Salamander Offshore Wind Farm

Offshore EIA Report

Volume ER.A.4, Annex 11.2: Marine Mammal Impact Assessment Southern Trench MPA

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Salamander Offshore Wind Farm: Assessment of potential impacts on the Southern Trench MPA for minke whale

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Acronyms & Abbreviations

Acronym/Abbreviation	Definition
ADD	Acoustic Deterrent Device
CEA	Cumulative Effect Assessment
ECC	Export Cable Corridor
EDR	Effective Deterrence Range
EIA	Environment Impact Assessment
EIAR	Environment Impact Assessment Report
HRA	Habitat Regulations Appraisal
kJ	Kilojoules
km	Kilometres
MBES	Multibeam Echosounder
MMMP	Marine Mammal Monitoring Programme
NCMPA	Nature Conservation Marine Protected Area
PTS	Permanent Threshold Shift
RIAA	Report To Inform Appropriate Assessment
SAC	Special Areas of Conservation
SBP	Sub Bottom Profiler
SPA	Special Protected Area
SEL	Sound Exposure Level
SEL_{cum}	Cumulative SEL
SPL	Sound Pressure Level
SSS	Side Scan Sonar
TTS	Temporary Threshold Shift
USBL	Ultra-short Baseline
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator

1 Introduction

Potential impacts to designated sites within the UK site network, comprising Special Areas of Conservation (SACs) and Special Protected Areas (SPAs) designated under various regulations transposing the EC Habitats Directive (92/43/EEC) and Bird Directive (2009/147/EC) into domestic law, are assessed as part of the Habitat Regulations Appraisal (HRA). As such, impacts in relation to marine mammal SACs are provided in the Report to Inform Appropriate Assessment (RIAA) accompanying the Salamander Offshore Wind Farm Environmental Impact Assessment Report (EIAR; see **Volume RP.A.1, Report 1: Report to Inform Appropriate Assessment (RIAA)**).

Nature Conservation Marine Protected Areas (MPAs) are designated under different legislation (The Marine (Scotland) Act 2010, '2010 Act' hereafter, and subsequent Orders), and therefore considered separately to SACs and SPAs. Under the 2010 Act, public authorities have general duties in relation to MPAs which must be met when issuing authorisations (e.g. granting Section 36 Consent and Marine Licences). Specifically, the authority must not grant authorisation for an activity unless it can be demonstrated that there is no significant risk of the activity hindering the achievement of the conservation objectives for the Nature Conservation MPA (see s83(4) of the 2010 Act). In this report, an assessment is provided of the potential for the Salamander Project to hinder the achievement of the conservation objectives of the marine mammal feature (minke whale) of the Southern Trench MPA[1]. This report should be read in-conjunction with **Volume ER.A.3, Chapter 11: Marine Mammals** of the Salamander EIAR, where the project design envelope is presented and impact pathways assessed for the Project alone and cumulatively.

1.1 Southern Trench MPA

The Southern Trench MPA was designated under the Southern Trench Nature Conservation Marine Protected Area Order 2020, listing minke whales (*Balaenoptera acutorostrata*) as one of the primary justifications for the selection of the site. This is the only marine mammal species designated under this site. This area persistently supports higher than average densities of minke whales compared to the rest of Scotland (NatureScot 2020). Part of the Salamander Project Offshore Export Cable Corridor (ECC) crosses through the southern part of this MPA (see **Volume ER.A.4, Annex 11.1: Marine Mammal Baseline Characterisation Report**) and the Offshore Array Area is located approximately 10 km from the MPA (**Figure 1**). The entire Offshore Development, including all offshore components of the Salamander Project (WTGs, Inter-array and Offshore Export Cable(s), floating substructures, mooring lines and anchors, and all other associated offshore infrastructure) is hereinafter referred to as 'Offshore Development'.

The Southern Trench MPA supports high densities of minke whales in the majority of the designated area, with the densities decreasing towards the more southern part of the MPA, east and south of Fraserburgh (**Figure 2**). The same trend is shown for predicted persistence of above mean densities during summer months. This area of lower density is where the Offshore ECC intersects the Southern Trench MPA (see **Volume ER.A.4, Annex 11.1: Marine Mammal Baseline Characterisation Report**).

[1] Other protected features (burrowed mud, fronts, and shelf deeps) are not considered here.

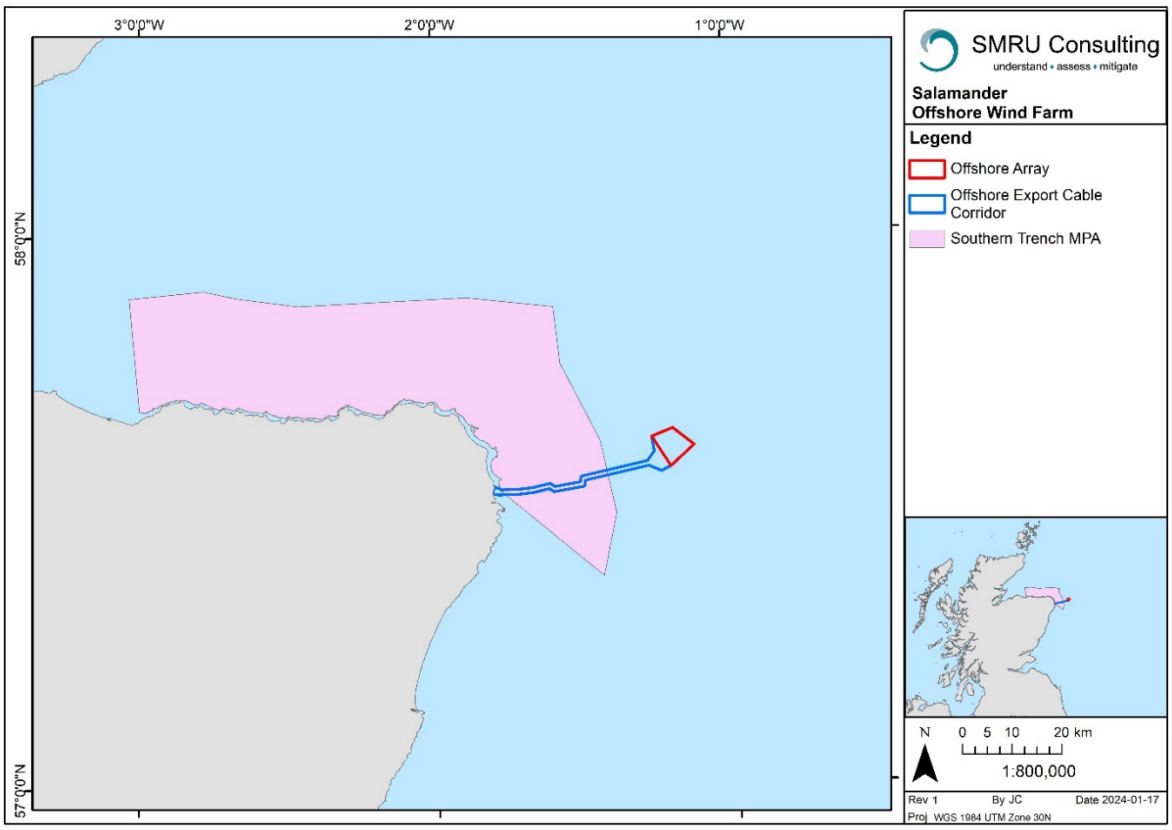

Figure 1 Location of the Salamander Offshore Array Area and Offshore ECC in relation to the Southern Trench MPA.

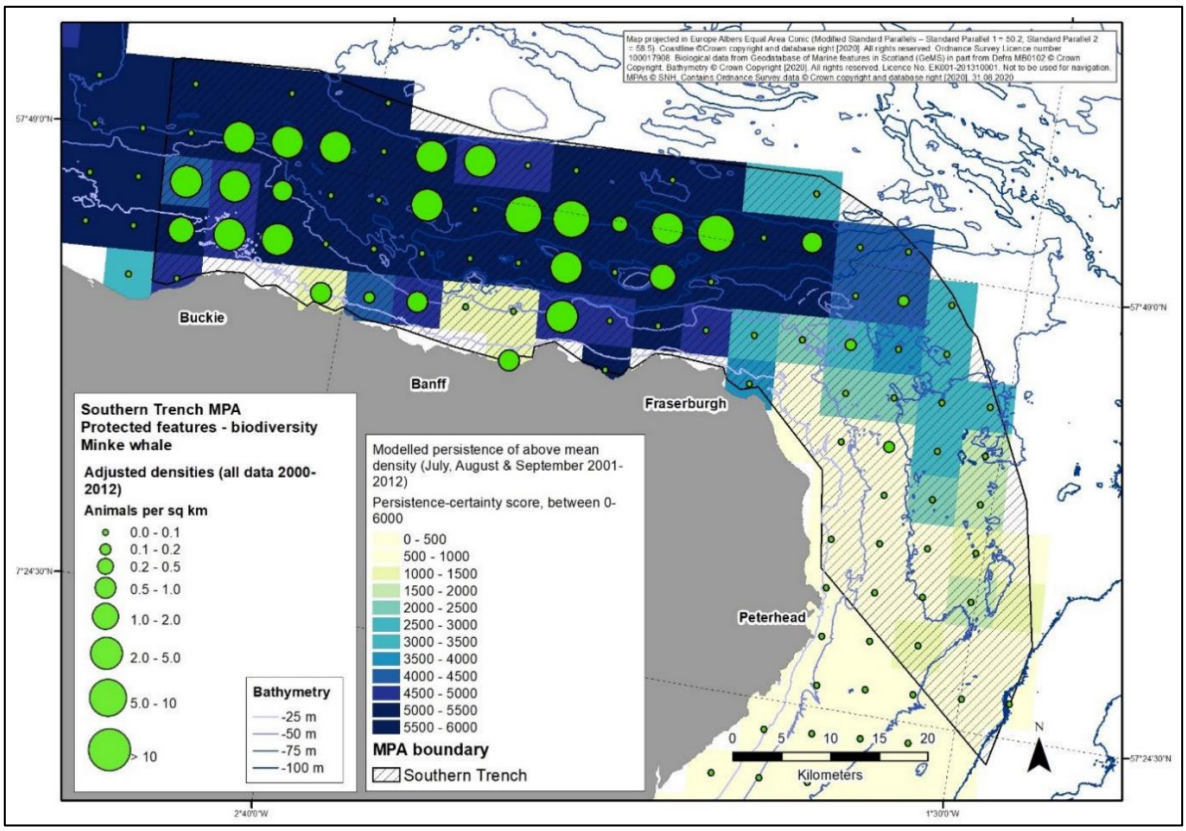

Figure 2 Minke whale densities and predicted persistence of above mean densities in Southern Trench MPA (NatureScot 2020).

2 Conservation Objectives

The Southern Trench Nature Conservation Marine Protected Area Order 2020 ('2020 Order hereafter) lists the minke whale feature as a mobile species of marine fauna, meaning "*a species of marine fauna with the ability to move freely between different locations that may be within, or outwith, the boundary of the Southern Trench MPA".*

The Order defines the high-level conservation objectives of the site as:

> *5.—(1) The conservation objectives of the Southern Trench MPA are that the protected features—*
>
> *(a) so far as already in favourable condition, remain in such condition,*
>
> *(b) so far as not already in favourable condition, be brought into such condition, and remain in such condition.*
>
> *(5) In paragraph (1) "favourable condition", with respect to a mobile species of marine fauna, means that—*
>
> *(a) the species is conserved or, where relevant, recovered to include the continued access by the species to resources provided by the MPA for, but not restricted to, feeding, courtship, spawning or use as nursery grounds,*
>
> *(b) the extent and distribution of any supporting feature upon which the species is dependent is conserved or, where relevant, recovered, and*
>
> *(c) the structure and function of any supporting feature, including any associated processes supporting the species within the MPA, is such as to ensure that the protected feature is in a condition which is healthy and not deteriorating.*
>
> *For the purpose of determining whether a protected feature is in favourable condition any alteration to that feature brought about entirely by natural processes is to be disregarded.*

At the most recent assessment (2019), the minke whale feature was considered to be in a **Favourable** condition at site level (NatureScot 2020).

The Conservation and Management Advice for the Southern Trench MPA (NatureScot 2020) provides the full, detailed conservation objectives, including site-specific advice and information on the features, how the objectives of the site may be furthered, or their achievement hindered, covering a range of activities. Full conservation objectives and advice in relation to minke is as follows:

1. **Species is conserved.**

- Minke whale in the Southern Trench MPA are not at significant risk from injury or killing.
- Any activities that take place within or outside the MPA that could kill or injure minke whale in the MPA should be considered in an assessment. An important consideration is whether any killing or injury would result in reduced densities within the site, from which recovery to above average densities cannot be expected.

