11.9.2.9 Overall, these studies suggest that there is a high likelihood that marine mammals will avoid vessels and therefore, collision, suggesting a low vulnerability. It is important to note that not all collisions that do occur are lethal, and there is a potential for recovery from injury. Furthermore, vessel collision is not considered to be a significant cause of marine mammal mortality (CSIP, 2019), but does have the potential to kill animals. As a result, all marine mammal species within this assessment are considered to be of reasonable adaptability, limited to no tolerance, have medium-term to no recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a High sensitivity to injury from vessel activities.

DISTURBANCE FROM VESSEL ACTIVITIES

HARBOUR PORPOISE

11.9.2.10 Harbour porpoises are particularly sensitive to high frequency noise and it is well documented that they typically avoid vessels (Culloch *et al.*, 2016; Benhemma-Le Gall *et al.*, 2021). During the construction of Beatrice and Moray East offshore windfarms in the Moray Firth, harbour porpoise occurrence decreased with increasing vessel presence, with the magnitude of decrease depending on the distance to the vessel (Benhemma-Le Gall *et al.*, 2021). As such, the probability of harbour porpoise occurrence at a mean vessel distance of 2 km decreased by up to 95% to 0.02 for the highest vessel intensity (Benhemma-Le Gall *et al.*, 2021). At a mean vessel distance of 3 km, the probability decreased by up to 57% to 0.16 for the highest vessel intensity, and no apparent response was observed at 4 km (Benhemma-Le Gall *et al.*, 2021).

11.9.2.11 Additional studies conducted during offshore windfarm construction demonstrated that harbour porpoise detections in the vicinity of the pile driving location decline prior to a piling event (Benhemma-Le Gall *et al.* 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018). For example, during a study conducted at seven offshore windfarms in the German Bight, a decline in harbour porpoise detections was observed within 2 km of the construction site and continued to be reduced for one to two days after (Brandt *et al.*, 2018). This was attributed to the increased vessel activity and traffic associated with construction-related activities (Brandt *et al.*, 2018).

11.9.2.12 In a large-scale study of harbour porpoise density in UK waters, increased vessel activity was generally associated with lower harbour porpoise densities (Heinänen and Skov, 2015). Furthermore, Wisniewska *et al.*, (2018) collected telemetry data to study the change in foraging rates of harbour porpoise in response to vessel noise in highly trafficked coastal waters in the inner Danish waters and Belt seas. The results show that occasional high-noise levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 µPa (16 kHz third-octave) (Wisniewska *et al.*, 2018).

11.9.2.13 Land-based surveys were conducted to examine the surfacing behaviour of harbour porpoise in relation to vessel traffic in Swansea Bay (Oakley *et al.*, 2017). The study found a significant correlation between harbour porpoise sightings and the number of vessels present, with 26% of interactions observed considered to be negative (animals moving away or prolonged diving) when vessels were up to 1 km away (Oakley *et al.*, 2017). The proximity of the vessel was found to be an important factor, with the greatest response occurring at 200 m from the vessel (Oakley *et al.*, 2017). Smaller motorised vessels (jet ski, speed boat, small fishing vessels) were associated with more negative behaviours than large cargo ships, although larger ships were less common in the area (Oakley *et al.*, 2017).

11.9.2.14 Behavioural responses of harbour porpoises to vessel noise have also been observed in more controlled conditions. For example, behavioural responses of four harbour porpoise in a semi-natural net pen were observed during exposure to low levels of medium to high frequency vessel noise (Dyndo *et al.*, 2015). 'Porpoising' (a stereotypical disturbance behaviour) was observed during 27.5% of recordings of boat noise (Dyndo *et al.*, 2015).

11.9.2.15 These studies discussed above evidence some changes in harbour porpoise behaviour and presence as a result of disturbance from vessel activity. Behavioural responses include increased fluking, interrupted foraging, change to vocalisations, prolonged dives and directed movement away from the sound source (Oakley *et al.*, 2017; Wisniewska *et al.*, 2018). Several studies have also evidenced an increase in vessel presence correlates with a decrease in harbour porpoise presence (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018). However, harbour porpoises occur widely throughout the Irish Sea (Berrow *et al.*, 2010; Rogan *et al.*, 2018a; Wall *et al.*, 2013) and therefore it is assumed (since they have a requirement to feed regularly) that there is suitable foraging habitat across their range. Therefore, relatively short-term localised disturbance within the vicinity of the Proposed Development is unlikely to lead to any population-level effects on harbour porpoise. As a result, harbour porpoises are considered to be of reasonable adaptability, limited tolerance, have high recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

BOTTLENOSE DOLPHIN

11.9.2.16 Studies on the interactions of bottlenose dolphins with vessels have shown various responses. In the Moray Firth, a passive acoustic monitoring study showed that the presence of vessels resulted in a short-term reduction in foraging activity by 49%, with animals resuming foraging after the vessel had travelled through the area, suggesting that disturbance was limited to the time the vessel was physically present (Pirotta *et al.*, 2015). As a result, the study concluded that the physical presence of vessels plays a larger role in disturbance, as vessel noise was not taken into consideration (Pirotta *et al.*, 2015).

11.9.2.17 In a modelling study by Lusseau *et al.* (2011), it was predicted that increased vessels movements associated with offshore wind development in the Moray Firth did not have a negative effect on the local population of bottlenose dolphins, although it did note that foraging may be disrupted by disturbance from vessels. Mathematical modelling was also conducted by New *et al.* (2013) to simulate the complex interactions of the bottlenose dolphin population in the Moray Firth and determine whether an increased rate of disturbance from vessel traffic from proposed offshore developments was biologically significant. The study statistically modelled an increase in vessel traffic from 70 to 470 vessels per year and found that an increase in commercial vessel traffic alone will not result in a biologically significant increase in disturbance, because dolphins have the ability to compensate for their immediate behavioural response. Therefore, their health and vital rates were predicted to be unaffected (New *et al.*, 2013).

11.9.2.18 Bottlenose dolphins have also been observed tolerating vessel disturbance, particularly in areas where vessel traffic has always been high (Pirotta *et al.* 2013). Similarly, the presence of bottlenose dolphin was positively correlated with overall vessel number during the construction works of an oil pipeline in Broadhaven Bay, northwest Ireland (Anderwald *et al.*, 2013). However, it was unclear whether the bottlenose dolphins were attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time (Anderwald *et al.*, 2013).

11.9.2.19 A study of Indo-Pacific bottlenose dolphin habitat occupancy along the coast of Western Australia found dolphin density to be negatively affected by vessels at one site, but no significant impact at the other (Marley *et al.*, 2017a). It is hypothesised that the quality of the habitat impacts the behavioural response to disturbance as the latter habitat is a known foraging area. Other studies along the coast of Western Australia have found that increased vessel presence was associated with significantly increased swim speeds for individuals when resting or socialising (Marley *et al.*, 2017b). Animals exposed to high levels of shipping traffic were also found to spend more time travelling and less time resting or socialising. The study also found that the whistle characteristics changed with increased broadband exposure, with the greatest variation occurring in the presence of low frequency noise (Marley *et al.*, 2017b). Other studies have reported similar

findings, for example, common bottlenose dolphins in Galveston Ship Channel, US, found that the presence of vessels was associated with significantly less foraging and socialising activity (Piwetz, 2019). For this population, a significant increase in swimming speeds was observed during the presence of recreational and tourism vessels, and shrimp trawlers (Piwetz, 2019).

11.9.2.20 Bottlenose dolphins have also been known to exhibit different behavioural responses to different vessel types. A study conducted in New Zealand showed that bottlenose dolphin resting behaviour decreased as the number of dolphin-watching tour boats increased (Constantine *et al.*, 2004). In a study conducted in Italy, dolphins exhibited an avoidance response to motorboats, but changed their acoustic behaviour in response to trawler vessels, presumably to compensate for masking (La Manna *et al.*, 2013). This study also found that bottlenose dolphins would tolerate vessel presence within certain levels and were more likely to leave an area if disturbance was persistent (La Manna *et al.*, 2013). Therefore, the degree to which an individual is disturbed is likely linked to their baseline level of tolerance (Bejder *et al.*, 2009).

11.9.2.21 These studies show that vessel disturbance can result in a variety of responses in bottlenose dolphins including changes to foraging behaviour, swim speed, behavioural state, and acoustic behaviour, and can cause avoidance responses (Constantine *et al.*, 2004; La Manna *et al.*, 2013; Marley *et al.*, 2017a; Marley *et al.*, 2017b; Pirotta *et al.*, 2015). However, where behavioural changes in bottlenose dolphins occur, predictive modelling of high levels of vessel disturbance has concluded that this is not biologically significant to a small population of bottlenose dolphins in the Moray Firth (New *et al.*, 2013). As a result, bottlenose dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, bottlenose dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

RISSO'S DOLPHIN

11.9.2.22 Limited information is available on the behavioural responses of Risso's dolphins to vessel disturbance. However, several studies have shown that vessel traffic can affect the behaviour, activity, energy budgets, habitat use, and reproductive success of dolphin species (Bejder *et al.*, 2006; Lusseau, 2003; 2004). A study on the behavioural responses of Risso's dolphins to vessel traffic in Pico, Azores suggested a disruption of resting behaviour by cetacean watching vessels (Visser *et al.*, 2006). In the Ionian Sea, a study on the impacts of cetacean watching vessels on behavioural activities of Risso's dolphins observed a neutral response to the presence of the vessel during 81.3% of sightings (Bellomo *et al.*, 2021).

