conditions deteriorate, nor if marine mammals occur within the 500 m radial mitigation zone. Marine mammals present at this point are deemed to have entered the ensonified area willingly.

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If there is a break in sound output for a period greater than 30 minutes (e.g. due to equipment failure, shut-down, survey line or station change) then all pre-survey monitoring and a subsequent soft-start procedure (where appropriate) must be undertaken.

For higher output survey operations which have the potential to produce injurious levels of underwater sound (including the MBES methods expected to be employed in geophysical surveying for the Project) as informed by the associated risk assessment, there will be a regulatory requirement to adopt a shorter 5-10 minute break limit after which period all pre-survey monitoring and a subsequent soft-start (where appropriate following pre-survey monitoring) shall recommence as for start-up.

The designed-in and mitigation measures detailed in this MMMP reduce the risk of auditory injury to an acceptable level in terms of PTS. With mitigation in place, the potential effect of geophysical acoustic surveys (auditory injury) on marine megafauna is considered to be of **slight significance**, which is not significant in EIA terms. Figure 1-3 illustrates the sequence of events and lines of communication required to implement the MMMP.

Marine Mammal Observer

During daylight hours at least two dedicated and qualified MMOs will conduct a visual search of the mitigation zone and conduct the pre-start searches from a vessel prior to the start of surveying (see section 1.6 for details). Visual monitoring for marine mammals will be conducted from a suitable platform on the vessel such as the ship's bridge, that allows 360-degree visualisation, and full coverage of the mitigation zone. MMOs must concentrate their efforts on the measures to be taken in advance of and during commencement, breaks in and resumption of the sound-producing activity (NPWS, 2014).

The MMO will be equipped with reticule binoculars and Marine Mammal Reporting forms and will be capable of determining the extent of the mitigation zone in relation to their viewing platform. A range stick may be used to aid the estimation of distance of the sighting from the survey vessel. The lead MMO should also be equipped with a two-way radio to ensure communication with both the vessel crew and the PAM operator. This is to allow any visual or acoustic detections of marine mammals or megafauna in the mitigation zone and any subsequent delay required to the commencement of surveying to be communicated quickly and effectively between all parties. The MMO will be responsible for recording all marine mammal sightings in the appropriate format, along with other environmental data. Together with the PAM Operator, the MMO will be responsible for compiling all the data on marine mammal observations and mitigation activities for reporting to NPWS.

The MMO must be experienced and familiar with the Irish regulatory procedures pertaining to managing risk to marine mammals from underwater sound and must be provided with full details of all licence/consent conditions relevant to the performance of their role in advance of activity commencement, to ensure compliance. The MMO will have the necessary authority (or support by Works Superintendent) to implement the plan and stop works if necessary.

PAM Operator

PAM will be undertaken during pre-start, ramp-up/soft-start and surveying activities. Two dedicated and qualified PAM Operators will be responsible for deployment, maintenance and operation of the PAM hydrophone, including spares. Both PAM Operators will be suitably trained in PAM and the use of PAMGuard, with training having been provided by an appropriate organisation (e.g. Seiche). PAM Operators will also have an appropriate level of field experience (i.e. a minimum of one-year PAM experience on offshore projects).

PAM Operators will be based on the vessel together with the MMO. PAM Operators will be responsible for recording all acoustic marine mammal detections in the appropriate format, and together with the MMO, will be responsible for compiling all the data on marine mammal observations and mitigation activities for reporting to NPWS. The PAM operator should also be equipped with a two-way radio to ensure communication with both the vessel crew and the lead MMO. This is to allow any visual or acoustic detections of marine mammals or megafauna in the mitigation zone and any subsequent delay required to the commencement of surveying to be communicated quickly and effectively between all parties.

PAM Operators must be experienced and familiar with the Irish regulatory procedures pertaining to managing risk to marine mammals from underwater sound and to ensure compliance must be provided with

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full details of all licence/consent conditions relevant to the performance of their role in advance of activity commencement. PAM Operators will have the necessary authority (or support by Works Superintendent) to implement the plan and stop works if necessary.