2. **Continued access by the species to resources provided by the MPA for, but not restricted to, feeding, courtship, spawning or use as nursery grounds.**

- Conserve the access to resources (e.g., for feeding) provided by the MPA for various stages of the minke whale life cycle and conserve the distribution of minke whale within the site by avoiding significant disturbance. There are two main ways in which minke whale's access to resources could be restricted and disturbance affected, i.e. large scale physical barriers, or significant disturbance.

- Large-scale physical barriers or obstructions within or outside the MPA may prevent or restrict access to resources to an extent that may result in significant impacts on stages of their life cycle, including feeding.
- Significant disturbance is defined as resulting in:
    - The contribution to long term decline in the use of the MPA;
    - Changes to the distribution on a continuing or sustained basis; and
    - Changes to the behaviour such that it reduces the ability of the species to feed efficiently, breed or survive.

3. Extent and distribution of any supporting feature and structure and function of any supporting feature, including any associated processes supporting the species.

- Conserve the extent and distribution of any supporting feature upon which minke whale is dependent (i.e., their prey) and conserve the structure and function of supporting features, including processes to ensure minke whale are healthy and not deteriorating.
    - Main prey species are the lesser sandeel *Ammodytes marinus*, sprat *Sprattus sprattus*, herring *Clupea harengus* and mackerel *Scomber scombrus*.
    - Activities with the potential to cause significant degradation or abrasion of these seabed habitats may result in the local depletion of these prey species and ultimately affect minke whale using the site. Therefore, relevant activities (e.g. dredging, aggregate extraction, dumping) should be considered.

3 Assessment of Potential Impacts – Project Alone

3.1 Methodology

The approach to an assessment for a Nature Conservation MPA, is typically split into 'Screening' and 'Main Assessment' stages. Screening focuses on what can reasonably be predicted as a consequence of the proposal, and whether it is '*capable of affecting (other than insignificantly)*' a protected feature of a NC MPA. The present report proceeds directly to the 'Main Assessment' and focuses on whether there is, or may be, a Significant Risk of the Offshore Development hindering the achievement of the Conservation Objectives of the MPA.

To assess whether there may be a significant risk of hindering the achievement of the objectives or purpose of the site, the impacts listed in **Table 1** are considered in this report for the Salamander Project alone. Impacts considered in the **Volume ER.A.3, Chapter 11: Marine Mammals** of the EIAR that were scoped out from further consideration in this MPA assessment are listed in **Table 2** with accompanying justification that considered advice provided in NatureScot (2020).

Table 1 Impacts with a potential of hindering the achievement of the objectives or the purpose of the Southern Trench MPA

Impact	Methodology
Construction Phase	
Auditory injury from Unexploded Ordnance (UXO) clearance	Two different thresholds SPL_{peak} (peak sound pressure level from a single noise pulse) and SEL_{ss} (accumulated sound energy (sound exposure level, SEL)), were used to assess the risk of auditory injury within the MPA, with SEL_{cum} thresholds being frequency-weighted to the low-frequency cetacean hearing group for minke whales. For this, the

	area of the MPA within permanent threshold shift (PTS) impact contours overlapped was calculated. A qualitative assessment on whether the risk of auditory injury will reduce the absolute densities within the site, from which recovery to above average densities cannot be expected, is provided.
Auditory injury from piling of anchors	Two different thresholds covering 'instantaneous' PTS (SPL_{peak}), and 'cumulative' PTS (SEL_{cum}, accumulated sound energy (sound exposure level) over 24 hours), were used to assess the risk of auditory injury within the MPA, with SEL_{cum} thresholds being frequency-weighted to the low-frequency cetacean hearing group for minke whales. For this, the area of the MPA within which both instantaneous and cumulative PTS impact contours overlapped was calculated. A qualitative assessment on whether the risk of auditory injury will reduce the absolute densities within the site, from which recovery to above average densities cannot be expected, is provided.
Disturbance from UXO clearance	Two quantitative approaches were assessed: assuming a 26 km EDR (effective deterrence range) for disturbance from high-order UXO clearance activities (as advised by JNCC (2020) for harbour porpoise SAC assessments), and a 5 km EDR for disturbance from low-order UXO clearance activities (as advised by JNCC (2023) in the MNR disturbance tool).
Disturbance from piling of anchors	Two quantitative approaches were assessed: calculation of the effective disturbance area using the porpoise dose-response function as a proxy for minke whales, and using a 15 km EDR as a proxy for minke whales to assess significant disturbance. a. The MPA area within which disturbance is expected was estimated using the dose-response function (for harbour porpoise) from Graham *et al.* (2017) and single strike SEL (SEL_{ss}) contours decreasing in 5 dB steps from 180 to 120 dB re 1 μPa^2s, following the method as used for the assessment of disturbance[2]. The area of the MPA within each noise contour was weighted with the probability of response expected by an animal within that contour, based on the Graham *et al.* (2017) dose-response function, to obtain the 'effective disturbance area'. b. When defining the radius of disturbance to an SAC, JNCC (2020b) recommend that a 15 km EDR is used for piling of pin piles for harbour porpoise. In the absence of equivalent EDRs for minke whales, the porpoise EDRs have been presented here as a proxy. The assessment of the significance of this disturbance was conducted qualitatively, considering the effective disturbance area as well as the timing and duration over which minke whales are likely to be impacted, and whether this may lead to a long-term decline in the use of the MPA or a non-recoverable change in distribution. An evaluation was made on whether the effects will last beyond the average generation time of minke whale.
Auditory Injury from geophysical surveys	A qualitative assessment informed by published literature on whether there is a risk of injury to minke whale due to geophysical surveys.
Disturbance from geophysical surveys	Based on operating characteristics and marine mammal functional hearing capability, there is only potential for disturbance to occur during operation of Sub Bottom Profiler (SBP) and Ultra-short Baseline (USBL) systems. As such, a qualitative assessment was undertaken on whether significant disturbance of minke whale shall arise due to these two types of geophysical surveys.
Disturbance from vessels	A qualitative assessment was undertaken on whether significant disturbance of minke whale shall arise due to vessel activities within the MPA, during the construction in the Offshore ECC, as informed by information in the published literature on minke whale disturbance from vessels.
Disturbance from other construction activities	A qualitative assessment informed by published literature on whether significant disturbance of minke whale present within the Southern Trench MPA shall arise due to dredging, drilling, trenching, and cable laying activities at the Offshore ECC during the construction phase.
Indirect impacts to minke whale prey	Minke whales in the North Atlantic are known to take a wide range of pelagic shoaling small fish species, and the main prey species are the lesser sandeel (*Ammodytes marinus*), sprat (*Sprattus sprattus*), herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) (Anderwald et al., 2007). Potential impacts of piling noise on minke whale prey are discussed in **Section 3.2.9**. Impacts to the physical benthic substrate (and any associated impacts to the prey) within the MPA is not a factor when considering impacts of piling at the wind farm site, though consideration has been given to impacts on minke

[2] See detail in the EIAR for why this is considered to be conservative, given the different hearing groups for porpoise and minke whales.

	whale prey items from activities occurring within the Offshore ECC, which overlaps the MPA.
Operation and Maintenance Phase	
Barrier effects	A qualitative assessment on whether presence of the Offshore Array Area could prevent or restrict access to resources within the site.
Auditory Injury from geophysical surveys	A qualitative assessment informed by published literature on whether there is a risk of injury to minke whale due to geophysical surveys.
Disturbance from geophysical surveys	Based on operating characteristics and marine mammal functional hearing capability, there is only potential for disturbance to occur during operation of Sub Bottom Profiler (SBP) and Ultra-short Baseline (USBL) systems. As such, a qualitative assessment was undertaken on whether significant disturbance of minke whale shall arise due to these two types of geophysical surveys.

Table 2 Impacts scoped out from further consideration for the Project Alone.

Impact	Methodology
Operation and Maintenance Phase	
Risk of injury resulting from entanglement	In line with NatureScot (2020), it is recognised that minke whales are considered sensitive to entanglement and incidental bycatch. However, any risk of entanglement, either with the mooring lines and dynamic cables within the array area, or marine debris which has become caught on the lines and cables within the array area, would be restricted to the Offshore Array Area, which is located approximately 10 km from the MPA. As such, it is considered that minke whale within the site are not at significant risk from injury or killing. In line with the advice to support management of the site (NatureScot 2020), the risk of entanglement outside of the MPA will be reduced by embedded mitigation measures, where mooring lines and floating inter-array cables will be inspected according to the maintenance plan to confirm the structural integrity of the cable systems using a risk-based adaptive management approach. During these inspections, the presence of discarded fishing gear will be evaluated for marine mammal entanglement risk and appropriate actions taken to remove if deemed necessary. Considering the above, the risk of entanglement is not considered further in this assessment.
Collision	It has been acknowledged that minke whales are sensitive to collisions. Two types of collisions are considered as potential impacts for the Offshore Development – collision with wind turbine generator (WTG) structures and collision with vessels. A collision of marine mammal with floating WTG structures has never been reported; however, due to the foraging behaviour of minke whales (lunge feeding), this impact cannot be excluded. Any risk of collision would be highly localised and restricted to the array area. Given that the Offshore Array Area is located outside of the MPA, it is considered that minke whale within the site are not at significant risk from injury or killing due to collision with WTG structures and therefore this impact is not considered further in this assessment. In line with the advice to support management of the site (NatureScot 2020), the risk of collisions with vessels will be reduced by embedded mitigation measures. Vessel movements will be managed through the implementation of a Vessel Management Plan that will mitigate the negative impacts to marine mammals (e.g. limited vessel speeds, adherence to vessel transit routes), following relevant guidance to minimise the risks of injury to marine mammals during the construction, operation and maintenance and decommissioning phases of the Salamander Project (SNH 2017b, a).
Operational noise	Based on Burns *et al.* (2022) findings as a result of analysis of operational sounds at Kincardine and Hywind Scotland floating offshore wind farms, minke whale would need to remain within 40 m of an operational turbine (assuming the wind speed was 15 knots) for 24 hours to reach the TTS-onset threshold. This is highly unlikely. Given the small scale of the project and that it is located outside of the MPA, it is considered that minke whale within the site are not at risk of significant disturbance (as per definition provided in NatureScot (2020)) and therefore this impact is not considered further in this assessment
Long-term habitat change and indirect impacts on prey	Avoidance of sensitive features during cable routing will be applied wherever practicable as a part of the embedded mitigation measures. Cables will be buried as the primary cable protection method; however, other cable protection methods will be used where adequate burial cannot be achieved. As such, there will be no or minimal habitat change

	within the export cable corridor that could affect minke whales foraging grounds within the MPA boundaries. Although minke whale presence has been recorded around oil and gas structures in the central North Sea (Delefosse *et al.* 2018), there is limited understanding on whether baleen whales can successfully navigate the spaces between turbines in the array, and forage within it. However, the Offshore Array Area is located outside of the Southern Trench MPA and therefore it will not affect the availability of prey within the site. As such, this impact is not considered further in this assessment.
Decommissioning Phase	
Auditory injury from decommissioning activities	The effects of underwater noise on minke whales during decommissioning are considered to be no greater than those described for the construction phase. The exact methods to be used for decommissioning are to be decided, the impact from PTS and disturbance levels of decommissioning activities cannot be accurately determined at this time. However, it is anticipated that with the implementation of embedded mitigation in the form of a Decommissioning Program and a Marine Mammal Monitoring Programme (MMMP) specific to decommissioning activities, the magnitude of the impacts on minke whale individuals are not anticipated to result in injury or significant disturbance. As such, this impact is not considered further in the assessment.
Disturbance from decommissioning activities	
Indirect impacts on prey	At this stage, it is assumed that the PDE will involve full removal of all infrastructure placed during construction. This assumption is subject to best practice methods and technology appropriate at the time of decommissioning. The effects of decommissioning activities on minke whale prey are considered to be no greater than those described for the construction phase. As such, this impact is not considered further in the assessment.

3.2 Construction Phase

3.2.1 Auditory injury from Unexploded Ordnance (UXO) clearance

The location and size of any UXOs are currently unknown and as such an illustrative assessment is provided here. There is the potential for UXOs to be located within the Offshore ECC and thus within the Southern Trench MPA. For minke whales, up to 13 individuals (using the SCANS IV Block NS-D density estimate) are predicted to experience auditory injury (PTS-onset) from high-order UXO clearance for the largest charge weight (Table 3). Therefore, there is the potential for a small number of minke whales within the Southern Trench MPA to experience injury as a result of high-order UXO clearance activities. Despite this, it is not expected that such an impact this would result in any change to the density of minke whales within the site over the long term or on a continued or sustained basis. Therefore, there is expected to be no significant risk to hindering the achievement of the objectives or purpose of the Southern Trench MPA.

The Salamander Project has committed to implementing a UXO-specific Marine Mammal Monitoring Programme (MMMP). Although the exact mitigation measures contained with the UXO MMMP are yet to be determined, they will be in line with the latest relevant guidance at the time of this stage of the Salamander Project. Multiple measures are available and have been implemented elsewhere for UXO clearance, such as the use of Acoustic Deterrent Devices (ADDs) and scarer charges to displace animals to beyond the PTS impact range, a preference for low-noise alternatives to high-order detonation, or noise abatement techniques where appropriate. It is noted that it is highly unlikely that high-order clearance activities would occur. The preference will be for low-order clearance methods, which are expected to result in impact to <1 individual whale (Table 3).