11.9.2.23 As limited information exists on the behavioural response of Risso's dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on Risso's dolphin behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction and O&M vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups. As a result, Risso's dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, Risso's dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

COMMON DOLPIN

11.9.2.24 Limited information is available on the behavioural responses of common dolphins to vessel disturbance. Marine mammal monitoring in Broadhaven Bay, northwest Ireland showed that an increase in vessel numbers resulted in a reduction in common dolphin presence (Culloch *et al.*, 2016).

11.9.2.25 Studies on disturbance effects from cetacean watching vessels reports that common dolphins spent significantly less time foraging when interacting vessels were present (Meissner *et al.*,

2015). Once disrupted, dolphins took at least twice as long to return to foraging when compared to control conditions (vessels >300 m away from dolphins) (Meissner *et al.*, 2015). The study also found that the probability of common dolphins starting to forage while engaged in travelling in the presence of cetacean watching vessels decreased by two thirds (Meissner *et al.*, 2015). Common dolphin foraging tactics include cooperative herding of prey (Neumann and Orams, 2003), therefore it is possible that the behavioural changes of some individuals within a group, as a result of approaching vessels, could compromise the success of the overall foraging event (Meissner *et al.*, 2015).

11.9.2.26 As limited information exists on the behavioural response of common dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on common dolphin behaviour have also been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction, O&M, and decommissioning vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups. As a result, common dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, common dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

MINKE WHALE

11.9.2.27 Limited information is available on the behavioural responses of minke whales to vessel disturbance. A study into the response of minke whales to construction-related vessel traffic in Broadhaven Bay, northwest Ireland found a significant negative correlation between the presence of minke whale and both the number of overall vessels and the number of utility vessels (those emitting lower frequency noise but moving around more than construction vessels), suggesting that minke whale were displaced from the area, most likely due to vessel presence and/or disturbance (Anderwald *et al.*, 2013).

11.9.2.28 A study by Christiansen *et al.* (2013) showed that minke whales change their diving patterns and behaviour in response to disturbance from whale watching vessels. Analysis of respiration rates found that energy expenditure of minke whales was 28% higher during vessel interactions (regardless of swim speed) and swim speed was found to increase with vessel presence (Christiansen *et al.*, 2013). These combined physiological and behavioural changes are considered to represent a stress response. The study also suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success (Christiansen *et al.*, 2013). It is important to note that noise levels were not measured in this study, therefore behavioural responses are considered to be related to vessel presence.

11.9.2.29 Christiansen *et al.* (2015) considered the spatial and temporal rates of minke whale exposure of the entire whale watching season and found no potential for a population-level effect as a result of disturbance.

11.9.2.30 The bioenergetic effects of disturbance from whale watching vessels on foetal growth were examined by Christiansen and Lusseau (2015) using a mechanistic model and found that the presence of whale watching vessels resulted in an immediate reduction in net energy intake by 63.5%. However, the impact of disturbance was negligible because it was considered below the threshold value for which whale watching vessels would have a significant impact on foetal growth, as the number of interactions with vessels was low during the foraging season (Christiansen and Lusseau, 2015).

11.9.2.31 It is expected that minke whales are more sensitive to low frequency sounds (Nowacek *et al.*, 2007) such as those produced by slow moving vessels, although limited information exists on the behavioural response of minke whales to construction-related vessels. Studies on the impact of whale watching vessels on minke whale behaviour have therefore been presented as a proxy to

inform this assessment, although it is important to note that disturbance effects from whale watching vessels are direct, whilst those from construction and O&M vessels would be indirect. As a result, minke whales are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, minke whale are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

GREY SEAL

11.9.2.32 Seals are particularly sensitive to disturbance in regions where vessel traffic overlaps with productive coastal waters (Robards *et al.*, 2016). Vessel disturbance may be particularly detrimental to grey seal if it changes their haul-out patterns or reduces the time they are able to spend resting or nursing pups during the breeding season. When disturbed, seals that are hauled-out typically 'flush' (enter) into the water which could be detrimental during pupping season (Terhune and Almon, 1983; Johnson and Acevedo-Gutiérrez, 2007). Key haul-outs for grey seal in proximity to the Proposed Development are at Arklow, co. Wicklow, along the coast of co. Dublin, and around Wexford Harbour (Duck and Morris, 2013; Morris and Duck, 2019).

11.9.2.33 Britton (2012) recorded a significant correlation between boat speed and the distance at which hauled-out grey seals on the Isle of Man showed alert behaviour. A similar association was also observed between boat speed and movement and flushing response (entering the water) although this was not tested. The duration of the boat interaction was, however, found to be important, with flushing occurring in all vessel interactions lasting four minutes or longer (Britton, 2012).

11.9.2.34 A study of grey seal pup tracks in the Celtic Sea and adult grey seals in the English Channel found that no animals were exposed to cumulative shipping noise that exceeded thresholds for TTS (using the Southall *et al.* (2019) thresholds (Trigg *et al.*, 2020).A study of vessel traffic and marine mammal presence at Broadhaven Bay, northwest Ireland found grey seals sightings decreased with increased vessel activity in the surrounding area, though the effect size was small, and the relationships between sightings and vessel numbers were weaker than those with environmental variables such as sea state (Anderwald *et al.*, 2013).

11.9.2.35 Grey seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, grey seals are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

HARBOUR SEAL

11.9.2.36 Seals are particularly sensitive to disturbance in regions where vessel traffic overlaps with productive coastal waters (Robards *et al.*, 2016). Vessel disturbance may be particularly detrimental to harbour seal if it changes their haul-out patterns or reduces the time they are able to spend resting or nursing pups during the breeding season. When disturbed, seals that are hauled-out typically 'flush' (enter) into the water which could be detrimental during pupping season (Johnson and Acevedo-Gutiérrez, 2007). Key haul-outs for harbour seal in proximity to the Proposed Development are at Arklow, co. Wicklow, along the coast of co. Dublin, and around Wexford Harbour (Duck and Morris, 2013; Morris and Duck, 2019).

11.9.2.37 Avoidance behaviour or alert reactions have been reported in harbour seal when vessels approach within 100 m of a haul-out (Richardson *et al.*, 1995). A study in which 37 harbour seals were telemetry tagged on the east coast of Scotland did not show any apparent response of seals at sea to close passing vessels (they neither moved towards nor away from them) (Onoufriou *et al.*, 2016).

11.9.2.38 Another telemetry study that included the tagging of 28 harbour seals in the UK found high exposure levels of harbour seals to shipping noise, and as a result 20 individuals may have experienced a TTS due to cumulative SELs exceeded the TTS-threshold for pinnipeds exposed

to continuous underwater noise (183dB re 1 μPa^2_s) (Jones *et al.*, 2017). The overlap between seals and vessel activity most frequently occurred within 50 km of the coast and in proximity to seal haul-outs. The study concluded that there was no evidence of reduced harbour seal presence as a result of vessel traffic, despite the spatial overlap and cumulative SELs (Jones *et al.*, 2017).

11.9.2.39 Harbour seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour seals are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

Construction phase

MAGNITUDE OF IMPACT

11.9.2.40 During the construction phase, a maximum of 66 installation vessels will be present within the Array Area at any one time, resulting in a maximum of 4,150 vessel return trips over the five-year construction period, and a maximum of 1,797 vessel return trips per year (Table 11.9). Vessels that will be used during the construction phase include jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels, and other support vessels (Table 11.9).

INJURY FROM VESSEL ACTIVITIES

11.9.2.41 Vessel traffic associated with the Proposed Development has the potential to lead to an increase in vessel movements within the Marine Mammal Study Area. This increase in vessel movement could lead to an increase in interactions between marine mammals and vessels during offshore construction. Whilst a broad range of vessel types have been involved in collisions with marine mammals (Laist *et al.*, 2001), vessels travelling at higher speeds pose a higher risk because of the potential for a stronger strike impact (Schoeman *et al.*, 2020). For example, a study by Laist *et al.* (2001) found that in 89% of collisions in which the whale was killed or seriously injured vessels were travelling at speeds of 14 Kn (7 m/s) or more, and the vessel exceeded a length of 80 m. Therefore, larger vessels travelling at 7 m/s or faster are those most likely to cause death or serious injury to marine mammals (Laist *et al.*, 2001). The majority of vessels used during the construction phase are likely to be large vessels that will either be travelling considerably slower than 7 m/s or will be stationary for significant periods of time. Therefore, the actual increase in vessel traffic moving within the Proposed Development and to/from port will occur over short periods of the offshore construction activity. Smaller vessels involved in construction activities (i.e. tug/anchor handlers, guard vessels, survey vessels, and crew transfer vessels) are able to move to avoid marine mammals (when detected), even when an animal is close and the vessel is going at high speed, due to better manoeuvrability compared to larger vessels (Schoeman *et al.*, 2020). In contrast, large vessels, such as jack-up vessels, have low manoeuvrability and may require larger distances to avoid an animal, but travel at slower speeds. In addition, the Factored In Measures (see Table 11.15) which include an EVMP, will advise that vessel traffic will move along predictable routes, which is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.*, 2001; Lusseau 2003; 2006). The EVMP will also provide best practice guidance to minimise interactions with marine mammals and define how vessels should behave in the presence of them.