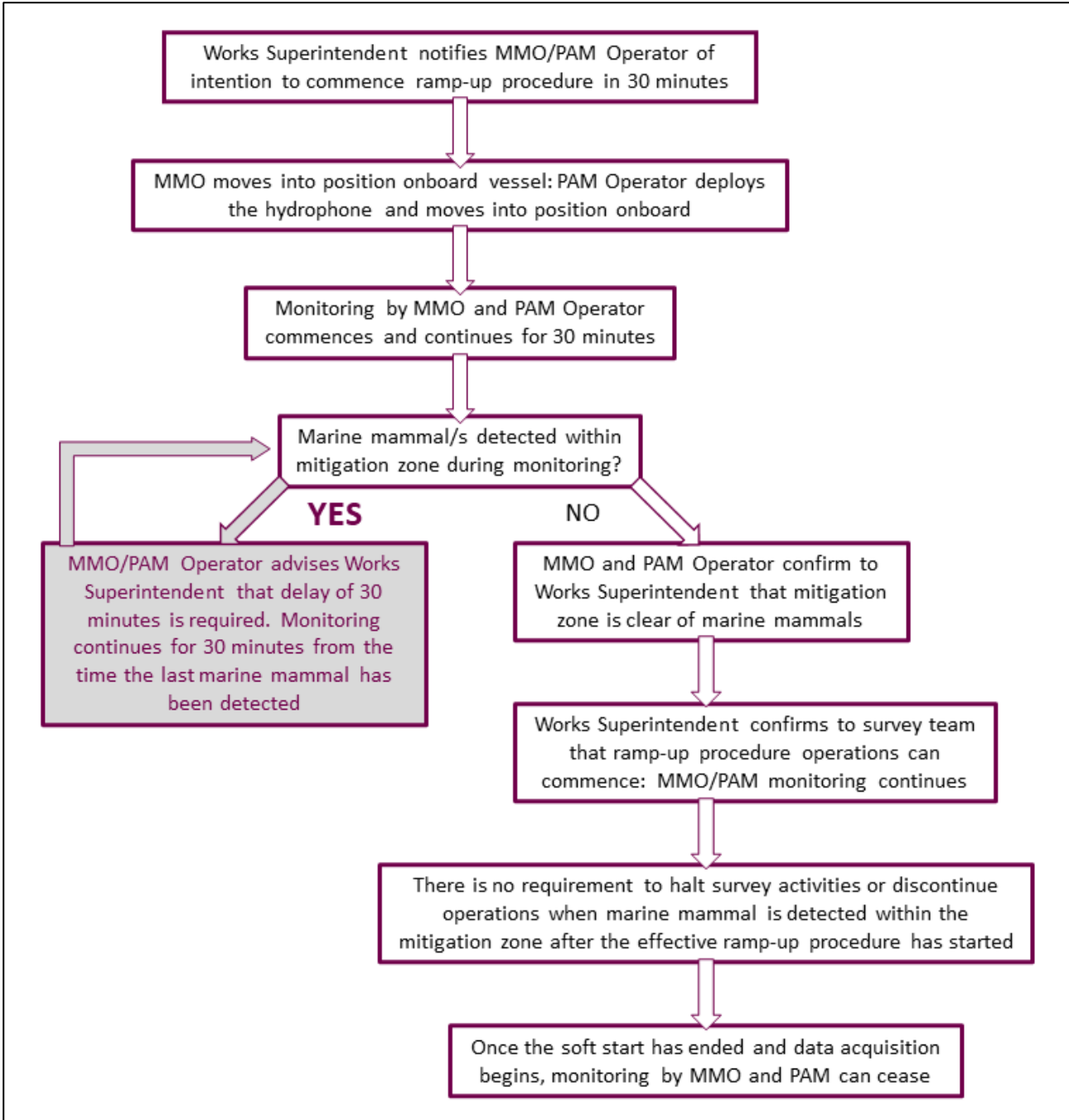


Figure 1-3: Task and communication plan for geophysical survey procedures start-up.

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1.6.4 Field records during geophysical acoustic surveying

Operations report

As per NPWS guidelines (2014) the Operations report will be provided to NPWS on completion of geophysical acoustic survey activities as outlined below and must include use of standard NPWS data forms provided in annex A.2:

- Details of the Client/Contractor involved in the plan/project;
- Details of the Platform/Vessel type(s) participating in the plan/project;
- The survey reference number supplied by the Regulatory Authority or other statutory body;
- Date and location of the plan/project;
- Latitudes, longitudes or grid references for the area of operations;
- Specifications and acoustic characteristics of all sound-producing equipment used;
- For seismic surveys: number and volume of each airgun used and a calculated total volume of the array;
- A daily log of how and when the sound-producing equipment was used including during ramp-up (soft-start) procedures, where relevant;
- Information on any technical problems encountered during pre-start-up procedures, ramp-up (soft-start) procedures or during full scale operation/activity.