Table 3 Summary of the auditory injury (PTS-onset) impact ranges from low order UXO clearance and high-order clearance of the largest expected UXO size.

UXO charge size	SEL_{ss}		SPL_{peak}	
	Range (km)	# whales	Range (km)	# whales
Low order (0.25 kg)	0.23	<1	0.17	<1
High order (698 kg + donor)	10	13	2.4	1

3.2.2 Auditory injury from piling of anchors

Two locations have been selected for the assessment of PTS and disturbance from pile driving of anchors: the East location in 89.7 m water depth, and the West location, in 97.1 m water depth. Two piling scenarios are presented at each modelling location:

- Scenario 1: installation of 4 piled anchors per day with a maximum hammer energy of 1,500 kJ, and
- Scenario 2: installation of 1 piled anchor per day with a maximum hammer energy of 2,500 kJ.

3.2.2.1 Piling: Instantaneous Permanent Threshold Shift (PTS)

At both the East and West piling locations, and under both Scenario 1 (1,500 kJ) and Scenario 2 (2,500 kJ), instantaneous PTS-onset (SPL_{peak}) impact areas for minke whale were <0.01 km^2 (<50 m) and thus do not overlap with the Southern Trench MPA. Therefore, no minke whales within the Southern Trench MPA are anticipated to be subject to instantaneous PTS.

3.2.2.2 Piling: Cumulative PTS

Under Scenario 1 (4 piled anchors per day at a maximum hammer energy of 1,500 kJ), the conservative estimates for cumulative PTS-onset impact ranges for minke whale are 4.7 km and 5.3 km at the West and East piling locations respectively. The cumulative PTS-onset impact ranges for piling at 1,500 kJ hammer energy at both the East and West piling locations did not overlap with the Southern Trench MPA (Figure 3) and, therefore, no minke whales within the Southern Trench MPA are anticipated to be subject to cumulative PTS under this piling scenario.

Under Scenario 2 (single piled anchor per day at 2,500 kJ hammer energy), the conservative estimates for cumulative PTS-onset (SEL_{cum}) impact ranges for minke whale are 21 km at both the West and East piling locations. The cumulative PTS-onset impact ranges for piling of a single piled anchor per day at 2,500 kJ hammer energy at the East piling location did not overlap with the Southern Trench MPA (Figure 3). The MPA area within which cumulative PTS-onset contours from the West location overlap is 1.29% (32.8 km^2) for piling of a single piled anchor at a hammer energy of 2,500 kJ (Figure 3).

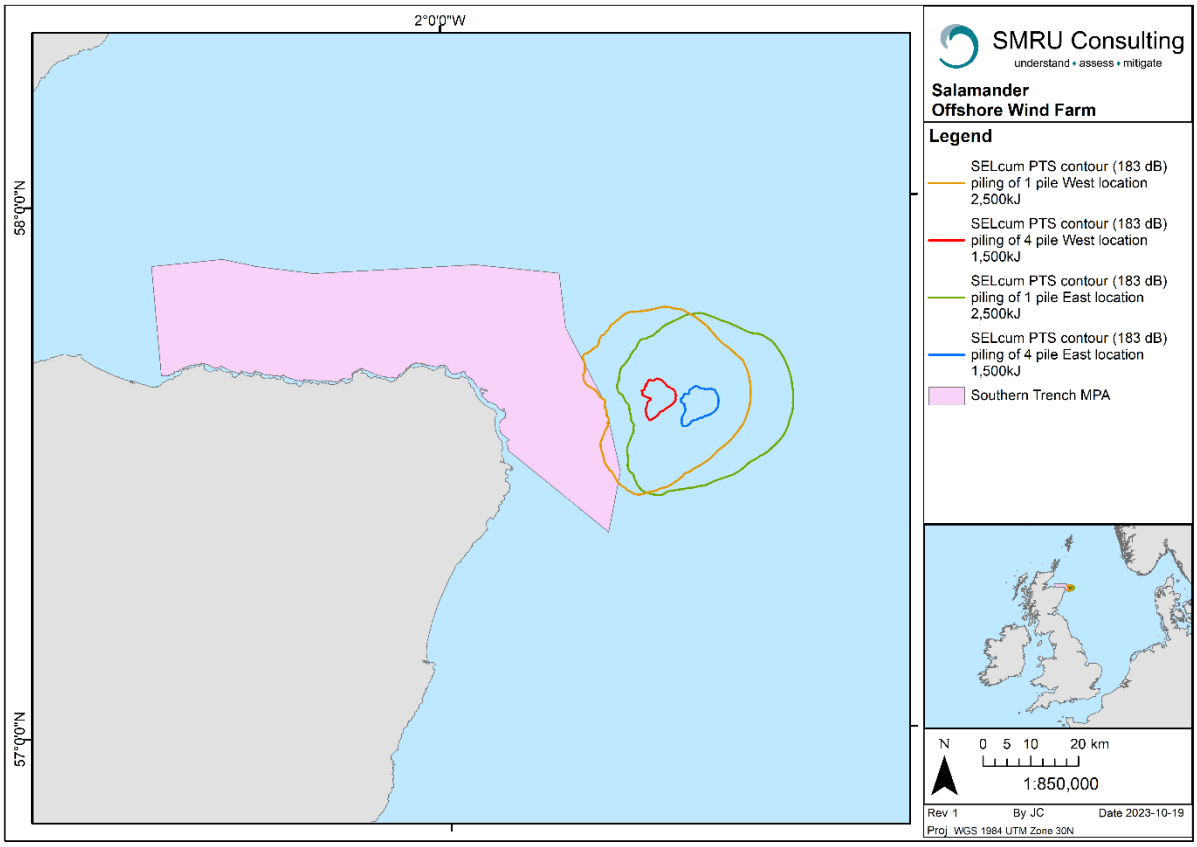

Figure 3 Auditory injury (PTS-onset) contours (SEL_{cum} isopleths (183 SEL re 1 μPa^2s)) for low frequency cetaceans (i.e., minke whale) for piling at the West and East piling locations, and their overlap with the Southern Trench MPA.

The predicted cumulative PTS-onset impact ranges for minke whales under the worst-case scenario (piling of a single piled anchor at 2,500 kJ hammer energy) are highly conservative. The ranges assume that sound is impulsive throughout, for which there is evidence to the contrary. Hastie *et al.* (2019) estimated the transition from impulsive to non-impulsive characteristics of impact piling noise during the installation of offshore wind turbine foundations at the Wash and in the Moray Firth. This analysis showed that the noise signal experienced a high degree of change in its impulsive characteristics with increasing distance. Based on these data it is expected that the probability of a signal being defined as "impulsive" (using the criteria of rise time being less than 25 milliseconds) reduces to only 20% between ~2 and 5 km from the source. In addition, signal duration was generally lower in the recordings closest to the source and increased rapidly to plateau from approximately 10 km from the source (Hastie *et al.* 2019), suggesting a less impulsive sound. Predicted PTS impact ranges based on purely impulsive noise thresholds are therefore overestimates in cases where the impact ranges extend beyond the 10 km range.

If a more realistic maximum cumulative PTS-onset range of 10 km was assumed, based on the findings of Hastie *et al.* (2019), then no cumulative PTS-onset contours would overlap with the MPA boundary and thus no minke whales within the Southern Trench MPA would be subject to cumulative PTS (Figure 4).

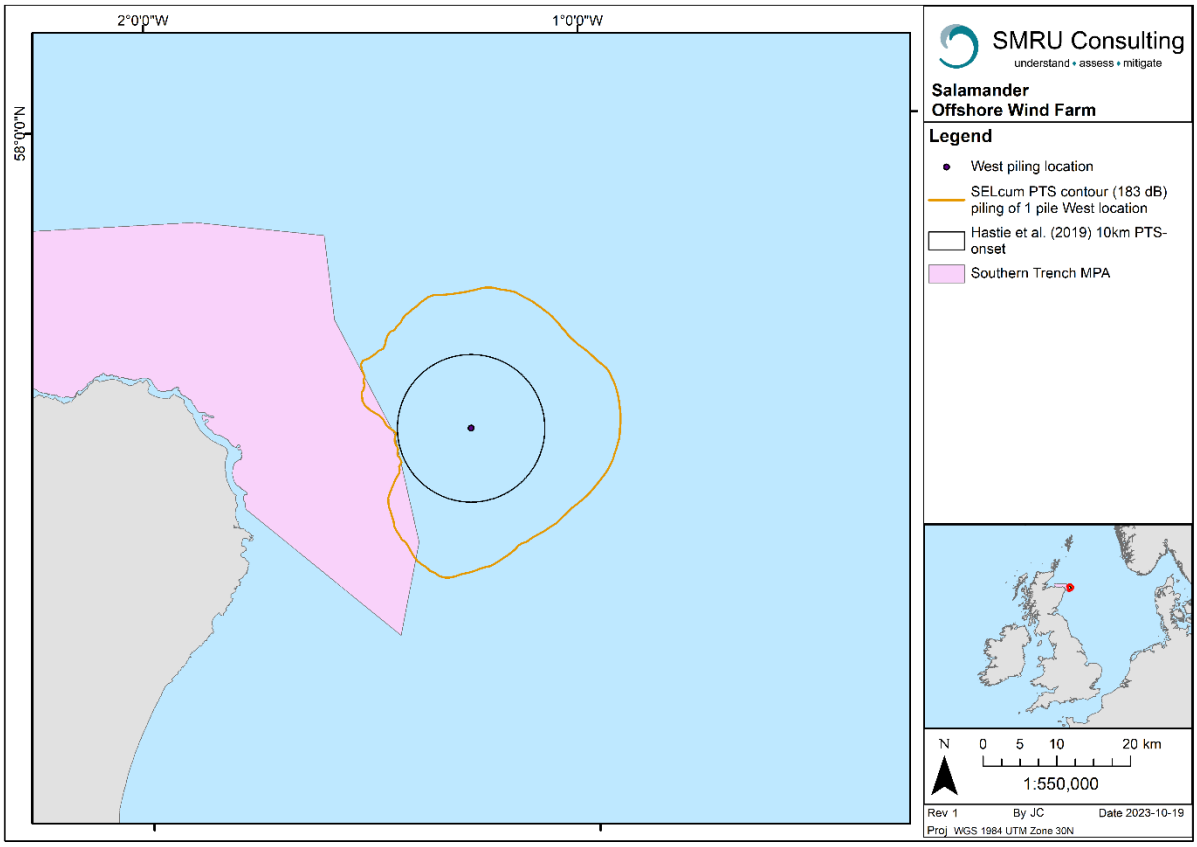

Figure 4 Auditory injury (PTS-onset) contours (SEL_{cum} isopleths (183 SEL re 1 μPa^2s), at 2,500 kJ hammer energy) for low frequency cetaceans (i.e., minke whale) for piling at the West piling locations, and their overlap with the Southern Trench MPA. This figure also demonstrates the more realistic maximum cumulative PTS-onset range of 10 km, based on the findings of Hastie *et al.* (2019) and assuming that underwater piling noise propagates in the same way in all directions.

3.2.2.3 Piling conclusions

Under the worst-case piling scenario (2,500 kJ hammer energy) cumulative PTS contours only overlap with 1.29% of the MPA area. It is important to note that this area of overlap is in an area of low predicted densities for minke whales (0.0-0.1 whales/km^2) (Figure 2), and thus is expected to impact 3 minke whales at most. It is also important to recognise the conservatism in the cumulative PTS impact ranges, and that more likely maximum ranges for impulsive noise (within 10 km) would mean no overlap with the MPA boundary. Even in the highly unlikely event that a very limited number of animals within the MPA experience auditory injury (PTS) as a result of pile-driven anchors per piling day, it is expected that there would be no non-recoverable change in the distribution of minke whale within the MPA. While auditory injury is a permanent effect, the potential impact to such a limited number of individuals over a limited number of piling days (40 days – most likely case, 80 days worst case scenario) is not expected to result in changes to the vital rates of a sufficient number of minke whales to result in any alteration to the population trajectory over a generational scale.

In addition, the Salamander Project has committed to implementing a piling-specific marine mammal mitigation plan (MMMP) to ensure the risks of auditory injury are reduced to negligible levels as far as reasonably possible. The exact mitigation measures contained with the piling MMMP are yet to be determined, but they will be in line with the latest relevant guidance at the time of this stage of the project. Multiple measures are available and have been implemented elsewhere for piling, such as the use of ADDs to displace animals (range limited), or noise abatement techniques where appropriate.