11.9.2.42 It is also likely that the noise emissions from vessels involved in the construction phase will be detectable by marine mammals and therefore will deter animals from the areas of potential impact. Whilst construction of the Proposed Development will lead to an uplift in vessel activity, vessel movements will be largely restricted to within the Array Area or along the Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Due to the volume of

vessel traffic around the Marine Mammal Study Area already, the introduction of additional vessels during the construction phase of the Proposed Development will not be a novel impact for marine mammals present in the area. Therefore, it is not expected that vessel activities during the construction phase would increase the risk of injury due to vessel collision.

11.9.2.43 The impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the construction phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.44 Disturbance to marine mammals by vessels will be driven by a combination of underwater noise and the physical presence of the vessel itself (Pirotta *et al.*, 2015). It is not simple to disentangle these drivers, therefore, disturbance from vessels is assessed within this Chapter in general terms, covering disturbance driven by both vessel presence and underwater noise.

11.9.2.45 Noise levels from construction vessels will result in an increase in non-impulsive, continuous sounds primarily from propellers, thrusters, and various rotating machinery in the vicinity of the Proposed Development. The main drivers influencing the magnitude of potential impact with respect to noise disturbance from vessels are vessel type, speed and ambient noise levels (Wilson *et al.*, 2007). Disturbance from vessel noise is likely to occur only when vessel noise associated with the construction of the Proposed Development exceeds the background ambient noise level.

11.9.2.46 Vessel noise levels are typically in the range of 10 to 100 Hz (Erbe *et al.*, 2019) with an estimated source level of 168 SEL_{cum} dB re 1 µPa @ 1 m (Root Mean Square (RMS)) for large construction vessels and 161 SEL_{cum} dB re 1 µPa @ 1 m (RMS) for medium construction vessels, travelling at a speed of 10 knots (see Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026)). In general, support and supply vessels (50-100 m) are expected to have broadband source levels in the range 165-180 dB re 1µPa, with the majority of energy below 1 kHz (OSPAR, 2009). Large commercial vessels (>100 m) produce relatively loud and predominately low frequency sounds, with the strongest energy concentrated below several hundred Hz (OSPAR, 2009).

11.9.2.47 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for marine mammals present in the area.

11.9.2.48 Thomsen *et al.* (2006) estimated that harbour porpoises will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. In addition, a study on the impacts of construction-related activities at Beatrice and Moray East offshore windfarms showed that harbour porpoises are displaced by offshore windfarm construction vessels (Benhemma-Le Gall *et al.*, 2021). Types of construction-related vessels that were assessed in this study included offshore service vessels for pile driving and jacket/turbine installation, guard vessels, crew-transfer vessels, and port service craft (Benhemma-Le Gall *et al.*, 2021). The median construction-related vessel density across the Moray Firth during the study period was 1.4 vessels/km^2. PAM data recorded at the site showed that the hourly occurrence of porpoise detections declined within 2 km of construction vessels, but that no response was observed out to 4 km, suggesting that responses declined within increasing distance to vessels (Benhemma-Le Gall *et al.*, 2021).

11.9.2.49 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026) and Volume III, Appendix 15.1: Navigational Risk Assessment (Revised March 2026)).

11.9.2.50 Throughout the construction of the Proposed Development, the EVMP (Table 11.15) will advise that vessel traffic moves along predictable routes and will define how vessels should behave in the presence of marine mammals.

11.9.2.51 For seals, Jones *et al.* (2017) analysed the predicted co-occurrence of ships and seals at sea which demonstrated that there is a large degree of predicted co-occurrence UK-wide, particularly within 50 km of the coast close to seal haul-outs. However, there is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and seals. In areas where seal populations are showing high levels of growth, such as southeast England, ship co-occurrences are highest (Jones *et al.*, 2017).

11.9.2.52 Although co-occurrence of vessels and seals is well documented through telemetry studies (Jones *et al.*, 2017), Thomsen *et al.* (2006) estimated that both harbour and grey seals will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. Where seals may respond, it is expected that any impact on behaviour would be short-term and localised and would return to baseline once the vessel disturbance has ended.

11.9.2.53 The proposed implementation of an EVMP (Table 11.15) will reduce the risk of vessel disturbance by providing guidance regarding the speed and movement of vessels, resulting in slower moving vessels travelling more predictable routes which are less likely to cause disturbance. This is supported by vessel simulation modelling by Findlay *et al.* (2023) which predicted that, when animals were exposed to vessels at a given distance with both a 20% and a 50% reduction in speed, all potential noise impacts were reduced. At a 20% reduction in speed, the vessel noise swath halved, reducing the average number of animals exposed by 50% and therefore reducing the number of animals that are likely to be disturbed (Findlay *et al.*, 2023). In addition, the study demonstrated that moderate slowdowns strongly reduce vessel source levels, with a 20% reduction in speed decreasing mean source levels by 6 dB and a 50% speed reduction by 18 dB (Findlay *et al.*, 2023).

11.9.2.54 Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.9.2.55 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the construction phase has been assessed as **Negligible adverse**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.56 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the construction phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the construction phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.2.57 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operations and Maintenance phase

MAGNITUDE OF IMPACT

11.9.2.58 During the operations and maintenance phase, a maximum of 30 vessels will be present within the Array Area at any one time, resulting in a maximum of 1,359 vessel return trips per year (Table 11.9). Vessels that will be used during the operations and maintenance phase include crew transfer vessels, jack-up vessels, cable repair vessels (Table 11.9).

INJURY FROM VESSEL ACTIVITIES

11.9.2.59 Baseline information on vessel traffic during the operations and maintenance phase is outlined in paragraph 11.9.2.58 and Table 11.9. The operations and maintenance phase may last for up to 36.5 years.

11.9.2.60 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026)). Vessel movements will be within the Array Area or along the offshore Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Therefore, the introduction of additional vessels during the operations and maintenance phase of the Proposed Development is not a novel impact for marine mammals present in the area and it is not expected that vessel activities during the operations and maintenance phase would increase the risk of injury due to vessel collision.

11.9.2.61 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.9.2.41 and Table 11.15, the implementation of the Factored In Measures, including an EVMP, will advise that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout O&M activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.9.2.62 Furthermore, all marine mammal species are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality, as highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2019).

11.9.2.63 Therefore, the impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the operations and maintenance phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very

unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.64 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity during the operations and maintenance phase is not considered a novel impact for marine mammals present in the area.

11.9.2.65 Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 ships/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026) and Volume III, Appendix 15.1: Navigational Risk Assessment (Revised March 2026)). Considering a maximum of 22 O&M vessels will be present within the Array Area at any one time, vessel traffic in the area around the Proposed Development is not likely to exceed the value presented by Heinänen and Skov (2015) even with the addition of vessels involved in the O&M phase.

11.9.2.66 As discussed in paragraph 11.9.2.41 and Table 11.15, the implementation of the Factored In Measures, including an EVMP, advises that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals, which will minimise the magnitude of any impact. Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the operations and maintenance phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.9.2.67 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the construction phase has been assessed as **Negligible**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the operations and maintenance phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.68 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the operations and maintenance phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the operations and maintenance phase for all marine mammal species is **Slight adverse** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.2.69 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the operations and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered

necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.9.2.70 Vessel traffic during the decommissioning phase is anticipated to be similar in nature, but of lower magnitude, to the construction phase (Table 11.9).

INJURY FROM VESSEL ACTIVITIES

11.9.2.71 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a high amount of vessel traffic (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026)). Vessel movements will be within the Array Area or along the offshore Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Therefore, the introduction of additional vessels during the decommissioning phase of the Proposed Development is not a novel impact for marine mammals present in the area and it is not expected that vessel activities during the decommissioning phase would increase the risk of injury from collision.

11.9.2.72 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.9.2.41 and Table 11.15, the implementation of the Factored In Measures, including an EVMP, will advise that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout decommissioning activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.9.2.73 Furthermore, all marine mammal species are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2019).

11.9.2.74 Therefore, the impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the decommissioning phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.75 The potential impacts during the decommissioning phase are anticipated to be similar to or less than the construction phase as the Rehabilitation Schedule confirms that no piling will be undertaken (Table 11.15).

11.9.2.76 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for marine mammals present in the area.

11.9.2.77 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation

(Revised March 2026) and Volume III, Appendix 15.1: Navigational Risk Assessment (Revised March 2026)).The EVMP (Table 11.15) will advise that vessel traffic moves along predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact.

11.9.2.78 Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the decommissioning phase, the effect is reasonably expected to occur, have short-term and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.9.2.79 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the decommissioning phase has been assessed as **Negligible**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the decommissioning phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.80 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the decommissioning phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the decommissioning phase for all marine mammal species is **Slight adverse** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.2.81 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.3 Impact 3 – Changes in fish and shellfish community affecting prey resources

11.9.3.1 Marine mammals are dependent on fish and shellfish species as prey resources, therefore there is potential for indirect effects on marine mammals to occur as a result of direct impacts on fish and shellfish and/or their supporting habitat.