Marine Mammal Observer/PAM Report

The Marine Mammal Observer/Passive Acoustic Monitoring Report will include:

- An Executive Summary: a concise text at the beginning of the report highlighting the MMO work undertaken and summarising in turn:
 - All marine mammal detections made during the survey programme;
 - All detections made prior to the commencement of the operation/activity (e.g. before ramp-up);
 - All operational responses to the presence of animals in the area and the associated outcomes;
 - All occurrences of night-time operation/activity, continuation into poor weather and stoppages;
 - Any and all problems arising during implementation of the prescribed mitigation;
 - Any recommendations based on the project and any marine mammal sightings/behaviour encountered during the survey operations which could benefit future projects; and
 - A concluding statement regarding the operational efficacy of the mitigation measures performed.
- Date and location(s) of the plan/project;
- Name, address and qualifications of the MMO(s) on the Platform/Vessel;
- Name of any other Platform/Vessel involved in the operation/activity;
- Latitudes, longitudes or grid references for the area(s) of operations monitored by the MMO;

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- Details of the observation platform used for marine mammal monitoring, including its height above sea level;
- Details of all sound-producing operations/activities undertaken during the period of survey;
- Details of monitoring watches conducted for marine mammals;
- Details of all marine mammal sightings recorded during monitoring watches;
- Details of all marine mammal sightings recorded outside monitoring watches (e.g. incidental observations), including records from additional personnel on board;
- Details of any problems encountered during marine mammal monitoring, start-up procedures, ramp-up (soft-start) procedures or during full scale operation/activity; and
- Details of any instances of non-compliance with NPWS guidelines.

1.7 Roles and responsibilities

1.7.1 Overview

This section sets out the key roles and responsibilities and lines of communications in relation to the MMMP. It identifies each key role involved in the construction phase of the Project and lists responsibilities associated with each role in relation to the MMMP.

1.7.2 Key roles

OWL Project Manager

The Project Manager has responsibility for ensuring that sufficient resources and processes are in place by the contractor and their subcontractors to implement the MMMP. The Project Manager will be responsible for ensuring that contractual obligations are met for contractors in relation to the MMMP, requiring that all construction personnel and contractors assist and support the Environmental Manager for the delivery of the commitments made under this MMMP.

The Project Manager will also ensure that the relevant Package Manager (in this case, the Marine Installation Package Manager) is responsible for:

- Requiring that sufficient resources and processes are in place to deliver/comply with the MMMP;
- Requiring that provision is made for matters relating to the delivery of the MMMP to form part of construction progress meetings and project inductions (e.g. outlining soft start and mitigation procedures as required by the MMMP; see section 1.6);
- Requiring that all construction personnel and contractors assist and support the MMOs and PAM and ADD operators (see below) and the Contractors Environmental Manager in delivering the MMMP and monitoring or auditing compliance with the MMMP;
- Ensuring contractual obligations are met for key contractors and their subcontractors in relation to the MMMP; and
- Reporting to the Project Manager on matters related to the MMMP (see section 1.8).

OWL Environmental Manager and OWL Environmental Clerk of Works

The OWL Environmental Manager is responsible for requiring contractor compliance with the Project consents and environmental legislation. Responsibilities of the OWL Environmental Manager/OWL Environmental Clerk of Works (ECoW) in relation to the MMMP include:

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- Quality assurance of this MMMP;
- Providing advice on compliance with the MMMP;
- Monitoring compliance with the MMMP;
- Reporting on compliance with the MMMP to the Department of Housing, Local Government and Heritage (DHLGH);
- Ensuring that the Contractor is providing appropriate training in relation to construction-related environmental measures and consents compliance; and
- Ensuring that the Contractor is also delivering toolbox talks (e.g. outlining soft start and mitigation procedures as required by the MMMP; see section 1.6) as appropriate.

Contractors

Contractors and their subcontractors are responsible for installing the Project infrastructure in compliance with this MMMP, as required by their contract with the Applicant, and for appropriate liaison with the MMOs and PAM and ADD operators (see below) and the Contractors Environmental Manager.

1.8 Reporting

Full reporting on MMO operations and mitigation undertaken must be provided to the Regulatory Authority. The Works Superintendent and MMO/PAM Operator tasked with monitoring the implementation of the mitigation plan and with conducting survey effort for marine mammals in accordance with this guidance, will submit a report to the Regulatory Authority within 30 days of completion of the relevant piling and/or geophysical survey activity. This will include a daily log concerning the testing and operation of all relevant sound-producing equipment/activities, including ADDs and a record of all marine mammal detections.

Reporting will be provided in line with the Operations Report and Marine Mammal Observer Report contents outlined in NPWS (2014) and details are provided in Annexes 1 and 2. The reports also provide information on any problems encountered during the survey activity or mitigation procedure (compliance reporting).