3.2.3 Disturbance from UXO clearance

The location and size of any UXOs are currently unknown and as such an illustrative assessment is provided here. There is the potential for UXOs to be located within the Offshore ECC and thus within the Southern Trench MPA. For minke whales, up to 89 individuals (using the SCANS IV Block NS-D density estimate) are predicted to experience disturbance from high-order UXO clearance for the largest charge weight, and up to 3 minke whales are predicted to experience disturbance from low-order UXO clearance (Table 4).

It is noted in the JNCC (2020b) guidance that, although UXO detonation is considered a loud underwater noise source, *"...a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement..."*. Whilst detonations will usually be undertaken as part of a campaign and, therefore, there may result in multiple detonations over several days (JNCC 2020b), each detonation will be of a short-term duration. Therefore, it is not expected that disturbance from a UXO detonation would result in any significant impacts, and that disturbance from a single noise event would not be sufficient to result in any changes to the vital rates of individuals.

While there is the potential for temporary disturbance to a limited number of individuals within the MPA, it is not expected that this would result in any change to the density of minke whales within the site over the long term or on a continued or sustained basis. Therefore, there is expected to be no significant risk to hindering the achievement of the conservation objectives or purpose of the Southern Trench MPA.

Table 4 Summary of the potential disturbance impact ranges from low-order UXO clearance and high-order clearance of the largest expected UXO size.

	Disturbance range (km)	Impacted area (km^2)	# whales
Low order (0.25 kg)	5 km EDR	78.54	3
High order (698 kg + donor)	26 km EDR	2,123.72	89

3.2.4 Disturbance from piling of anchors

3.2.4.1 Area impacted: Dose-response approach

3.2.4.1.1 Piling Scenario 1: 1,500 kJ

For piling Scenario 1 (at 1,500 kJ hammer energy), there was no overlap between the MPA and single strike sound exposure level (SEL_{ss}) disturbance contours above 160 dB for any piling location modelled. Thus, results are only presented for ≤160 dB (**Figure 5** & **Figure 6**).

The proportion of the MPA area within which some level of disturbance is predicted (i.e., within the minimum 120 dB SEL_{ss} contour) during piling at 1,500 kJ hammer energy at the West piling location is 81% of the total MPA area and 76% of the total MPA area for the East piling location (**Table 5** & **Table 6**). To acknowledge that not all animals will respond within this area, the effective disturbance area is 43% of the total MPA area at the West location and 37% of the total MPA area at the East location (**Table 5** & **Table 6**).

Table 5 Calculation of the % MPA within which minke whale are potentially disturbed using the Graham et al. (2017) dose-response function for the West piling location (1,500 kJ hammer energy). The area of overlap with the MPA is the total area by which each noise contour increment overlaps within the MPA boundaries. The effective disturbance area is calculated using the Graham *et al.* (2017) dose-response values to obtain the area within which a response is expected to occur (i.e., effective disturbance area = area of overlap with MPA for each noise contour, multiplied by the proportion of animals expected to respond).

dB Level	Proportion of animals expected to respond using the Graham *et al.* (2017) dose-response	Incremental area of overlap with MPA (km^2)	Effective disturbance area (km^2)
160	0.9192	45.60	41.92
155	0.8266	399.30	330.06
150	0.6849	521.09	356.89
145	0.5090	366.33	186.46
140	0.3312	313.87	103.95
135	0.1852	276.80	51.26
130	0.0878	96.92	8.51
125	0.0349	33.55	1.17
120	0.0115	11.20	0.13
Total MPA area exposed/disturbed (km^2)		**2,064.66**	**1,080.36**
Total area disturbed as % of total MPA area		**81%**	**43%**

Table 6 Calculation of the % MPA within which minke whale are potentially disturbed using the Graham et al. (2017) dose-response function for the East piling location (1,500 kJ hammer energy). The area of overlap with the MPA is the total area by which each noise contour increment overlaps within the MPA boundaries. The effective disturbance area is calculated using the Graham *et al.* (2017) dose-response values to obtain the area within which a response is expected to occur (i.e., effective disturbance area = area of overlap with MPA for each noise contour, multiplied by the proportion of animals expected to respond).

dB Level	Proportion of animals expected to respond using the Graham *et al.* (2017) dose-response	Incremental area of overlap with MPA (km^2)	Effective disturbance area (km^2)
160	0.9192	<0.00	0.00
155	0.8266	170.83	141.21
150	0.6849	589.49	403.74
145	0.5090	441.57	224.76
140	0.3312	334.19	110.68
135	0.1852	275.35	50.99
130	0.0878	83.18	7.30
125	0.0349	14.86	0.52
120	0.0115	6.52	0.07

Total MPA area exposed/disturbed (km^2)	**1,915.99**	**939.28**
Total area disturbed as % of total MPA area	**76%**	**37%**

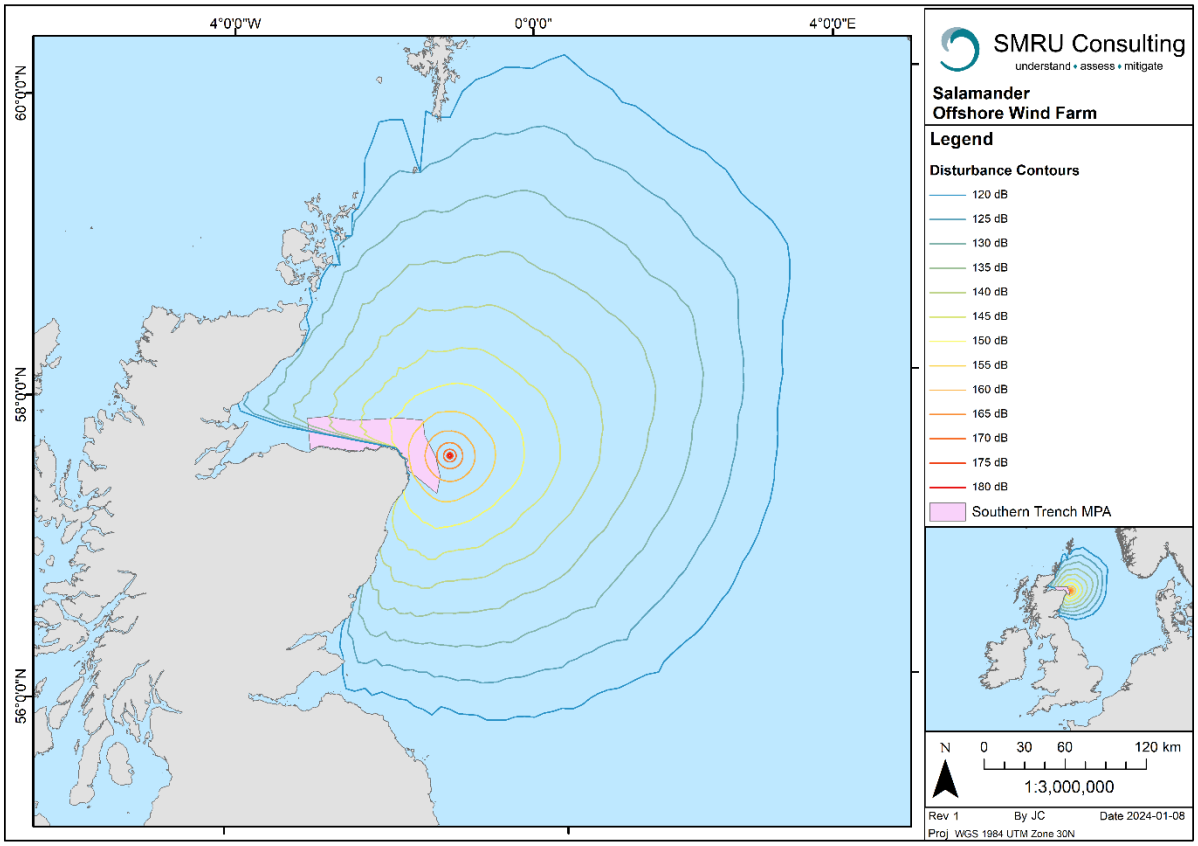

Figure 5 Disturbance contours showing SEL_{ss} isopleths between 120 – 180 dB re 1 μPa^2s in 5 dB steps for piling at the West piling location (1,500 kJ), and their overlap with the Southern Trench MPA.

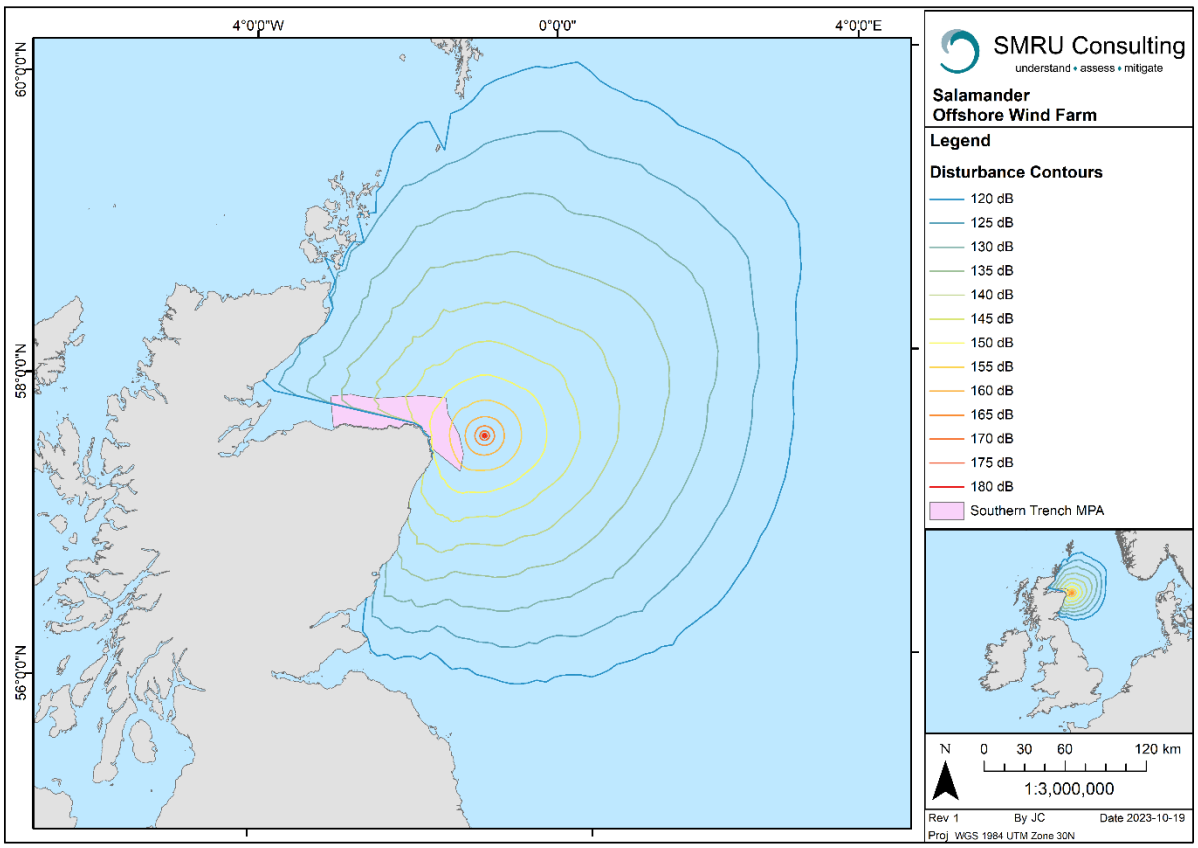

Figure 6 Disturbance contours showing SEL_{ss} isopleths between 120 – 180 dB re 1 μPa^2s in 5 dB steps for piling at the East piling location (1,500 kJ), and their overlap with the Southern Trench MPA.

3.2.4.1.2 Piling Scenario 2: 2,500 kJ

For piling Scenario 2 (at 2,500 kJ hammer energy), there was no overlap between the MPA and single strike sound exposure level (SEL_{ss}) disturbance contours above 160 dB for any piling location modelled. Thus, results are only presented for ≤160 dB (**Figure 7** & **Figure 8**). The proportion of the MPA area within which some level of disturbance is predicted (i.e., within the minimum 120 dB SEL_{ss} contour) during piling at 2,500 kJ hammer energy at the West piling location is 81% of the total MPA area and 76% of the total MPA area for the East piling location (**Table 7** and **Table 8**). To acknowledge that not all animals will respond within this area, the effective disturbance area is 47% of the total MPA area at the West location and 42% of the total MPA area at the East location (**Table 7** and **Table 8**).