11.9.3.2 The key prey species for marine mammals within this assessment are presented in Table 11.35.

Table 11.35: Key prey species for marine mammals, where region outlines where the study took place

Species	Key prey species	Region	Reference
Harbour porpoise	Whiting (*Merlangius merlangus*), herring (*Clupea harengus*), poor cod (*Trisopterus* spp)	Ireland	Hernandez-Milian *et al.* (2011)
Bottlenose dolphin	Whiting, blue whiting (*Micromesistius poutassou*), pollock (*Pollachius*), saithe (*Pollachius virens*), haddock (*Melanogrammus aeglefinus*), poor cod, European hake (*Merluccius merluccius*), horse mackerel (*Trachurus trachurus*), flatfish (*Pleuronectiformes*), pelagic squid (*Loligo spp.*), octopus (*Octopus spp.*).	Ireland	Hernandez-Milian *et al.* (2011; 2015)
Risso's dolphin	Octopus species, squid species, cuttlefish species (*Sepiida*), crustaceans (*Crustacea*), poor cod, haddock, whiting	Scotland	MacLeod *et al.* (2014)
Common dolphin	Poor cod, goby (*Caragobius urolepis*), blue whiting, whiting, cephalopods (*Cephalopoda*), Atlantic herring, European sprat (*Sprattus sprattus*), haddock	Ireland	Brophy *et al.* (2009)
Minke whale	Sandeel, herring, sprat, mackerel, poor cod, gobies	UK	Pierce *et al.* (2004); Whooley (2016); Robinson *et al.* (2023)
Grey seal	Poor cod, salmonids (*Salmonidae*), sandeel, dragonet (*Callionymidae*), whiting, bib (*Trisopterus luscus*), blue whiting, haddock, pollock, saithe, herring, rockling (*Ciliata Mustela* and *Gaidropsarus vulgaris*), Norway pout (*Trisopterus esmarkii*), mackerel, hake, eels (Anguilliformes), wrasse (*Labridae*), perch (*Perca fluviatili*), sole (*Solea*), halibut (*Hippoglossus hippoglossus*), dab (*Limanda limanda*), flatfish species, squid species, octopus species	Ireland	Gosch *et al.* (2014); Wilson and Hammond (2019)
Harbour seal	Sandeel, sole, poor cod, dragonet, whiting, rockling, Atlantic horse mackerel, crustaceans, squid species, octopus species	Ireland	Kavangah *et al.* (2010)

SENSITIVITY OF THE RECEPTOR

11.9.3.3 Impacts to prey resources will be largely restricted to the boundaries of the Proposed Development and, therefore, marine mammals occurring within this area also have the potential to be affected. However, the fish and shellfish species identified in Volume II: Chapter 10: Fish, Shellfish, and Sea Turtle Ecology (Revised March 2026) are typical of those present within the western Irish Sea, and as marine mammals are highly mobile, it is reasonable to assume that they will be able to feed on sufficient, similar prey resource that is available in the wider area.

11.9.3.4 While there may be particular prey species that comprise a high proportion of their diet, all marine mammals within this assessment are considered as generalist feeders, therefore they can exploit a variety of prey resources and are not reliant on a single prey species (Table 11.35). As a result, all marine mammal species within this assessment are considered to be of high adaptability, high tolerance, have high recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Low sensitivity to changes in fish and shellfish community affecting prey resources.

Construction phase

MAGNITUDE OF IMPACT

11.9.3.5 Potential impacts on fish and shellfish during the construction phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026) and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition;
- Injury and/or disturbance as a result of underwater noise and vibration during pile driving and cable installation activities; and
- Accidental pollution.

11.9.3.6 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026), which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the construction phase providing that Factored In Measures are implemented.

11.9.3.7 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur relatively frequently throughout the construction phase, have intermittent and/or short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the construction phase.

SIGNIFICANCE OF EFFECT

11.9.3.8 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the construction phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.3.9 The significance of effect from changes in fish and shellfish community affecting prey resources during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operations and Maintenance phase

MAGNITUDE OF IMPACT

11.9.3.10 Potential impacts on fish and shellfish during the operations and maintenance phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026) and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition;
- Accidental pollution;
- Long-term habitat loss;
- Alteration of seabed habitats arising from changes in physical processes; and
- Changes in EMF from subsea electrical cabling.

11.9.3.11 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026), which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the operations and maintenance phase.

11.9.3.12 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur continuously throughout the operations and maintenance phase, have very short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the operations and maintenance phase.

SIGNIFICANCE OF EFFECT

11.9.3.13 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the operations and maintenance phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the operations and maintenance phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.3.14 The significance of effect from changes in fish and shellfish community affecting prey resources during the operations and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.9.3.15 Potential impacts on fish and shellfish during the decommissioning phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026) and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition; and
- Accidental pollution.

11.9.3.16 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026), which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the decommissioning phase.

11.9.3.17 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur relatively frequently throughout the decommissioning phase, have intermittent and/or short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the decommissioning phase.

SIGNIFICANCE OF EFFECT

11.9.3.18 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the decommissioning phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the decommissioning phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.3.19 The significance of effect from changes in fish and shellfish community affecting prey resources during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.4 Impact 4 – Accidental pollution

11.9.4.1 There is the potential for an accidental release of pollutants to occur from vessels and equipment associated with the construction, operations and maintenance and decommissioning phases of the Proposed Development, which may result in adverse effects on marine mammals. Pollutants may include diesel fuel, bentonite (from drilling activities), lubricants, grease and oils, anti-fouling biocides, and grout.

SENSITIVITY OF THE RECEPTOR

11.9.4.2 In the event of an accidental spill, given the density and distribution of marine mammals in the Marine Mammal Study Area, it is possible that individuals could come into contact with contaminants.

11.9.4.3 Direct impacts include ingestion, inhalation, and absorption. All of which may result in physiological responses with health and long-term survival and/or reproduction consequences, the most serious of which could be damage to the respiratory system (Helm *et al.*, 2015).

11.9.4.4 Indirect impacts include short- and long-term reductions in food availability, disruption to social bonds, reduced reproduction, and/or cumulative effects on individuals, populations, and the ecosystem (Helm *et al.*, 2015).

11.9.4.5 Cetaceans are at risk from oil pollution in the marine environment because they lack the ability to leave the water to avoid oil. Cetaceans are however highly mobile and wide ranging, therefore any contact with a spill would be expected to be brief. They are also capable of detecting surface slicks, for example, experiments with captive bottlenose dolphins have shown that they can visually discriminate between oil and uncontaminated water and avoid oil on the surface of the water (Geraci and St. Aubin, 1984). Dolphins appear to rely on tactile clues to detect and avoid oil and it is unlikely that they would be unknowingly subjected to prolonged or repeated exposure to oil in the wild (Helm *et al.*, 2015).

11.9.4.6 Cetaceans must surface periodically to breathe, potentially bringing them into contact with floating oil and volatile toxic components. The more extensive the slick, the more likely that an animal will surface within it (Geraci and St. Aubin, 1980). While oil does not readily penetrate cetacean skin, exposure could affect mucus membranes, eyes, and other external soft tissue areas, potentially resulting in mortality (Helm *et al.*, 2015).

11.9.4.7 In the event of an accidental spill, prey species may also become oiled. Ingestion of oil through consumption of contaminated prey may cause damage to internal organs and have long-term consequences for individuals (Helm *et al.*, 2015).

11.9.4.8 Unlike cetaceans, seals are reliant on terrestrial haul-out sites for resting, moulting, and breeding which makes them particularly vulnerable to the effects of pollution. Information on key haul-outs for grey seals and harbour seals in the vicinity of the Proposed Development is presented in section 11.5.2. Seals have been shown to develop conjunctivitis, corneal abrasion, and swollen eyelid membranes in response to exposure to crude oil (Geraci and St. Aubin, 1980). While external oiling is not expected to significantly impact the ability of adult seals to maintain their core body temperature as they rely on blubber for insulation, seal pups entering the water could be vulnerable as oil residues can reduce the thermal properties of neonate animals, increasing their susceptibility to hypothermia (Helm *et al.*, 2015).

11.9.4.9 All marine mammal species within this assessment are considered to be of reasonable adaptability, reasonable tolerance, have medium recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Medium sensitivity to accidental pollution.

Construction phase

MAGNITUDE OF IMPACT

11.9.4.10 The installation of the offshore infrastructure for the Proposed Development may lead to the accidental release of pollutants through spills and leaks from vessels and equipment. The project design parameters for Project Design Option 1 during the construction phase are outlined in Table 11.9 and include the installation of 53 WTGs, two OSPs, between 110 and 122 km of inter-array cables, between 25 and 28 km of interconnector cables, and between 35 and 40 km offshore export cables. There will also be up to 4,150 vessel round trips and 294 helicopter round trips during the construction phase (including activities at the Landfall).

11.9.4.11 The magnitude of the impact of accidental pollution will be dependent on the quantities of potential pollutants carried by construction vessels and within equipment. The release of a large inventory of fuel oil from a construction vessel is, however, considered to represent the greatest potential accidental pollution event from installation activities. In the event of an accidental spill from vessels, equipment or from construction activities, the spill would be subject to immediate dilution and rapid dispersal (Marappan *et al.,* 2022).

11.9.4.12 Given the Factored In Measures (see Table 11.15), the likelihood of accidental release is considered extremely low. The measures in the EMP include storage of chemicals in secure designated areas on vessels in line with appropriate regulations and guidelines, and double skinning of any tanks and pipes containing hazardous substances. All chemicals used will be subject to a chemical risk assessment to ensure risks are understood and minimised. The EMP also includes a MPCP which will contain key emergency contact details and response procedures in the event of a spill of any magnitude (Tier I, II or III) to ensure minimal impact. Compliance with these procedures will also reduce the magnitude of any spill. Adherence to the Factored In Measures outlined in Table 11.15, including the EMP and MPCP will significantly reduce the likelihood of an accidental pollution incident occurring, and the magnitude of its impact.