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References

- Boisseau, O., McGarry, T., Stephenson, S., Compton, R., Cucknell, A. C., Ryan, C. and Moscrop, A. (2021). Minke whales *Balaenoptera acutorostrata* avoid a 15 kHz acoustic deterrent device (ADD). *Marine Ecology Progress Series*, 667, 191-206.
- Doherty, P. D., Baxter, J. M., Gell, F. R., Godley, B. J., Graham, R. T., Hall, G., Hall, J., Hawkes, L. A., Henderson, S. M., Johnson, L. and Speedie, C. (2017). Long-term satellite tracking reveals variable seasonal migration strategies of basking sharks in the north-east Atlantic. *Scientific reports*, 7, p.42837.
- Hammond, P.S., Macleod, K., Berggren, P., Borchers, D.L., Burt, L., Cañadas, A., Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D. and Gordon, J. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. *Biological Conservation*, 164, pp.107-122.
- Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. May 2017, 40 pp.
- King, G. L., and Berrow, S. D. (2009). Marine turtles in Irish waters. *The Irish Naturalists' Journal*, 30, 1-30.
- McGarry, T., De Silva, R., Canning, S., Mendes, S., Prior, A., Stephenson, S. and Wilson, J. (2022). Evidence base for application of Acoustic Deterrent Devices (ADDs) as marine mammal mitigation (Version 4.0) JNCC Report No. 615, October 2022. JNCC, Peterborough. ISSN 0963-8091. Available at: <https://hub.jncc.gov.uk/assets/e2d08d7a-998b-4814-a0ae-4edf5d887a02>. Accessed April 2023
- National Marine Fisheries Service (NMFS) (2018). Revision to Technical Guidance for Assessing Effects of Anthropogenic Sound on Marine Mammal Hearing.
- National Parks and Wildlife Service (NPWS) (2014). Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters. Available at: <https://www.npws.ie/marine/best-practice-guidelines>. Accessed April 2023
- Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, Th., Coombs, S., Ellison, W. T., Gentry, R., Halvorsen, M. B., Lokkeborg, S., Rogers, P., Southall, B. L., Zedler, D. G. and Tavolga, W. N. (2014) ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer and ASA Press, Cham, Switzerland.
- Thompson, P. M., Graham, I. M., Cheney, B., Barton, T. R., Farcas, A. and Merchant, N. D. (2020). Balancing risks of injury and disturbance to marine mammals when pile driving at offshore windfarms. *Ecological Solutions and Evidence*, 1(2), e12034.

A.1 NPWS data recording sheets for pile-driving activities

DATA FORM FOR COASTAL/MARINE WORKS - MARINE MAMMAL SIGHTING RECORDS

Options in italics should be circled or underlined as appropriate. Complete 1 record per sheet.

Operation/Activity (please tick)		Dredging	Drilling	Pile Driving	Blasting	Other (specify)
Date (dd/mm/yyyy)	Time (Local)	Time (GMT/UTC)		Sighting Record no.		
How did this sighting occur? (please tick)						
While you were keeping a continuous watch for marine mammals						___
Spotted incidentally by you or someone else						___
Other (please specify)						___
Details:.....						
Platform type & name (e.g. ship, rig, headland)				Observer's name		
Observer's position (Latitude/Longitude or 6-figure Grid reference)					Water depth (metres) (if available)	
Species recorded			Certainty of identification (underline) <i>Definite / probable / possible</i>			
Total number of animals (best estimate)		No. of adults	No. of juveniles	No. of calves		
Maximum number (estimated total)			Minimum number (estimated total)			
Description (include features such as overall size; shape of head; position, shape and size of dorsal fin; colour and patterning; height, direction, shape of blow)				Photograph or video taken Yes / No		
				Direction of travel of animals in relation to platform/vessel (draw arrow) 		
Behaviour				Direction of travel of animals (compass points or degrees)		
Activity of platform/vessel	Operation/activity under way (when animals first seen) <i>Yes / No / Pre-Start watch</i>			Closest distance of animals from platform/vessel (metres) (Record even if not operating)		

A.2 NPWS data recording sheets for geophysical acoustic survey activities

MARINE MAMMAL RECORDING FORM - COVER PAGE

Regulatory reference number (e.g. DECC no., MMS permit no., OCS lease no., etc.)	Country	Ship/ platform name
Client	Contractor	Survey type <input type="checkbox"/> site <input type="checkbox"/> 4C <input type="checkbox"/> 2D <input type="checkbox"/> VSP <input type="checkbox"/> 3D <input type="checkbox"/> WAZ <input type="checkbox"/> 4D <input type="checkbox"/> other <input type="checkbox"/> OBC
Start date	End date	