Table 7 Calculation of the % MPA within which minke whale are potentially disturbed using the Graham et al. (2017) dose-response function for the West piling location (2,500 kJ hammer energy). The area of overlap with the MPA is the total area by which each noise contour increment overlaps within the MPA boundaries. The effective disturbance area is calculated using the Graham *et al.* (2017) dose-response values to obtain the area within which a response is expected to occur (i.e., effective disturbance area = area of overlap with MPA for each noise contour, multiplied by the proportion of animals expected to respond).

dB Level	Proportion of animals expected to respond using the Graham *et al.* (2017) dose-response	Incremental area of overlap with MPA (km^2)	Effective disturbance area (km^2)
160	0.9192	144.99	133.27
155	0.8266	539.11	445.63
150	0.6849	441.51	302.39
145	0.5090	338.55	172.32

dB Level	Proportion of animals expected to respond using the Graham *et al.* (2017) dose-response	Incremental area of overlap with MPA (km^2)	Effective disturbance area (km^2)
140	0.3312	298.71	98.93
135	0.1852	199.57	36.96
130	0.0878	62.63	5.50
125	0.0349	30.16	1.05
120	0.0115	10.53	0.12
Total MPA area exposed/disturbed (km^2)		**2,065.76**	**1,196.18**
Total area disturbed as % of total MPA area		**81%**	**47%**

Table 8 Calculation of the % MPA within which minke whale are potentially disturbed using the Graham et al. (2017) dose-response function for the East piling location (2,500 kJ hammer energy). The area of overlap with the MPA is the total area by which each noise contour increment overlaps within the MPA boundaries. The effective disturbance area is calculated using the Graham *et al.* (2017) dose-response values to obtain the area within which a response is expected to occur (i.e., effective disturbance area = area of overlap with MPA for each noise contour, multiplied by the proportion of animals expected to respond).

dB Level	Proportion of animals expected to respond using the Graham *et al.* (2017) dose-response	Incremental area of overlap with MPA (km^2)	Effective disturbance area (km^2)
160	0.9192	0.39	0.36
155	0.8266	410.96	339.70
150	0.6849	546.53	374.32
145	0.5090	386.72	196.84
140	0.3312	302.91	100.32
135	0.1852	223.45	41.38
130	0.0878	31.09	2.73
125	0.0349	10.32	0.36
120	0.0115	4.37	0.05
Total MPA area exposed/disturbed (km^2)		**1,916.74**	**1,056.06**
Total area disturbed as % of total MPA area		**76%**	**42%**

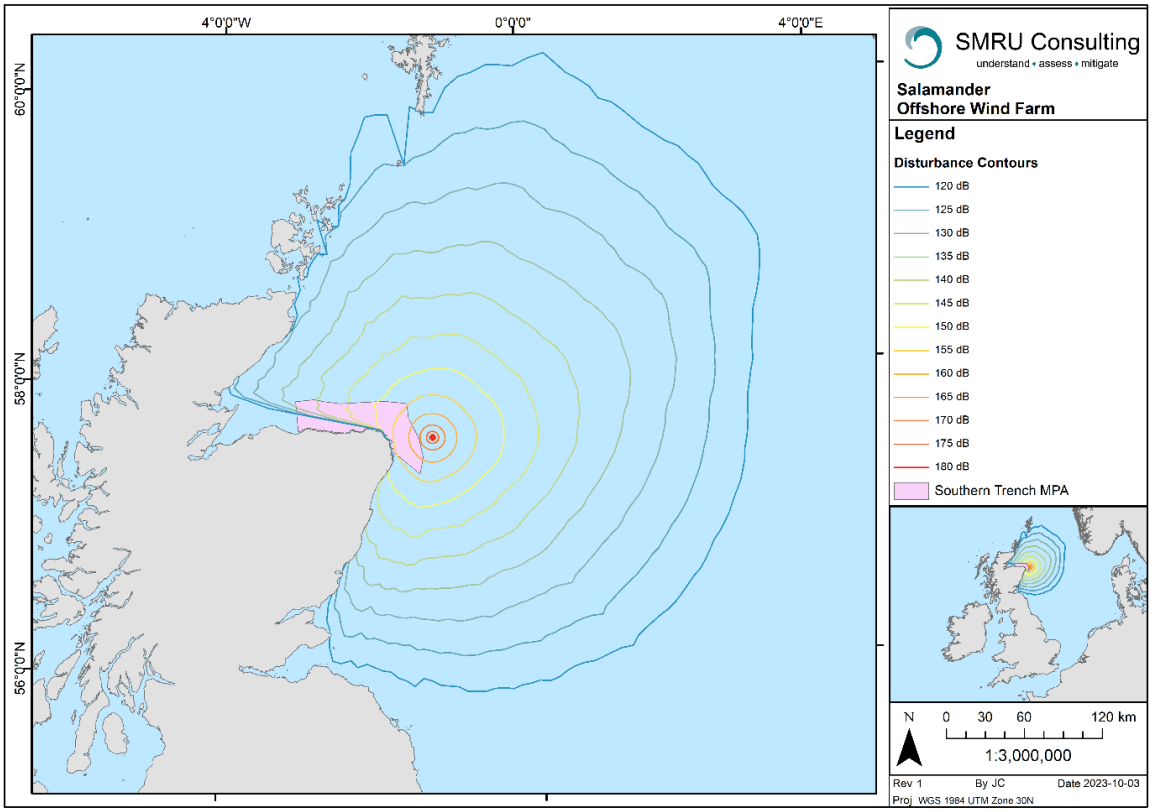

Figure 7 Disturbance contours showing SEL_{ss} isopleths between 120 – 180 dB re 1 µPa²s in 5 dB steps for piling at the West piling location (2,500 kJ), and their overlap with the Southern Trench MPA.

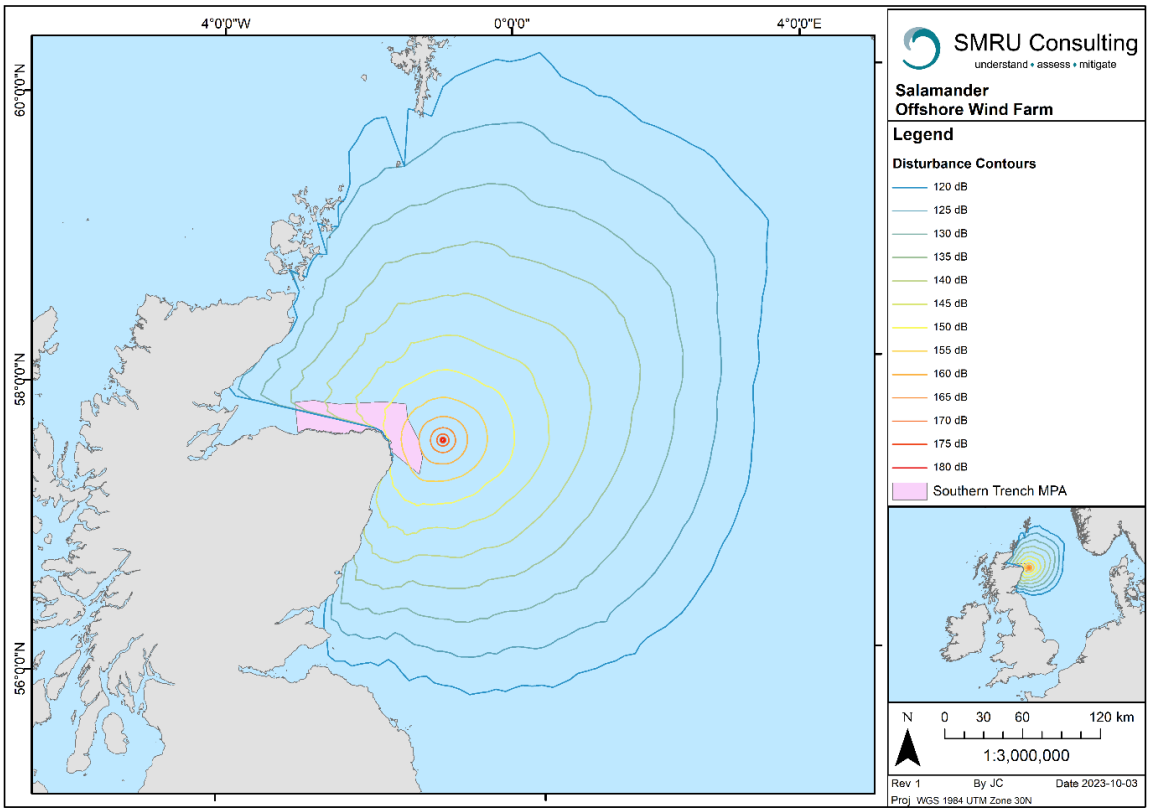

Figure 8 Disturbance contours showing SEL_{ss} isopleths between 120 – 180 dB re 1 µPa²s in 5 dB steps for piling at the East piling location (2,500 kJ), and their overlap with the Southern Trench MPA.

3.2.4.1.3 Precaution in the assessment

Using the dose-response function for harbour porpoise in the absence of empirical species-specific dose-response data for minke whales is highly conservative given their different hearing groups. Studies have shown that other cetacean species show comparatively less of a disturbance response from underwater noise compared with harbour porpoise (Bailey *et al.* 2010, Stone *et al.* 2017), hence the responses of minke whales to disturbance arising from potential piling activities are anticipated to be less severe than those of harbour porpoise. Therefore, the application of the porpoise dose-response curve to minke whales is anticipated to be highly precautionary and thus expected to overestimate the extent of disturbance to minke whale within the Southern Trench MPA limits.

Studies using harbour porpoise detection rates to reveal the extent of porpoise displacement during pile driving revealed that harbour porpoise were only displaced from the piling area in the short term (Brandt *et al.* 2011, Brandt *et al.* 2016, Brandt *et al.* 2018). In addition, a recent study by Benhemma-Le Gall *et al.* (2021a) provided two key findings in relation to harbour porpoise response to pile driving:

1. Harbour porpoise were not completely displaced from the piling site: detections of clicks (echolocation) and buzzing (associated with prey capture) in the short-range (2 km) did not cease in response to pile driving; and
2. Harbour porpoise appeared to compensate: detections of both clicks (echolocation) and buzzing (associated with prey capture) increased above baseline levels with increasing distance from the pile.

This suggests that those harbour porpoise that are displaced from the near-field resume foraging at a greater distance from the piling location (Benhemma-Le Gall *et al.* 2021a) and, therefore, harbour porpoise that experience displacement are expected to be able to compensate for the lost foraging opportunities. Due to their large size and capacity for energy storage, it is expected that minke whales will be able to tolerate temporary displacement from foraging areas at least as well as harbour porpoise.

3.2.4.1.4 Dose-response conclusion

Using the porpoise dose-response function as a proxy for disturbance for minke whales, the effective disturbance area is at most 47% of the total MPA area under the worst-case piling scenario (2,500 kJ hammer energy) and 43% under the most likely piling scenario (1,500 kJ hammer energy). However, as detailed above, using the dose-response function for harbour porpoise as a proxy for disturbance for minke whales in highly conservative given their different hearing groups, and is thus expected to overestimate the extent of disturbance to minke whale within the Southern Trench MPA limits.

It is important to note that while this approach attempts to estimate the total area effectively disturbed, the inclusion of impact contours down to 120 dB SEL_{ss} represents an extremely low likelihood of response. Therefore, an additional assessment using the effective deterrence range (EDR) approach to assess the area of disturbance (i.e. the area encompassing the majority of disturbance effects) is also provided below.

3.2.4.2 Area impacted: EDR approach

When defining the area of an SAC disturbed by activities, JNCC (2020b) recommend that a 15 km EDR is used for piling of pin piles for harbour porpoise. In the absence of equivalent EDRs for minke whales, the porpoise EDRs have been presented here as a proxy. For piling of anchor pin piles at Salamander, assuming disturbance occurs within the 15 km EDR, then only 2% of the total MPA area is predicted to experience disturbance from piling at the West location, and there is no overlap with the MPA from piling at the East location (**Table 9**).