11.9.4.13 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the construction phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.9.4.14 For all marine mammal species, the magnitude of the impact of accidental pollution during the construction phase has been assessed as **Low adverse**, with the sensitivity of the receptor being

Medium. Therefore, the significance of effect from accidental pollution during the construction phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.4.15 The significance of effect from accidental pollution during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operations and Maintenance phase

MAGNITUDE OF IMPACT

11.9.4.16 There is the potential for the accidental release of pollutants during the operations and maintenance phase of the Proposed Development as a result of the presence of offshore infrastructure, associated equipment, and vessel movements. The project design parameters for Project Design Option 1 during the operations and maintenance phase are outlined in Table 11.9. This includes synthetic compound, for example from antifouling biocides, heavy metal, and hydrocarbon contamination as a result of the presence of 53 WTGs and two OSPs as well as from maintenance activities. There will also be up to 1,359 vessel round trips and 485 helicopter round trips per year during the operations and maintenance phase.

11.9.4.17 The magnitude of the impact of accidental pollution will be dependent on the quantities of potential pollutants carried by operations and maintenance vessels and within equipment. Any accidental spill from vessels or equipment or from maintenance activities would be subject to immediate dilution and rapid dispersal (Marappan *et al.,* 2022). As discussed in paragraph 11.9.4.12 and Table 11.15, the implementation of the Factored In Measures, including an EMP and MPCP, will ensure that the likelihood of accidental release occurring is extremely low and, in the event that an accidental release does occur, will limit the magnitude of the impact.

11.9.4.18 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the operations and maintenance phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.9.4.19 For all marine mammal species, the magnitude of the impact of accidental pollution during the operations and maintenance phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the operations and maintenance phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.4.20 The significance of effect from accidental pollution during the operations and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.9.4.21 The magnitude of the potential impact to marine mammals from accidental pollution during the decommissioning phase is expected to be the same as described previously for the construction phase (see paragraphs 11.9.4.10 *et seq.*).

11.9.4.22 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the decommissioning phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.9.4.23 For all marine mammal species, the magnitude of the impact of accidental pollution during the decommissioning phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the decommissioning phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.4.24 The significance of effect from accidental pollution during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.5 Impact 5 – Changes in Electromagnetic Fields (EMF) from subsea electrical cabling

11.9.5.1 The conduction of electricity through subsea power cables has the potential to emit a localised EMF which could potentially affect the sensory mechanisms of marine mammal species (Centre for Marine and Coastal Studies (CMACS), 2003; Copping, 2018; Normandeau *et al.*, 2011).

11.9.5.2 There are no thresholds for assessing impacts to marine life from EMFs, therefore by necessity, this impact assessment is qualitative by nature, based on the available evidence base (a combination of laboratory experiments and field studies). An overview of the expected levels of EMF and the potential impacts associated are presented below.

SENSITIVITY OF THE RECEPTOR

11.9.5.3 The effects of EMF on marine mammals are not well understood and, more broadly, there has been a lack of studies investigating the effects of EMFs on the behaviour of magneto- and electrosensitive animals.

11.9.5.4 There is no evidence that seals can detect or respond to EMF, however there is evidence to suggest that some species of cetacean may be able to detect variations in magnetic fields, therefore it is plausible that they are magneto-sensitive (Normandeau *et al.*, 2011). Kirschvink *et al.* (1986) suggested that species that were sensitive to changes in the Earth's magnetic field and that are likely to be present within the Proposed Development include harbour porpoise, Risso's dolphin, and common dolphin. However, the majority of these have had a theoretical evidence base, coming to differing conclusions regarding species' sensitivity to changes in electric and magnetic fields (Normandeau *et al.*, 2011). The only evidence of electro-sensitivity in marine

mammals to date is reported in Guiana dolphin (*Sotalia guianensis*) as they have been shown to possess an electroreceptive system which is used to detect electrical stimuli (Czech-Damal *et al.*, 2013).

11.9.5.5 Potential responses of cetaceans from EMF could include avoidance behaviour, disruption in orientation, and effects on feeding or social interaction (Normandeau *et al.*, 2011), although it is important to note that these responses are all currently hypothetical. Whilst subsea cables could create a very localised change in the geomagnetic field (Taormina *et al.*, 2018), modelling studies of EMF from cables suggests that the likelihood of such a change affecting a large enough area to elicit a significant course alteration would be low (Normandeau *et al.*, 2011).

11.9.5.6 Theoretically, there is the potential for some very localised behavioural effects, although no evidence exists at present that marine mammal species within this assessment are magneto sensitive. All marine mammal species within this assessment are considered to be of high adaptability, high tolerance, have high recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Negligible sensitivity to changes in EMF from subsea electrical cabling.

Operations and Maintenance phase

MAGNITUDE OF IMPACT

11.9.5.7 EMFs are a combination of an electrical field and a magnetic field, with the electrical field generated by static charges and the magnetic field generated by moving currents.

11.9.5.8 Anthropogenic sources of EMF are primarily subsea cables used for power generation and telecommunications or submarine communications (Normandeau *et al.*, 2011; Tasker *et al.*, 2010). Therefore, the presence and operation of between 110 and 122 km of 66 kV inter-array cables, between 35 and 40 km of 220 kV offshore export cables, and between 25 and 28 km of 220 kV OSP interconnector cables during the lifetime of the Proposed Development (see Table 11.9) may lead to localised EMF effects on marine mammals.

11.9.5.9 Submarine cables can cause three different types of EMFs: electrical (E) fields, magnetic (B) fields, and induced electric (iE) fields. E-fields are measured in volts per metre (V/m) and are generated by the voltage of the cable. B-fields are measured in microtesla (μT) or milligauss (mG) where 1 μT = 10 mG and are generated by the current of the power through the cable. They attenuate both horizontally and vertically away from the cable, with field strength directly related to the power of the current passing through the cable, rather than being specifically related to the voltage. iE-fields are measured in V/m and are generated by the fluctuation of the B-fields (in AC transmission) or by the motion of the seawater (or an organism) through the B-field. Therefore, they are dependent on the strength of the B-field, thus the strength of the iE-field is directly related to the B-field, which is strongest closest to the cable, attenuating horizontally and vertically away from it.

11.9.5.10 EMFs also occur naturally in the marine environment from a variety of sources including background levels from the Earth's magnetic field, and very small fields generated by electrical currents moving through organisms (Tricas and Gill, 2011). The Earth's static B-field is present in both terrestrial and aquatic environments and lies in the range 25 to 65 μT (Hutchison *et al.*, 2018). The B-field strength of the Irish Sea is approximately 49 μT (National Oceanic and Atmospheric Administration (NOAA), 2020).

11.9.5.11 Measurements of EMF for subsea cables associated with offshore windfarms vary, with the strength of the B-field generated generally related to the wind speed captured by the turbines. A variety of design and installation factors affect EMF levels in the vicinity of the cables such as current flow, distance between cables, cable insulation, number of conductors, configuration of cable and burial depth. For example, EMFs produced by inter-array cables are smaller than those

of export and OSP interconnector cables as they are lower powered in comparison. Furthermore, the B-fields generated by High Voltage Alternating Current (HVAC) and High Voltage Direct Current (HVDC) cables are significantly different, with HVDC cables typically generating much larger EMFs than HVAC cables (Tricas and Gill, 2011). The transmission system used for the Proposed Development will only comprise HVAC.

11.9.5.12 CMACS (2003) reported that for a 132 kV three-phase AC cable with perfect shielding, the predicted B-field in close proximity to the cable was 1.6 µT and the respective iE-field was 91.25 µV/m above the cable if buried to 1 m depth, which reduced to 10 µV m-1 8 m from the cable. Gill *et al.* (2009) measured iE-fields of 30 µV/m and 110 µV/m at two different offshore windfarm cables (both three-phase AC, 36 kV, 100 A) close to the cables and B-fields of 0.23 µT and 6.5 µT, respectively. Continental Shelf Associates (CSA, 2019) compared offshore windfarm subsea cables and found EMF levels directly over live AC undersea power cables associated with offshore wind energy projects ranged between 5 to 15 mG (0.5 to 1.5 µT) for inter-array cables and 10 to 40 mG (1 to 4 µT) for export cables, at heights of 1 m above the seabed. At lateral distances of between 3 m and 7.5 m from the cable, B-fields greatly reduced to <0.1 to 7 mG (<0.01 to 0.7 µT) for inter-array cables, and <0.1 to 12 mG (<0.01 to 1.2 µT) for export cables, at heights of 1 m above the seabed. Measurements of the iE-fields directly over live AC undersea power cables in the same study ranged between 0.1 to 1.2 mV/m for the inter-array cables and 0.2 to 2.0 mV/m for export cables, at heights of 1 m above the seabed (CSA, 2019). At lateral distances of between 3 m and 7.5 m, iE-fields reduced to between 0.01 to 0.9 m V/m for inter-array cables and 0.02 to 1.1 mV/m for export cables at heights of 1 m above the seabed.

11.9.5.13 The strength of the B-field (and consequently, iE-fields) decreases rapidly horizontally and vertically with distance from source (Normandeau *et al.*, 2011). Burial of cables, in particular, can therefore reduce the strength of the B- and iE-fields. However, it is unlikely that cables can be buried to sufficient depths that will reduce the magnitude of the B-field, and hence the sediment-seawater interface iE-field, to the extent that these fields could not be detected by certain marine organisms on or close to the seabed (Gill *et al.*, 2005). A study conducted by CSA (2019) found that inter-array and export cables buried between depths of 1 m to 2 m reduces the magnetic field at the seabed surface four-fold. For cables that are unburied and instead protected by thick concrete mattresses or rock berms, the field levels were found to be similar to buried cables.