Number of source vessels	Type of source (e.g. airguns)	Number of airguns (only if airguns used)	Source volume (cu. in.)
Source depth (metres)	Frequency (Hz)	Intensity (dB re. 1µPa or bar metres)	Shot point interval (seconds)
Method of soft start <input type="checkbox"/> increase number of guns <input type="checkbox"/> increase pressure (where permitted) <input type="checkbox"/> increase frequency (where permitted) <input type="checkbox"/> other			

Visual monitoring equipment used (e.g. binoculars, big eyes, etc.)	Magnification of optical equipment (e.g. binoculars)	Height of eye (metres)	How was distance of animals estimated? <input type="checkbox"/> by eye <input type="checkbox"/> with laser rangefinder <input type="checkbox"/> with rangefinder stick/ calipers <input type="checkbox"/> with reticle binoculars <input type="checkbox"/> by relating to object at known distance <input type="checkbox"/> other
Number of dedicated MMOs	Training of MMOs <input type="checkbox"/> JNCC approved MMO induction course for UK waters <input type="checkbox"/> PSO training course for the Gulf of Mexico <input type="checkbox"/> MMO training course for Irish waters <input type="checkbox"/> other <input type="checkbox"/> none		

Was PAM used? <input type="checkbox"/> yes <input type="checkbox"/> no	Number of PAM operators	
Description of PAM equipment		
Range of PAM hydrophones from airguns (metres)	Bearing of PAM hydrophones from airguns (relative to direction of travel)	Depth of PAM hydrophones (metres)

MARINE MAMMAL RECORDING FORM - SIGHTINGS

Regulatory reference number (e.g. DECC no., MMS permit no., OCS lease no., etc.)	Ship/ platform name	Sighting number (start at 1 for first sighting of survey)	Acoustic detection number (start at 500 for first detection of survey)
Date		Time at start of encounter (UTC, 24hr clock)	Time at end of encounter (UTC, 24hr clock)
Were animals detected visually and/ or acoustically? <input type="checkbox"/> visual <input type="checkbox"/> acoustic <input type="checkbox"/> both	How were the animals first detected? <input type="checkbox"/> visually detected by observer keeping a continuous watch <input type="checkbox"/> visually spotted incidentally by observer or someone else <input type="checkbox"/> acoustically detected by PAM <input type="checkbox"/> both visually and acoustically before operators/ observers informed each other		
Observer's/ operator's name	Position (latitude and longitude)		Water depth (metres)
Species/ species group		Description (include features such as overall size; shape of head; colour and pattern; size, shape and position of dorsal fin; height, direction and shape of blow)	
Bearing to animal (when first seen or heard)	Range to animal (when first seen or heard) (metres)		
Total number	Number of adults (visual sightings only)	Number of calves (visual sightings only)	
Behaviour (visual sightings only)			
Direction of travel (relative to ship) <input type="checkbox"/> towards ship <input type="checkbox"/> away from ship <input type="checkbox"/> parallel to ship in same direction as ship <input type="checkbox"/> travelling in opposite direction to ship		Direction of travel (compass points) <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> NE <input type="checkbox"/> SW <input type="checkbox"/> E <input type="checkbox"/> W <input type="checkbox"/> SE <input type="checkbox"/> NW <input type="checkbox"/> variable	
Airgun (or other source) activity when animals first detected <input type="checkbox"/> full power <input type="checkbox"/> not firing <input type="checkbox"/> soft start <input type="checkbox"/> reduced power (other than soft start)	Airgun (or other source) activity when animals last detected <input type="checkbox"/> full power <input type="checkbox"/> not firing <input type="checkbox"/> soft start <input type="checkbox"/> reduced power (other than soft start)	Closest distance of animals from airguns (or other source) (metres)	Time of closest approach (UTC, 24hr clock)
		If seen during soft start give: First distance Closest distance Last distance during soft start (metres)	

What action was taken? (according to requirements of guidelines/ regulations in country concerned) <ul style="list-style-type: none"> <input type="checkbox"/> none required <input type="checkbox"/> delay start of firing <input type="checkbox"/> shut-down of active source <input type="checkbox"/> power-down of active source <input type="checkbox"/> power-down then shut-down of active source 	Length of power-down and/ or shut-down (if relevant) (length of time until subsequent soft start, in minutes)	Estimated loss of production (if relevant) due to mitigating actions (km)