Table 9 Calculation of the % MPA within which minke whale are potentially disturbed using the 15 km EDR approach

Location	EDR	Area overlap with MPA (km^2)	% of MPA
West	15 km	61.33	2%
East	15 km	0.00	0%

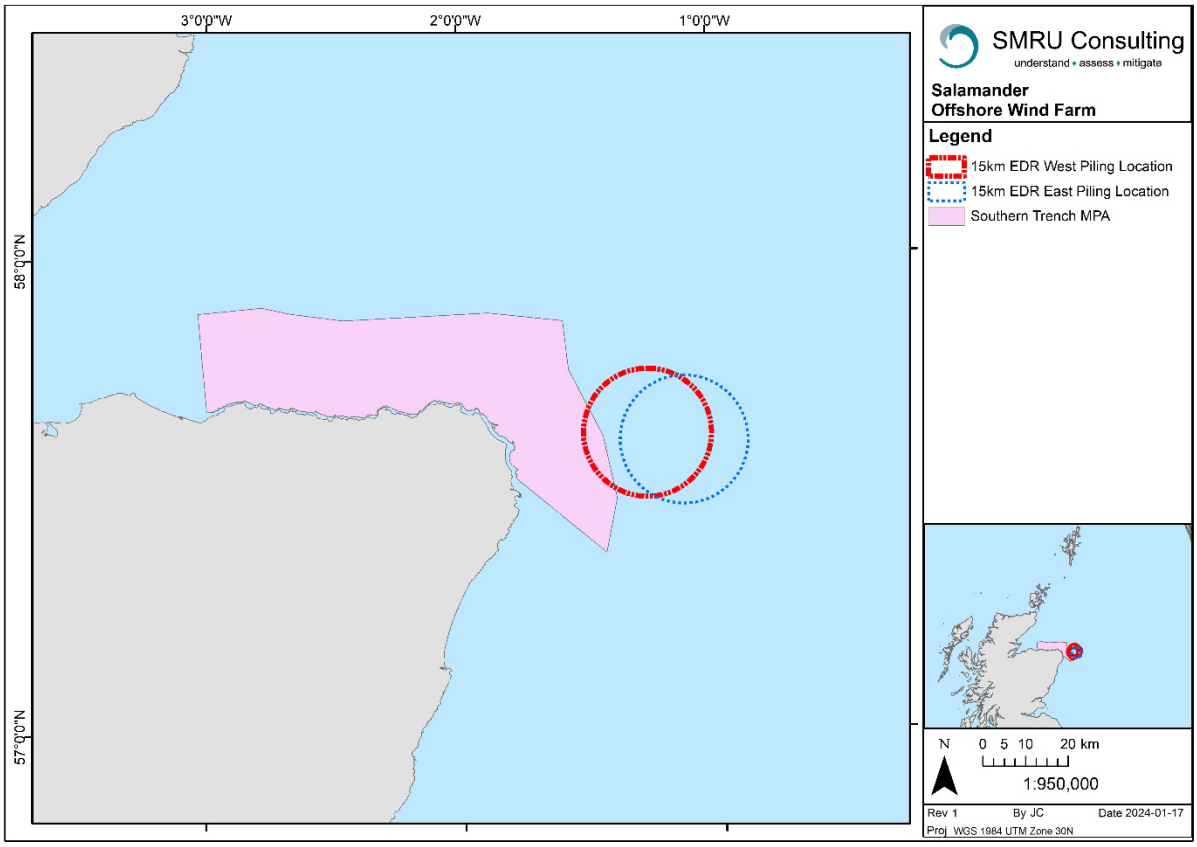

Figure 9 Disturbance contours assuming a 15 km EDR for piling of anchor pin piles, and the overlap with the Southern Trench MPA.

3.2.4.3 Piling conclusion

All piling is expected to occur during one annual cycle for a maximum of 80 days under a worst-case scenario (40 days under the more likely piling scenario; see **Volume ER.A.3, Chapter 11: Marine Mammals** of the EIAR). Any disturbance impacts will be short in duration, intermittent and temporary, this is expected to result in a non-significant impact (a recoverable change in distribution). This temporally and spatially limited disturbance is not expected to result in any long-term decline in the use of the MPA, nor a sustained change in the distribution of minke whales, nor sufficient levels of disturbance to result in foraging ability, breeding or survival rates.

Further, minke whales are expected to primarily be present in the summer months (July – September, although individual minke whales are regularly sighted between May and October and can be present in Scottish waters year-round). Therefore, any pile driving activities that occur outside the summer months are expected to have less of an impact on minke whales within the MPA. Given the limited amount of disturbance that shall occur within the MPA over the piling year, impacts are not anticipated to pose a significant risk to hindering the achievement of the objectives or purpose of the site.

Table 10 Summary of the assessment of disturbance from pile driving activities on the Southern Trench MPA conservation objectives.

Significant disturbance	Assessment conclusion
The contribution to long-term decline in the use of the MPA	Behavioural effects from pile driving activities are expected to be reversible, with animals returning to the area following cessation of piling. While behavioural effects from pile driving over a maximum of 80 piling days (40 under the most-likely piling scenario) may result in temporary disturbance and displacement of animals within the MPA, the duration of impact will be short-term and intermittent, with animals expected to return after piling ceases. There is therefore expected to be no long-term decline in the use of the MPA.
Changes to the distribution on a continuing or sustained basis	Behavioural effects from pile driving activities are expected to be reversible, with animals returning to the area following cessation of piling. While behavioural effects from pile driving over a maximum of 80 piling days (40 under the most-likely piling scenario) may result in temporary disturbance and displacement of animals within the MPA, the duration of impact will be short-term and intermittent, with animals expected to return after piling ceases. There is therefore expected to be no change to the distribution of animals within the MPA on a continuing or sustained basis.
Changes to the behaviour such that it reduces the ability of the species to feed efficiently, breed or survive	Minke whales have been shown to change their diving patterns and behavioural state in response to disturbance from whale watching vessels; and it was suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success in this capital breeding species (Christiansen *et al.* 2013a). Behavioural effects from pile driving activities may potentially disturb minke whales such that foraging activity is temporarily disrupted. However, due to their large size and capacity for energy storage, it is expected that minke whales will be able to tolerate temporary displacement from foraging areas and individuals are expected to be able to recover from any impact on vital rates quickly. Given the small number of piling days, it is not expected that temporary disruption in foraging will result in changes to individual breeding or survival.
Overall	**Pile driving of anchors is not anticipated to pose a significant risk to hindering the achievement of the objectives or purpose of the Southern Trench MPA.**

3.2.5 Auditory injury from geophysical surveys

It should be noted that any geophysical surveys taking place within the Offshore Array Area will be outside of the MPA and therefore the assessment below refers to the geophysical surveys that could take place within the Offshore ECC, which overlaps with the Southern Trench MPA. The Offshore ECC will not overlap with the areas where high densities of the minke whales (southern coastline of the outer Moray Firth between Lossiemouth and Fraserburgh) have been recorded (Robinson *et al.* 2009, Robinson *et al.* 2023).

Pre-construction and construction geophysical equipment could include any or all of the following: SBP, multibeam echosounder (MBES); Side Scan Sonar (SSS) with piggybacked magnetometer and USBL.

The source levels of USBL equipment are below the PTS-onset thresholds for minke whale, and therefore there is no risk of injury. JNCC (2017) do not advise that mitigation to avoid injury from use of MBES is necessary in shallow (<200 m) waters where the MBES used are of high frequencies (as they are planned to be here). EPS Guidance (JNCC *et al.* 2010) for use of SSS states that "*this type of survey is of a short-term nature and results in a negligible risk of an injury or disturbance offence (under the Regulations)*." An equivalent conclusion was reached by DECC (2011). Furthermore, a recent comprehensive assessment of the characteristics of acoustic survey sources proposed that MBES and SSS should be considered *de minimis* in terms of being not likely to result in injury or behavioural disturbance to marine mammals, based on a behavioural disturbance threshold of 160 dB re 1 µPa (SPL_{rms}) adopted in the United States (Ruppel *et al.* 2022).

There is the potential for a source level of the SBP to cause an auditory injury for minke whale. However, an individual animal would need to be in a relatively small zone of ensonification and stay in that zone associated with the vessel for a longer period of time. The risk to minke whale from use of this lower frequency acoustic equipment is further reduced by the orientation of the sound source, e.g. equipment and resulting sound waves are directed downwards to the seabed, reducing the area Impacted by noise. As such, the potential for auditory injury to minke whale from SBP is very low to negligible. Additionally, for all geophysical surveys using SBPs, the JNCC (2017) guidelines for minimising the risk of injury to marine mammals from geophysical surveys will be implemented to reduce any risk of PTS to a negligible level. These guidelines include procedures such as the use of visual observers and passive acoustic monitoring to ensure no animals are within injury risk areas before surveys commence, and gradual ramp-up of SBPs (where possible).

Considering the above, no auditory injury to minke whales within the MPA from geophysical surveys taking place within the MPA (along the Offshore ECC) is anticipated.

3.2.6 Disturbance from geophysical surveys

It should be noted that any geophysical surveys taking place within the Offshore Array Area will be outside of the MPA and therefore the assessment below refers to the geophysical surveys that could take place within the Offshore ECC, which overlaps with the Southern Trench MPA.

The expected sound frequency during operation of MBES and SSS is above 200 kHz and therefore above the hearing frequency range of minke whales. As such, there is no potential for disturbance effects to occur through use of these survey equipment.

JNCC *et al.* (2010) EPS Guidance concludes that the use of SBPs in geophysical surveys "*could, in a few cases, cause localised short-term impacts on behaviour such as avoidance."* There is only one study showing minke whale reactions to sonar signals located at approximately 8 km distance from the animal using a sonar source that transmitted signals between 1.3 to 2.0 kHz frequency-modulated hyperbolic upsweeps (Sivle *et al.* 2015). The study recorded behavioural response including horizontal avoidance and progressive aversion in which minke whale progressively increased speed and changed dive pattern in order to move away from the sound source. However, should the short-term operations result in a response by an animal, this would be temporary.

Considering the above, the geophysical surveys are unlikely to:

- contribute to long term decline in the use of the site by minke whale; and
- change to the distribution of minke whale on a continuing or sustained basis.

Animals may choose to cease foraging in response to noise by fleeing the affected area; however, it is anticipated that individuals will recommence these activities following cessation of impact (underwater noise). As such, geophysical surveys are unlikely to alter minke whale behaviour such that it reduces ability of the species to feed efficiently or breed for prolonged periods of time and therefore its survival will not be affected.

3.2.7 Disturbance from vessels

Disturbance to minke whale may also occur as a result of vessel activity during cable laying and trenching activities in the creation of the Offshore ECC within the MPA. However, there are currently limited studies available regarding the effects of vessel disturbance on minke whale.

It is conservatively anticipated there will be a maximum of 39 vessels on site throughout the Offshore Development Area simultaneously during the construction period (excluding pre-construction surveys). This includes vessels that will transit within the Offshore ECC and to and from the Offshore Array Area. It is noted that this total number of simultaneous vessels relates to different activities (e.g. WTG mooring, cable installation), phases and locations. While clusters of vessels will occur around specific activities, the number of vessels within any one cluster will be lower than the maximum simultaneous number on site. The anticipated maximum simultaneous vessels on site associated with cable installation is 24, albeit only a subset of these will be associated with Offshore ECC installation. Similarly, of the ≤ 95 days of anticipated cable laying vessel activity (including Inter-Array Cable installation), only a subset will occur within the boundary of the Southern Trench MPA.

Although there are very few studies that indicate a critical level of activity in relation to behavioural disturbance for minke whale, analysis by Christiansen *et al.* (2013a) estimated energy expenditure of minke whales to be 28% higher during boat interactions, regardless of swim speed. In addition, minke whale foraging activity has been found to decrease with increased vessel interactions (Christiansen *et al.* 2013a), exemplified by shorter dives and changes in movement patterns. However, it was reported that there is no potential for a population-level effect from these acute disturbances (Christiansen *et al.* 2015, Christiansen and Lusseau 2015).

When considering the impacts described above, it is important to note that these results were derived from minke whale interactions with whale-watching vessels. As disturbance effects from whale watching are direct impacts, whilst those from construction activities are indirect, these impacts cannot be directly transposed as the vessel types and underwater noise produced are very different. However, as there are little empirical data on the behavioural plasticity of minke whale as a result of vessel disturbance, the information presented above is used as a proxy to inform this assessment.

Considering the anticipated maximum number of simultaneous vessels in the Offshore Revelopment Area , that only a proportion of which may be transiting through the MPA at any one time, and that vessel number associated with works in the ECC overlapping the MPA will be fewer, it is unlikely that any minke whale-vessel interactions shall be direct and repeated. In addition, as part of the Salamander Project, there is a commitment to the adoption of best practice vessel-handing protocols (e.g., following the Codes of Conduct provided by the WiSe (Wildlife-Safe) Scheme, Scottish Marine Wildlife Watching Code or Guide to Best Practice for Watching Marine Wildlife). These will be incorporated into a Vessel Management Plan (VMP) during construction, and will minimise the potential for any effects of disturbance on minke whales in the MPA. As such, impacts are not anticipated to pose a significant risk to hindering the achievement of the objectives or purpose of the site.

3.2.8 Disturbance from other construction activities

Dredging, drilling, trenching and cable laying activities to create the Offshore ECC during the construction phase will overlap the MPA site boundaries. As such, there is a need to assess the potential for disturbance of minke whales within the Southern Trench MPA as a result of these activities.

Dredging

In northwest Ireland, dredging activities have been linked to reduced minke whale presence (Culloch *et al.* 2016), whilst the distances between minke whale sightings and active construction sites

increased and relative abundance decreased during dredging and blasting activities in Newfoundland (Borggaard *et al.* 1999).