11.9.5.14 While there may be some change to EMFs in the vicinity of inter-array, export, and OSP interconnector cables, the studies presented above indicate that these would likely be highly localised, with the strength of EMFs dissipating quickly with increased distance from the buried cables. The impact of EMFs on marine mammals is considered to occur throughout the operations and maintenance phase, is reasonably expected to occur, and have intermittent and recoverable consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.9.5.15 For all marine mammal species, the magnitude of the impact of changes in EMFs from subsea electrical cabling has been assessed as **Low adverse**, with the sensitivity of the receptor being **Negligible**. Therefore, the significance of effect from changes in EMFs from subsea electrical cabling during the operations and maintenance phase for all marine mammal species is **Imperceptible**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.5.16 The significance of effect from changes in EMFs from subsea electrical cabling during the operations and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered

necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.6 Impact 6 – Injury and/or disturbance to marine mammals from underwater noise during UXO clearance

11.9.6.1 It is possible that UXO items with a range of charge weights (or quantity of contained explosive) are present within the boundaries of the Proposed Development, therefore there is potential for UXO clearance to be required prior to construction. While it may be possible for identified UXO to be either avoided, removed, or relocated, there is potential that underwater detonation could be required where it is deemed necessary and unsafe to remove the UXO.

11.9.6.2 Methods of UXO clearance considered for the Proposed Development may include high order and low order detonation. It is important to note that while high order detonation represents the worst-case scenario for UXO clearance, high order detonation may be avoided, and low order clearance methods (deflagration) used instead.

11.9.6.3 The number of UXO that may require clearance and duration of UXO clearance operations are currently unknown. Therefore, it is important to note that the assessments for UXO clearance presented within this Chapter are, at this stage, illustrative.

11.9.6.4 The severity of the consequences of UXO detonation will depend on several variables, including, but not limited to, the charge weight and its proximity to the receptor. Potential effects of underwater detonation of UXOs on marine mammals include auditory injury from exposure to the acoustic wave, resulting in permanent auditory injury or loss in hearing sensitivity (PTS), or temporary loss in hearing sensitivity (TTS); and behavioural disturbance which could impact on feeding, mating, breeding, and/or resting (Ketten, 2004; Richardson *et al.,* 1995; von Benda-Beckmann *et al.,* 2015).

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY – PTS

11.9.6.5 All species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al*., 2007). The ecological consequences of PTS are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al*., 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.9.6.6 The primary acoustic energy produced by a high order detonation is below the region of greatest sensitivity for most marine mammal species (harbour porpoise, dolphin species, seals) considered within this assessment (Southall *et al.,* 2019), with most acoustic energy produced below a few hundred Hz, and decreasing by SEL ~10 dB per decade above 100 Hz (von Benda-Beckmann *et al.,* 2015; Salomons *et al.,* 2021). There is also a pronounced reduction in energy levels above ~5-10 kHz (von Benda-Beckmann *et al.,* 2015; Salomons *et al.,* 2021). Furthermore, recent evidence shows that the sound produced during UXO detonation has lower frequency components (<100 Hz) than was previously assumed (Robinson *et al.,* 2022), therefore this assessment is likely to be overly precautionary for species, such as minke whale, whose hearing sensitivity was previously assumed to overlap with the primary acoustic energy produced by a high order detonation.

11.9.6.7 If PTS were to occur within this low frequency range, it is unlikely that it would result in a significant impact on the vital rates of harbour porpoise, dolphin species, and seals. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, harbour porpoise, dolphin species, and seal species are assessed as having a Low sensitivity to PTS from underwater noise during UXO clearance. Minke whales are assessed as having a Medium sensitivity to PTS from underwater noise during UXO clearance, although as discussed in paragraph 11.9.6.6, this is precautionary.

BEHAVIOURAL DISTURBANCE

11.9.6.8 JNCC (2020) states that 'a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement'. Each donation will be of short-term duration; therefore, it is not expected that behavioural disturbance from a single UXO detonation would cause a significant impact.

11.9.6.9 As a result, all marine mammal species are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, they are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during UXO clearance.

Construction phase

MAGNITUDE OF IMPACT

AUDITORY INJURY – PTS

11.9.6.10 The following section provides the quantitative assessment of the impact of PTS from UXO clearance on marine mammals. A UXO detonation is defined as a single pulse, therefore both the weighted SEL_{cum} criteria and the unweighted SPL_{peak} criteria from Southall *et al.* (2019) have been presented in Table 11.18 and the source levels (unweighted SPL_{peak} and SEL_{ss}) for each charge weight are presented in Table 11.19, whereby SEL_{cum} is equivalent to SEL_{ss}. As a result, animal fleeing assumptions do not apply to the values presented. The predicted impact ranges for auditory injury (PTS-onset) from UXO clearance for each FHG are presented in Table 11.36 and the number of animals predicted to experience PTS-onset from UXO clearance are presented in Table 11.37.

11.9.6.11 Generally, the estimated auditory injury (PTS-onset) impact ranges increased with the size of the charge for all FHGs (Table 11.36). For harbour porpoise, the maximum PTS-onset impact range was 14 km (SPL_{peak}) (Table 11.36). This equates to a maximum of 234 individuals experiencing auditory injury (0.37% of the reference population) from a high order UXO clearance using the greatest charge weight (800 kg plus donor) using the site-specific DAS density estimate (Table 11.37).

11.9.6.12 At all charge sizes, HF cetaceans (dolphin species) have the smallest predicted impact range of up to 840 m (SPL_{peak}) (Table 11.36). For bottlenose dolphin, Risso's dolphin, and common dolphin, the maximum PTS-onset impact range was 840 m (SPL_{peak}), which equates to <1 individual experiencing auditory injury from UXO clearance (Table 11.37).

11.9.6.13 For all FHGs, the unweighted SPL_{peak} impact ranges are higher than the weighted SEL_{ss} impact ranges with the exception of LF cetaceans, such as minke whale, due to the sensitivity of their hearing (Table 11.36). For minke whale, the maximum PTS-onset impact range was 11 km (SEL_{ss}) (Table 11.36). This equates to a maximum of 17 individuals experiencing auditory injury (0.09% of the reference population) from a high order UXO clearance using the greatest charge weight (800 kg plus donor) (Table 11.37).

11.9.6.14 For seals, the maximum PTS-onset impact range was 2.8 km (SPL_{peak}) (Table 11.36). This equates to two grey seals (0.12% of the reference population) and <1 harbour seal (<0.01% of

the reference population) experiencing auditory injury from a high order UXO clearance using the greatest charge weight (Table 11.37).

11.9.6.15 For all FHGs, the auditory injury (PTS-onset) impact range for low order clearance is small, with a maximum range of <1.2 km (Table 11.36).

11.9.6.16 For all marine mammal species, the impact is considered to result in a very small proportion of the population affected and very unlikely to affect the population trajectory, although auditory injury (PTS) is expected to have a permanent change to the receptor. Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoise, minke whale, and grey seal. For dolphin species and harbour seal, <1 animal is predicted to experience auditory injury (PTS), therefore the magnitude of impact is assessed as Negligible.

Table 11.36: Summary of auditory injury (PTS-onset) impact ranges for UXO detonation using the impulsive noise criteria from Southall *et al.* (2019) for marine mammals

Charge weight (kg)	PTS-onset (unweighted SPL_{peak})				PTS-onset (weighted SEL_{ss})			
	VHF cetacean	HF cetacean	LF cetacean	PCW	VHF cetacean	HF cetacean	LF cetacean	PCW
0.5 (low order)	1.2 km	70 m	220 m	240 m	110 m	<50 m	320 m	60 m
25 + donor	4.6 km	260 m	820 m	910 m	570 m	<50 m	2.2 km	390 m
55 + donor	6.0 km	340 m	1.0 km	1.1 km	740 m	<50 m	3.2 km	570 m
120 + donor	7.8 km	450 m	1.3 km	1.5 km	950 m	<50 m	4.7 km	830 m
240 + donor	9.8 km	560 m	1.7 km	1.9 km	1.1 km	<50 m	6.5 km	1.1 km
525 + donor	12.0 km	730 m	2.2 km	2.5 km	1.4 km	50 m	9.5 km	1.6 km
700 + donor	14.0 km	810 m	2.4 km	2.7 km	1.5 km	60 m	10.0 km	1.9 km
800 + donor	14.0 km	840 m	2.6 km	2.8 km	1.6 km	60 m	11.0 km	2.0 km

Table 11.37: Predicted impact of PTS-onset for marine mammals from UXO clearance; # = number of animals disturbed; % = the percentage of the reference population[2]