Drilling

Information on the disturbance effects of drilling is limited and the majority of the research available was conducted more than 20 years ago (Sinclair *et al.* 2023). For example, drilling and dredging playback experiments observed that 50% of bowhead whales exposed to noise levels of 115 dB re 1 µPa exhibited some form of response, including changes to calling, foraging and dive patterns (Richardson and Wursig 1990). More recent studies of bowhead whales also observed changes in behaviour from increased drilling noise levels, specifically an increase in call rate. However, the call rate plateaued and then declined as noise levels continued to increase, which could be interpreted as the whales aborting their attempt to overcome the masking effects of the drilling noise (Blackwell *et al.* 2017). Playback experiments of drilling and industrial noise have also been undertaken with grey whales at a noise level of 122 dB re 1 µPa. This resulted in a 90% response from the individuals in the form of diverting their migration track (Malme *et al.* 1984). Overall, the literature indicates that the impacts of drilling disturbance on marine mammals may occur at distances of between 10-20 km, and will vary depending on the species (Greene Jr 1986, LGL and Greeneridge 1986, Richardson and Wursig 1990). Whilst information is not available for impacts of drilling on minke whale, it is still considered useful as it suggests that minke whale may experience disturbance as a result of drilling activities should they occur in areas of the Offshore ECC which overlap with the MPA. Furthermore, drilling is considered under the umbrella of industrial and construction noise, and has similar properties to dredging. Therefore, it is considered that drilling could potentially cause disturbance over distances of up to 5-10 km from the noise source based on results for dredging, or potentially up to 20 km based on results from the drilling literature, although this literature is considered slightly outdated.

Cable laying Activities

Cable installation, including trenching activities, shall occur within an 18-month period; however, only a small portion of this will occur within the Southern Trench MPA. Total cable laying vessel and cable burial vessel days associated with construction are ≤95 days each. There is a lack of information in the literature on disturbance ranges for other cable installation activities such as cable laying, trenching or rock placement. While construction-related activities (acoustic surveys, dredging, rock trenching, pipe laying and rock placement) for an underwater pipeline in northwest Ireland resulted in a decline in harbour porpoise detections, there was a considerable increase in detections after construction-activities ended which suggests that any impact is localised and temporary (Todd *et al.* 2020). Similar observations are also assumed for other cetacean species.

Summary

It is expected that any disturbance impact will be primarily driven by the underwater noise generated by the vessel during non-piling construction-related activities and, as such, it is expected that any impact of disturbance is highly localised (within 5 km). Due to their large size and capacity for energy storage, it is expected that minke whales will be able to tolerate temporary displacement from foraging areas and individuals are expected to be able to recover from any impact on vital rates. Therefore, any disturbance to minke whales arising from that construction activities such as dredging, trenching or cable laying are anticipated to be localised, of short duration and temporary, and impacts are therefore not anticipated to pose a significant risk to hindering the achievement of the objectives or purpose of the Southern Trench MPA.

3.2.9 Indirect impacts on prey

Any change in fish abundance and/or distribution a within the MPA as a result of construction is important to assess as there is the potential for indirect effect on minke whale. During construction, there is the potential for impacts upon prey items, including:

- Increased underwater noise levels;
- Temporary loss of habitat;
- Temporary increase in suspended-solid concentrations and sediment deposition;
- Direct physical damage and disturbance;
- Seabed disturbances leading to the release of sediment contaminants and/or accidental contamination; and
- Changes to supporting seabed habitats arising from effects on physical processes.

Both minke whale adults and juveniles studied within the Southern Trench MPA have a similar foraging preference for sandy gravel sediment types (Robinson *et al.* 2023). Although minke whales exhibit flexibility in their resource preferences when options are limited, the installation of infrastructure in sandy habitats may affect their preferred foraging grounds. It should be noted that the Offshore ECC will not overlap with the areas where forging behaviour of minke whales was recorded (southern coastline of the outer Moray Firth between Lossiemouth and Fraserburgh) (Robinson *et al.* 2009, Robinson *et al.* 2023).

Piling within the Offshore Array Area was assessed to have no significant impacts to sandeel and herring, main prey species of minke whales (see **Section 4.11** of **Volume ER.A.3, Chapter 10: Fish and Shellfish Ecology**). Therefore, it is not expected that piling activities shall have any direct effects on the MPA. In addition, no impacts within the MPA are expected to the structure and function of supporting features, i.e. the benthic substrate prey species rely on, as piling activities will be taking place at the Offshore Array Area.

As highlighted in **Volume ER.A.3, Chapter 10: Fish and Shellfish Ecology**, temporary habitat loss or disturbance during the installation of all assets and placement of vessel anchors on the seabed may have negative impacts upon individual sandeel and herring within the Offshore Development Area. Given that the potential supporting habitat for sandeel and spawning habitat for herring within the Offshore Development Area is limited when compared to the extent of the similar habitat in the wider vicinity of the Salamander Project, population-level effects on both species of minke whale prey are unlikely to occur. All other impacts assessed as part of **Volume ER.A.3, Chapter 10: Fish and Shellfish Ecology** for construction activities (including changes to seabed habitat and temporary increase in suspended sediment/contaminant concentrations) were assessed as having no significant impacts to prey species.

Considering the above, no impacts within the MPA due to other construction activities (such as cable installation within the Offshore ECC) are expected to the structure and function of supporting features, i.e. prey species minke whales rely on, and impacts are not anticipated to pose a significant risk to hindering the achievement of the objectives or purpose of the site.

3.3 Operation and Maintenance Phase

3.3.1 Barrier Effects

The physical presence of array infrastructure at the Offshore Array Area has the potential to create barrier effects, whereby the regular movements of a particular species are impacted by the presence of the wind farm (Onoufriou *et al.* 2021). Throughout the Offshore ECC, the Offshore Export Cable(s) will be buried as a preferred option or will include remedial cable protection where burial is not possible with only Offshore Array Area including a proportion of dynamic cabling. Therefore, this infrastructure is not anticipated to limit the passage of animals across the Offshore ECC.

Although minke whale presence has been recorded around oil and gas structures in the central North Sea (Delefosse *et al.* 2018), there is limited understanding on whether baleen whales can successfully

navigate the spaces between turbines in the array, especially within floating offshore wind arrays where a meaningful proportion of the water column is intersected by mooring lines and cables. A complete design of the array is currently unavailable and therefore it is challenging to estimate the distances between mooring lines and dynamic cables during operation. However, the Offshore Array Area will consist of a maximum 7 WTGs, each with a maximum of 8 mooring lines, totalling up to 56 total mooring lines. Therefore, even if any barrier effects could occur these will be very localised and limited to the Offshore Array Area only, which is located outside of the MPA.

Considering the above, it is not expected that the infrastructure associated with the Salamander Project may prevent or restrict access to the MPA and resources within.

4 Assessment of Potential Impact – Cumulatively with other Projects

4.1 Methodology

4.1.1 Projects

For the purpose of the cumulative assessment for the Southern Trench MPA and project screening, a similar approach to that taken within the RIAA (see **Volume RP.A.1, Report 1: Report to Inform Appropriate Assessment (RIAA)**) has been used. Within the RIAA, projects which fell beyond a 200 km screening distance were scoped out of a qualitative assessment. Given the mobility of minke whales and ability to range over long distances, the 200 km screening distance ensures a balance between conservatism of including projects that may affect minke whales within their Management Unit and those which have a realistic potential to affect them cumulatively with the Project. This resulted in a total of 11 offshore projects included in the cumulative assessment (**Table 11**).

Table 11 Offshore projects screened into the cumulative assessment for the Southern Trench MPA (based on a 200 km screening range, as per the RIAA), piling/main construction timelines (dark blue) and expected O&M phase (light blue) for each.

Plan/Project	Year(s)								
	2023	2024	2025	2026	2027	2028	2029	2030	2031
Salamander									
Public domain information includes a project-level RIAA as a minimum [1]									
Green Volt									
Pentland									
Seagreen 1A									
Moray West									
Berwick Bank									
Inch Cape									
Neart na Gaoithe									
Public domain information limited to Scoping [1]									
Muir Mhor									
Marram Wind									
Caledonia									

1 Indicative timeframe is the same for piling and cable installation activities.

4.1.2 Impacts

The list of impacts with a potential to hinder the achievement of the objectives or purpose of the site cumulatively with other projects is in line with the approach presented in **Section 3.1** for the

Salamander Project alone. The cumulative assessment is based on data for Salamander Project and information available in the public domain for other projects.

All projects considered in **Section 4.1.1** are expected to put in place an MMMP to reduce the risk of injury (PTS) to negligible levels. Therefore, it is expected that there will no cumulative effect on the MPA as a result of auditory injury (PTS) from underwater noise generated by offshore activities associated with any of the projects.

To summarise, the following impacts have been considered in the cumulative assessment for the construction phase:

- Disturbance from piling;
- Disturbance from UXO clearance;
- Disturbance from other construction activities and vessels;
- Disturbance from geophysical surveys; and
- Indirect impacts on prey.

Additionally, for the operation and maintenance phase, the cumulative effects as a result of presence of floating offshore wind farms and cumulative disturbance from geophysical surveys were considered.

In line with the approach presented for the Project Alone, several potential impacts were scoped out from further consideration in the cumulative assessment (see **Table 2**).

4.2 Construction Phase

4.2.1 Underwater noise

4.2.1.1 Piling

The EIAR (**Volume ER.A.3, Chapter 11: Marine Mammals**) presented the predicted number of minke whales that may be disturbed by piling cumulatively on an annual basis by projects across the period between 2023 to 2031. Of these, 11 offshore wind projects are located within the 200 km screening range for RIAA and are thus included in the cumulative assessment for piling (**Table 11**). Of the projects screened into the cumulative assessment for piling, only Caledonia is expected to have construction timelines that overlap with the Salamander Project indicative 2028 piling window (**Table 11**).

Across the timeframe of disturbance from cumulative projects (2023 to 2031), the Salamander Project will contribute to the overall level of disturbance within the MPA. However, piling is expected to be taking place only within the array areas of respective projects. None of the projects considered in the cumulative assessment have the array area overlapping with the Southern Trench MPA, although some of the projects are located in the close vicinity, e.g. Caledonia, Moray West, Muir Mhor, Marram Wind, Green Volt (**Table 11**). Moray Offshore Windfarm (West) Limited (2023) reported that there will be no overlap between the MPA and noise contours above 155 dB. For contours lower than 155 dB, the predicted effective disturbance area represented up to 42% of the MPA. However, most of this disturbance would be occurring in non-summer months within one annual cycle and will not contribute to a long-term decline in the use of the MPA by minke whales. Given that the construction at Moray West is anticipated to be completed in 2024, four years before piling at the Salamander Project commences, the potential for cumulative effects between the two projects is limited.

Of those projects with greater potential for temporal overlap in piling with Salamander, only Green Volt have the quantitative assessment available in the public domain (Royal HaskoningDHV 2023) and data for other projects is limited resulting in uncertainty about the duration of construction activities

within the Southern Trench MPA. None of the predicted impact ranges for minke whale as a result of piling at Green Volt will overlap with the Southern Trench MPA.

Although piling may be taking place intermittently over a number of years, even if the noise contours overlap with the MPA, it is unlikely to change minke whale distribution within the site on a sustained basis. It may result in temporary changes in behaviour (e.g. feeding and/or breeding) (Sivle *et al.* 2015, McGarry *et al.* 2017, Durbach *et al.* 2021) including fleeing (McGarry *et al.* 2017). Minke whales are capital breeders and therefore their reproductive success could be affected by disrupted feeding activities (Stephens *et al.* 2009, Christiansen *et al.* 2013b) and the Southern Trench represent important foraging area (NatureScot 2020, Robinson *et al.* 2023). Therefore, the magnitude of impact on minke whales would depend on the extent of overlap of noise contours with the MPA and duration of piling at respective projects. It is important to note that piling at Salamander Project is expected to take place over between 20 to 80 days with 40 days being the most realistic estimate (see **Volume ER.A.3, Chapter 11: Marine Mammals**).

Considering the above, the piling activities cumulatively with other projects are unlikely to:

- contribute to long term decline in the use of the site by minke whale; and
- change to the distribution of minke whale on a continuing or sustained basis.

Based on sightings collated between 2011 and 2022, Robinson *et al.* (2023) reported that it is most probably to encounter minke whale adult and juvenile within 5.52 km and 2.66 km from the shore, respectively. In line with results presented on **Figure 5** to **Figure 8**, due to the location of the Offshore Array Area, the noise overlap with coastal areas alongside the southern coastline of the Moray Firth is limited. Animals may choose to cease foraging in response to noise by fleeing the affected area, however, it is anticipated that individuals will recommence these activities following cessation of impact (underwater noise). Given lack of temporal overlap between piling phases (**Table 11**), piling activities at respective projects are not anticipated to displace animals from alternative feeding grounds within the site. As such, piling cumulatively with other projects is unlikely to alter minke whale behaviour such that it reduces ability of the species to feed efficiently or breed for prolonged periods of time and therefore its survival will not be affected.

4.2.1.2 UXO

Presence of UXOs within the array areas and ECCs of respective projects may cause a safety issue and therefore clearance campaign is usually undertaken prior to the commencement of the construction phases (**Table 11**). As such, it is expected that UXO clearance may be taking place within the MPA at projects with ECCs potentially overlapping with the MPA (Green Volt, Muir Mhor, Salamander, Marram Wind, Caledonia) between 2023 to 2031. The UXO clearance at the Salamander Project is anticipated to take place in 2026 (see **Section 4.6** of **Volume ER.A.2, Chapter 4: Project Description**). Considering that the UXO clearance is undertaken prior to the construction commencement at other projects, there is potential for temporal overlap with Green Volt and Caledonia (**Table 11**).