Species	Density (animals/km²)	Impact	PTS-onset (unweighted SPL_{peak})								PTS-onset (weighted SEL_{ss})							
			0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor	0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor
Harbour porpoise	0.38	#	2	26	43	73	115	172	234	234	<1	<1	1	1	1	2	3	3
		%	<0.01	0.04	0.07	0.12	0.18	0.27	0.37	0.37	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.2803	#	1	19	32	54	85	127	173	173	<1	<1	<1	1	1	2	2	2
		%	<0.01	0.03	0.05	0.09	0.14	0.20	0.28	0.28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Grid-cell specific	#	1	8	14	23	36	53	72	72	<1	<1	<1	<1	<1	1	1	1
		%	<0.01	0.01	0.02	0.03	0.05	0.08	0.11	0.11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bottlenose dolphin	0.0201	#	0	0	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	0.00	<0.01	<0.01	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.2352	#	0	<1	<1	<1	<1	<1	<1	1	0	0	0	0	0	0	0	0
		%	0.00	0.02	0.03	0.05	0.08	0.13	0.17	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grid-cell specific	#	<1	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	<0.01	0.01	0.02	0.04	0.06	0.11	0.13	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Risso's dolphin	0.031	#	<1	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	<1
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01
Common dolphin	0.0272	#	<1	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	<1
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01
	Grid-cell specific	#	<1	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minke whale	0.045	#	<1	<1	<1	<1	<1	1	1	1	<1	1	1	3	6	13	14	17
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.03	0.06	0.07	0.09
	0.017	#	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	2	5	5	6
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.03	0.03
	Grid-cell specific	#	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	2	2	2

Species	Density (animals/km²)	Impact	PTS-onset (unweighted SPL_{peak})								PTS-onset (weighted SEL_{ss})							
			0.5 kg (low order)	**25 kg + donor**	**55 kg + donor**	**120 kg + donor**	**240 kg + donor**	**525 kg + donor**	**700 kg + donor**	**800 kg + donor**	**0.5 kg (low order)**	**25 kg + donor**	**55 kg + donor**	**120 kg + donor**	**240 kg + donor**	**525 kg + donor**	**700 kg + donor**	**800 kg + donor**
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01
Grey seal	0.08	#	<1	<1	<1	1	1	2	2	2	0	<1	<1	<1	<1	1	1	1
		%	<0.01	0.01	0.02	0.03	0.05	0.09	0.11	0.12	0.00	<0.01	<0.01	0.01	0.02	0.04	0.05	0.06
Harbour seal	0.0003	#	0	0	0	0	0	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	0.00	0.00	0.00	0.00	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TTS

11.9.6.17 The following section provides the qualitative assessment of the impact of TTS from UXO clearance on marine mammals. The predicted impact ranges for TTS-onset from UXO clearance for each FHG are presented in Table 11.38. As outlined in paragraph 11.7.5.6, no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given.

11.9.6.18 Generally, the estimated TTS-onset impact ranges increased with the size of the charge for all FHGs. For harbour porpoises (VHF cetaceans), the maximum TTS-onset impact range was 26 km (SPL_{peak}) for a high order detonation using the greatest charge weight (800 kg plus donor) (Table 11.38).

11.9.6.19 For dolphin species (HF cetaceans), the maximum TTS-onset impact range was 1.5 km (SPL_{peak}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.38).

11.9.6.20 For minke whale, the maximum TTS-onset impact range was 120 km (SEL_{ss}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.38).

11.9.6.21 For seals, the maximum TTS-onset impact range was 23 km (SEL_{ss}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.38).

11.9.6.22 For all FHGs, the TTS-onset impact range for low order clearance is small, with a range of <4.5 km.

Table 11.38: Summary of TTS-onset impact ranges for UXO detonation using the impulsive noise criteria from Southall *et al.* (2019) for marine mammals

Charge weight (kg)	TTS-onset (unweighted SPL_{peak})				TTS-onset (weighted SEL_{ss})			
	VHF cetacean	HF cetacean	LF cetacean	PCW	VHF cetacean	HF cetacean	LF cetacean	PCW
0.5 (low order)	2.3 km	130 m	410 m	450 m	930 m	<50 m	4.5 km	800 m
25 + donor	8.5 km	490 m	1.5 km	1.6 km	2.4 km	150 m	29 km	5.2 km
55 + donor	11 km	640 m	1.9 km	2.1 km	2.8 km	210 m	41 km	7.5 km
120 + donor	14 km	830 m	2.5 km	2.8 km	3.2 km	300 m	57 km	10 km
240 + donor	18 km	1.0 km	3.2 km	3.5 km	3.5 km	390 m	76 km	14 km
525 + donor	23 km	1.3 km	4.1 km	4.6 km	4.0 km	530 m	100 km	19 km
700 + donor	25 km	1.4 km	4.5 km	5.0 km	4.1 km	590 m	110 km	22 km
800 + donor	26 km	1.5 km	4.7 km	5.3 km	4.2 km	620 m	120 km	23 km

BEHAVIOURAL DISTURBANCE

11.9.6.23 This section presents the quantitative assessment for behavioural disturbance during UXO clearance using high order and low order methodologies as described in section 11.7.5.

20 KM EDR FOR HIGH ORDER CLEARANCE

11.9.6.24 The number of each marine mammal species predicted to experience behavioural disturbance as a result of high order UXO detonation using a 20 km EDR is quantified by multiplying the area of impact (assuming a 20 km EDR results in an impact area of 1,256.64 km^2) by the respective species-specific density estimate. The results are presented in Table 11.39 and assessed as the proportion of the respective reference population (as presented in Table 11.7). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

Table 11.39: Predicted impact of disturbance to marine mammals from UXO assuming a 20 km EDR. For further information on the densities used[2]

Species	Density (animals/km^2)	Number of animals disturbed	Percentage of the reference population
Harbour porpoise	0.38	478	0.76
	0.2803	352	0.56
Bottlenose dolphin	0.0201	26	8.87
	0.2352	296	101.02
	0.2352	296	3.56[4]
Risso's dolphin	0.031	39	0.32
Common dolphin	0.0272	35	0.03
Minke whale	0.045	57	0.28
	0.017	22	0.11
Grey seal	0.08	101	6.08
Harbour seal	0.0003	1	0.55

11.9.6.25 The greatest estimated disturbance occurs for harbour porpoise, bottlenose dolphin, and grey seal, where up to 478 harbour porpoises, 296 bottlenose dolphins, and 101 grey seals are predicted to be disturbed (Table 11.39).

11.9.6.26 The estimated number of harbour porpoise and percentage of the reference population impacted is greatest when using the using the site-specific density estimate of 0.38 animals/km^2 from the DAS (Table 11.39). However, this assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea and is therefore considered to be highly conservative. Using the uniform density estimate of 0.2803 animals/km^2 from the wider SCANS-IV surveys, it was estimated that 352 animals will experience behavioural disturbance as a result of UXO detonation, using the 20 km EDR (Table 11.39), which is considerably lower.

11.9.6.27 The estimated number of bottlenose dolphins and percentage of the reference population impacted is greatest when using the density estimate of 0.2352 animals/km^2 from the SCANS-IV surveys (Table 11.39). However, the percentage of the reference population impacted is not considered to be realistic as it does not account for the variability in coastal and offshore population densities and distributions within the Irish Sea. Furthermore, the design of broad scale surveys, such as SCANS, used to derive MU population estimates are not designed to capture localised, coastal populations such as that of Cardigan Bay; therefore, the reference population

size has been under-estimated. Therefore, the more realistic numbers for this assessment are those using the density estimate from Rogan *et al.* (2018), or if using the SCANS-IV density estimate, using the larger reference population size derived from SCANS-IV (8,326 animals). Both methods result in <10% of the population being impacted, and this has been used in the assessment conclusion.

11.9.6.28 The estimated number of minke whale and percentage of the reference population impacted is greatest when using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys and is therefore considered to be the most conservative estimate (Table 11.39).

11.9.6.29 While it is expected that a high order UXO detonation would elicit a startle response and therefore, only a very short-term duration behavioural response is expected (JNCC, 2020); however, there is no empirical evidence of any marine mammal species' response to these events. The impact is considered to result in a small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

5 KM EDR FOR LOW ORDER CLEARANCE

11.9.6.30 The 5 km EDR has been used in this assessment for illustrative purposes and should be viewed with caution as there is no evidence to support this impact range. The number of each marine mammal species predicted to experience behavioural disturbance as a result of low order UXO detonation using a 5 km EDR is quantified by multiplying the area of impact (78.54 km^2) by the respective species-specific density estimate. The results are presented in Table 11.40 and assessed as the proportion of the respective reference population (as presented in Table 11.7). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

Table 11.40: Predicted impact of disturbance to marine mammals from UXO assuming a 5 km EDR[2]

Species	Density (animals/km^2)	Number of animals disturbed	Percentage of the reference population
Harbour porpoise	0.38	30	0.05
	0.2803	23	0.04
Bottlenose dolphin	0.0201	2	0.68
	0.2352	19	6.48
	0.2352	19	0.23[4]
Risso's dolphin	0.031	3	0.02
Common dolphin	0.0272	3	<0.01
Minke whale	0.045	4	0.02
	0.017	2	0.01
Grey seal	0.08	7	0.42
Harbour seal	0.0003	1	0.55

11.9.6.31 The greatest estimated disturbance occurs for harbour porpoise, bottlenose dolphin, and grey seal, where up to 30 harbour porpoises, 19 bottlenose dolphins, and 7 grey seals are predicted to be disturbed (Table 11.40).

11.9.6.32 The estimated number of harbour porpoise and percentage of the reference population impacted is greatest when using the using the site-specific density estimate of 0.38 animals/km^2 from the DAS (Table 11.40). However, this assumes that the density within the site-specific Marine

Mammal Study Area is the same across the wider extent of the Irish Sea and is therefore considered to be highly conservative.