Out of all projects with ECCs potentially overlapping with the MPA, only Green Volt have the quantitative assessment available in the public domain. The project assumed low-order clearance as standard with high-order clearance only to be undertaken where the former is not possible or failed (Royal HaskoningDHV 2023). For low-order UXO clearance, Royal HaskoningDHV (2023) predicted a disturbance range of 5 km. Due to the lack of empirical evidence of minke whale avoidance from such events, assessment in **Volume ER.A.3, Chapter 11: Marine Mammals** assumed that behavioural disturbance may take place within 26 km EDR, although that is highly precautionary (it is based on harbour porpoise sensitivity to underwater noise as per JNCC (2020a). It is expected that the detonation of a UXO would elicit a startle response and potentially very short-duration behavioural responses and would therefore not be expected to cause widespread and prolonged displacement (JNCC 2020b).

As such, cumulatively, the UXO clearance is not expected to:

- contribute to long term decline in the use of the site by minke whale;
- change to the distribution of minke whale on a continuing or sustained basis; and
- alter minke whale behaviour such that it reduces ability of the species to feed efficiently, breed or survive.

4.2.1.3 Disturbance from other construction activities and vessels

Construction activities at projects with ECCs potentially overlapping with the MPA (Green Volt, Muir Mhor, Salamander, Marram Wind, Caledonia) are anticipated to take place between 2027 to 2031. It should be noted that cable installation at the Salamander Project will take only 18 months within three years of construction phase (2026 to 2028) and not all activities will be taking place within the Southern Trench MPA. Additionally, the Offshore ECC will not overlap with the areas where high densities of minke whale have been recorded (southern coastline of the outer Moray Firth between Lossiemouth and Fraserburgh) (Robinson *et al.* 2009, Robinson *et al.* 2023). Based on project timelines provided in **Table 11**, temporal overlap with Green Volt and Caledonia cannot be discounted.

Only Green Volt have the quantitative assessment available in the public domain (Royal HaskoningDHV 2023) and data for other projects is limited resulting in uncertainty about the duration of construction activities within the Southern Trench MPA. Royal HaskoningDHV (2023) assessed that activities such as cable trenching, cutting, cable laying and vessel activity, which will be taking place within the MPA, may disturb minke whales out to 9,284 m, affecting up to 11 minke whales during construction phase.

As presented in **Section 3.2.8** for the Salamander Project alone, dredging activities have been linked to reduced minke whale densities (Borggaard *et al.* 1999, Culloch *et al.* 2016). The literature indicates that the impacts of drilling disturbance on marine mammals may occur at distances of between 10-20 km and will vary depending on the species (Greene Jr 1986, LGL and Greeneridge 1986, Richardson and Wursig 1990). In line with findings of a study measuring the harbour porpoise response to construction-related activities, any impact on minke whales is anticipated to be localised and temporary (Todd *et al.* 2020).

Considering the above, the construction activities cumulatively with other projects are unlikely to:

- contribute to long term decline in the use of the site by minke whale; and
- change to the distribution of minke whale on a continuing or sustained basis.

Animals may choose to cease foraging in response to noise by fleeing the affected area; however, it is anticipated that individuals will recommence these activities following cessation of impact (underwater noise). As such, construction activities cumulatively with other projects are unlikely to alter minke whale behaviour such that it reduces ability of the species to feed efficiently or breed for prolonged periods of time and therefore its survival will not be affected.

4.2.1.4 Disturbance from geophysical surveys

Construction activities at projects with ECCs potentially overlapping with the MPA (Green Volt, Muir Mhor, Salamander, Marram Wind, Caledonia) are anticipated to take place between 2027 to 2031. Only Green Volt have the quantitative assessment available in the public domain and considered underwater noise from geophysical surveys as potential effect on marine mammals (Royal HaskoningDHV 2023). Other projects in their respective Scoping Reports identify geophysical surveys as a part of the construction phase (Caledonia Offshore Wind Farm Limited 2022, Marram Wind 2023, Muir Mhor 2023). Although the temporal overlap is unlikely, geophysical surveys taking place within the MPA and producing noise at respective projects could lead to a longer duration of effect.

As a part of the Green Volt project, geophysical surveys may be taking place within the MPA and maximum disturbance ranges of 1,425 m were assessed for disturbance (Royal HaskoningDHV 2023). This represents a relatively small proportion of the MPA that may experience temporary disturbance effects from a transient source. It is noted that Green Volt committed to best practice mitigation for geophysical surveys as per the JNCC (2017) guidelines to reduce potential impacts to minke whale within the site between June and October.

As presented in **Section 3.2.6** for the Salamander Project alone, there is no potential for disturbance effects to occur through use of MBES and SSS. The effect behavioural disturbance as a result of SBPs and USBL is considered to be intermitted over the duration of the survey (short-term) and reversible. It should be also noted that the Offshore ECC will not overlap with the areas where high densities of the minke whales (southern coastline of the outer Moray Firth between Lossiemouth and Fraserburgh) have been recorded (Robinson *et al.* 2009, Robinson *et al.* 2023).

Considering the above, geophysical surveys cumulatively with other projects are unlikely to:

- contribute to long term decline in the use of the site by minke whale; and
- change to the distribution of minke whale on a continuing or sustained basis.

Animals may choose to cease foraging in response to noise by fleeing the affected area; however, it is anticipated that individuals will recommence these activities following cessation of impact (underwater noise). As such, geophysical surveys cumulatively with other projects are unlikely to alter minke whale behaviour such that it reduces ability of the species to feed efficiently or breed for prolonged periods of time and therefore its survival will not be affected.

4.2.2 Indirect impacts on prey

The cumulative impacts on fish and shellfish receptors are considered in **Volume ER.A.3, Chapter 10: Fish and Shellfish Ecology**. The assessment concluded that due to limited footprints of works at the Offshore Development and localised effects, there will be no potential for cumulative effects for temporary habitat loss or disturbance and fish aggregation around the floating substructures and associated infrastructure.

Cumulative effects were considered for impacts such as disturbance or damage to sensitive species due to underwater noise generated from construction and operation and maintenance activities, temporary increases in suspended sediment concentrations and potential sedimentation/smothering of fish and shellfish, ghost fishing due to lost fishing gear becoming entangled in installed infrastructure and decommissioning. The cumulative assessment concluded no significant effects on fish and shellfish receptors.

It should be highlighted that the Offshore ECC will not overlap with the areas where forging behaviour of minke whales was recorded (southern coastline of the outer Moray Firth between Lossiemouth and Fraserburgh) (Robinson *et al.* 2009, Robinson *et al.* 2023). A few other projects are planning to install the ECCs within the MPA (Green Volt, Muir Mhor, Salamander, Marram Wind, Caledonia). Impacts associated with these projects are expected to be localised within respective ECCs within various timeframes (**Table 11**) and therefore there is limited potential for cumulative effects between projects.

Considering the above, the extent and distribution of any supporting feature upon which minke whale is dependent (i.e., their prey) is not expected to be adversely affected in the long term and cumulative impacts are not anticipated to pose a significant risk to hindering the achievement of the objectives or purpose of the site.

4.3 Operation and Maintenance Phase

4.3.1 Barrier Effects

In addition to the Salamander Project, there will be four offshore wind projects installed in the vicinity of the Southern Trench MPA, all using floating designs (Green Volt, Muir Mhor, Marram Wind and Caledonia). Only Green Volt have the quantitative assessment available in the public domain (Royal HaskoningDHV 2023). Although data for other projects is limited, in the respective Scoping Reports other projects suggested that export cable burial will be the preferred option (Caledonia Offshore Wind Farm Limited 2022, Marram Wind 2023, Muir Mhor 2023). As such, there will be no barrier effects across the ECCs, and it can be assumed that only array areas will include a proportion of dynamic cabling. Therefore, no physical barriers are anticipated to be present within the MPA boundaries.

As previously discussed in **Section 3.3.1**, there is limited understanding on whether baleen whales can successfully navigate the spaces between turbines in the array, especially within floating offshore wind arrays where meaningful proportion of the water column is intersected by mooring lines and cables. It is however anticipated that, even if any barrier effects could occur these will be very localised and limited to the respective array areas only, each located outside of the MPA.

Considering the above, it is not expected that the infrastructure associated with the Salamander Project may prevent or restrict access to the MPA and resources within.

4.3.2 Disturbance from geophysical surveys

Geophysical surveys are anticipated to take place intermittently during the operation and maintenance of projects with ECCs potentially overlapping with the MPA (Green Volt, Muir Mhor, Salamander, Marram Wind, Caledonia). The temporal overlap of such surveys taking place is unlikely but cannot be excluded. In line with the cumulative assessment presented for the construction phase in **Section 4.2.1.4**, any behavioural effects are considered to be intermitted over the duration of the survey (short-term) and reversible. It should be noted that the Offshore ECC will not overlap with the areas where high densities of the minke whales (southern coastline of the outer Moray Firth between Lossiemouth and Fraserburgh) have been recorded (Robinson *et al.* 2009, Robinson *et al.* 2023).

Considering the above, the geophysical surveys cumulatively with other projects are unlikely to:

- contribute to long term decline in the use of the site by minke whale; and
- change to the distribution of minke whale on a continuing or sustained basis.

Animals may choose to cease foraging in response to noise by fleeing the affected area; however, it is anticipated that individuals will recommence these activities following cessation of impact (underwater noise). As such, geophysical surveys cumulatively with other projects are unlikely to alter minke whale behaviour such that it reduces ability of the species to feed efficiently or breed for prolonged periods of time and therefore its survival will not be affected.

5 Conclusion

In conclusion, activities associated with construction, operation and maintenance of the Salamander Project alone and cumulatively with other projects are not anticipated to pose a significant risk of hindering the achievement of the conservation objectives, as defined in Section 5 of the 2020 Order and site-specific advice (NatureScot 2020), for the minke whale feature of the Southern Trench MPA.

More specifically, piling activities at the Offshore Array Area shall not cause any significant risks to auditory injury of minke whales within the Southern Trench MPA, and shall not reduce absolute densities of minke whales within the MPA. The total number of 80 piling days (under a worst-case scenario) occurring within one annual cycle shall not contribute to any long-term declines in the use

of the MPA by minke whales, or to changes in their distribution within the MPA on a continuing/sustained basis. Moreover, piling shall not contribute to long-term changes in the behaviour of minke whale within the MPA and shall not reduce the ability of the species to feed efficiently or survive. Although there is a risk of auditory injury to minke whales as a result of UXO clearance within the Offshore Array Area and the Offshore ECC, this will be reduced by the implementation of mitigation measures in the UXO-specific MMMP. Each UXO detonation will be of a short-term duration and, therefore, it is not expected that disturbance from a UXO detonation would result in any disturbance within the MPA. The risk of injury during the geophysical surveys will be reduced by implementation of JNCC (2017) guidelines and the disturbance as a result of the geophysical surveys (during construction and operation and maintenance) is expected to be localised and short-term. Similarly, disturbance as a result of other construction activities (dredging, drilling, cable laying) is expected to be localised, short-term and temporary. Due to the low numbers of vessels expected during construction of the Offshore ECC, and thus within the MPA, disturbance of minke whales from vessel activities shall not occur at levels at which long-term declines in the use of the MPA, or changes in the distribution of minke whale within the MPA on a continuing/sustained basis are expected. No significant impacts to prey are expected directly from piling or indirectly to the benthic substrate of the MPA. Although the potential for barrier effects due to the presence of floating WTGs, mooring lines and dynamic cables cannot be excluded, it will be restricted only to the Offshore Array Area which is located outside of the MPA.

Due to the lack of temporal overlap, piling at the Salamander Project and other projects is unlikely to have cumulative effects. However, across the cumulative timeframe (2023 to 2031), the Salamander Project will contribute to the overall level of disturbance within the MPA. Given that piling will occur outside of the MPA, intermittently across the years, it is unlikely to contribute to long-term decline or change to distribution of minke whale within the MPA on sustained basis. However, as in the case of other noise-producing activities with potential to take place within the MPA (geophysical surveys, UXO, other construction activities), minke whales may cease foraging in response to noise by fleeing the affected area. It is anticipated that individuals will recommence these activities following cessation of impact and therefore noise-producing activities at Salamander Project cumulatively with other projects are unlikely to alter minke whale behaviour such that it reduces ability of the species to feed efficiently or breed for prolonged periods of time. The cumulative assessment concluded no significant impacts on minke whale prey species. Additionally, although the potential for barrier effects due to the presence of floating offshore wind farms and associated infrastructure cannot be excluded, it will be restricted only to the respective array areas which are located outside of the MPA and is not considered capable of hindering the site's conservation objectives.

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