11.9.6.33 The estimated number of bottlenose dolphins and percentage of the reference population impacted is greatest when using the density estimate of 0.2352 animals/km^2 from the SCANS-IV surveys and is therefore considered to be the most conservative estimate (Table 11.40). As in the assessment of high order UXO clearance, the number of animals predicted to be impacted using the Rogan *et al.* (2018) density estimate is considered more realistic.

11.9.6.34 The estimated number of minke whale and percentage of the reference population impacted is greatest when using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys and is therefore considered to be the most conservative estimate (Table 11.40).

11.9.6.35 The impact of low order detonation is considered to result in a very small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT.

AUDITORY INJURY - PTS

11.9.6.36 For harbour porpoise, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour porpoise from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

11.9.6.37 For bottlenose dolphin, Risso's dolphin, and common dolphin, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to bottlenose dolphin, Risso's dolphin, and common dolphin from underwater noise during UXO clearance is **Not Significant**, which is **not significant** in EIA terms.

11.9.6.38 For minke whale, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium.** Therefore, the significance of effect from PTS to minke whale from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

11.9.6.39 For grey seal, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to grey seal from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

11.9.6.40 For harbour seal, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour seal from underwater noise during UXO clearance is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.9.6.41 For all marine mammal species, the impact of behavioural disturbance from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.6.42 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during UXO clearance is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.6.43 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). Therefore, the Developer has committed to a UXO MMMP to further reduce the risk of PTS-onset, which also applies to both harbour and grey seals (which are not EPS).

11.9.7 Impact 7 – Injury and/or disturbance from underwater noise during site surveys

11.9.7.1 In 2023, the Developer submitted a Foreshore Licence Application (FLA) to carry out site surveys at the site of the Proposed Development. The details provided within this assessment are aligned with the Arklow Bank Wind Park – Foreshore Licence Application for Site Surveys – Annex IV Species Risk Assessment (RPS, 2023), and the accompanying Schedule of Works. Surveys will be carried out before the construction phase, prior to the installation of the offshore infrastructure, and routinely during the operations and maintenance phase.

11.9.7.2 The key parameters for assessment of Project Design Option 1 considers underwater noise from site surveys (Table 11.9). Site surveys of relevance to this Chapter are those that produce underwater noise and include geophysical and geotechnical surveys. Geophysical survey sources such as Multibeam Echo Sounder (MBES), Side Scan Sonar (SSS) and Ultra-Short Baseline (USBL) typically produce sound sources that are sonar-based or non-impulsive. Geotechnical surveys such as vibrocoring, typically produce non-impulsive sound sources, whilst some geotechnical surveys, such as grab sampling will not result in any measurable noise. The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore examples of the different survey equipment and expected source levels are presented in Table 11.41 for geophysical equipment, and Table 11.42 for geotechnical survey equipment.

Table 11.41: Expected geophysical surveys and equipment, with indicative source levels

Survey type	Equipment type	SEL (unweighted) (dB re 1µPa^{2}s at 1 m)	SPL_{rms} T90 (dB re 1µPa at 1 m)	SPL_{pk} (dB re 1µPa at 1 m)
Non-impulsive sonar-based surveys / equipment				
Multibeam echo sounder (MBES)	Konsberg EM2040 or Seabat 7125	N/A	213	N/A
Side scan sonar (SSS)	Edgetech FS4200 or Klein 5000	N/A	210	N/A
Sub-bottom profiler (SBP)	Innomar SES Standard / Medium or Applied Acoustics AA251 or Egdetech 6205S	N/A	245	N/A

Survey type	Equipment type	SEL (unweighted) (dB re 1µPa²s at 1 m)	SPL_{rms} T90 (dB re 1µPa at 1 m)	SPL_{pk} (dB re 1µPa at 1 m)
Ultra-short baseline (USBL)	Sonardyne Compatt 6 8300-3111	202	184	202
Impulsive surveys / equipment				
Seismic refraction	TI sleeve 10CU	195	214	224
Sparker (2DUHRS and 3DUHRS)	Geosource 200 – 400	182	214	219

Table 11.42: Expected geotechnical surveys and source levels.

Survey type	Source level (dB re 1µPa re 1 m (peak)	Source SEL (dB re 1 µPa²s re 1 m) (unweighted)	SPL rms T90
Seismic CPT[1]	220	189	203
Vibrocore	190	223[2]	187
Grab sample	N/A	N/A	N/A

[1]Equipment is pushed into the seabed and therefore would not result in a measurable noise source.

[2]Based on one hour of operation for a single core sample.

11.9.7.3 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.18) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised (Table 11.20; Southall *et al.*, 2019). Noise levels generated from site surveys (geophysical and geotechnical) were predicted by Seiche Ltd. Full details of the underwater noise modelling methodology, assumptions, and resulting impact ranges are detailed in Seiche Ltd. (2022).

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY- PTS

11.9.7.4 Very limited information exists on the impacts of site surveys (geophysical and geotechnical) to marine mammals, with most available studies investigating the impact of seismic airguns. However, all species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al.*, 2007). The ecological consequences of PTS are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al.*, 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.9.7.5 A study by Lucke *et al.* (2009) indicated that TTS could be induced in harbour porpoise at 350 m when exposed to an airgun impulse at a peak pressure of 200 dB_{pk-pk} re 1 µPa with corresponding SEL of 164.5 dB re $\mu Pa^2{}_s$) in shallow waters (~4 m), however this study is highly conservative as it assumes that the animal would remain stationary throughout the exposure. Evidence from other studies suggests that harbour porpoises exposed to such noise sources would likely move away from the source, and therefore leave the impact range of PTS-onset (Hermannsen *et al.,* 2015). Furthermore, it is expected that vessel presence will act as a deterrent to harbour porpoise, reducing the risk of auditory injury (Benhemma-Le Gall *et al*., 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity at the start of any survey activity or source.

11.9.7.6 While PTS is a permanent effect which cannot be recovered from, the most likely response of a marine mammal to noise levels that could induce TTS is to flee the area (Southall *et al.,* 2007). Therefore, animals exposed to these noise levels that could induce TTS are likely to actively avoid hearing damage by moving away from the source.

11.9.7.7 The limited information available for the impacts of underwater noise from site surveys on marine mammals make it challenging to assess the risk for all species. However, it is unlikely that PTS from site surveys would significantly impact the survival of reproductive rates of marine mammal species in this assessment. As a result, they are considered to be of high adaptability, reasonable tolerance, have between no and full recoverability, and are of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to auditory injury from underwater noise during site surveys.

BEHAVIOURAL DISTURBANCE

11.9.7.8 Limited information exists on the impacts of behavioural disturbance from site surveys (geophysical and geotechnical) to marine mammals, with most available studies investigating the impact of seismic airguns.

11.9.7.9 An analysis of MMO reports found that small cetaceans (including harbour porpoise) have a tendency to swim away from seismic airguns at speed or tend to avoid survey vessels when airguns are firing up to a distance of ~1 km away (Moulton and Miller, 2005; Pirotta *et al.,* 2014; Stone, 2003). Acoustic data collected by Pirotta *et al.* (2013) showed that harbour porpoise that remained in the seismic survey impact area reduced their echolocation activity by 15% during the survey, which could be indicative of changes to foraging or social behaviour (van Beest *et al.,* 2018). Although, Thomspon *et al.* (2013) found that short-term disturbance by a seismic survey in the North Sea did not lead to long-term displacement of harbour porpoises as animals were typically detected again within a few hours following the survey works. Similarly, Hoekendijk *et al.* (2018) concluded that short-term, irregular disturbance events are unlikely to significantly affect the energetic status of harbour porpoise, particularly where surveys are conducted in shallow waters as sound cannot propagate as far.

11.9.7.10 For common dolphins, evidence suggests that there is no change in occurrence or sighting densities of common dolphin during active seismic surveys (Kavanagh *et al.*, 2019; Stone *et al.*, 2017). Similarly, Risso's dolphin showed no response to seismic airguns (Stone *et al.,* 2017) or simulated military sonar (Southall *et al.*, 2011). Whereas a study on minke whale investigating the impacts of exposure to naval sonar (with acoustic characteristics of 1.3 – 2 kHz to a maximum SL of 214dB re 1µPa @ 1 m) found that whales increased their swimming speeds to avoid the sound source (Kvadsheim *et al.,* 2017). Increases in metabolic rates associated with avoidance behaviour could have implications on energy expenditure and survival for individuals (Kvadsheim *et al.,* 2017).

11.9.7.11 Very limited studies on the effects of seismic airguns on seals, however other studies on the behavioural effects of impulsive noise sources to seals have shown varying responses of grey

seals. During pile driving, grey seals were most commonly recorded changing behaviour from foraging to horizontal movement; although changes in swim speed, surfacing and diving behaviour and no response were also observed (Aarts *et al.,* 2018). A telemetry study during piling in southeast England showed that harbour seals within the area returned to usage levels similar to that of non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term (Russell *et al.,* 2016). Seals are generally considered to be relatively adaptable due to their generalist diets, wide foraging ranges, and adequate fat stores which enable them to compensate for lost foraging opportunities as a result of disturbance (Booth *et al.,* 2019; Smout *et al.,* 2014; Stansbury *et al.,* 2015).

11.9.7.12 The limited information available for the impacts of underwater noise from site surveys on marine mammals make it challenging to assess the risk for all species. Based on evidence available, all marine mammal species within this assessment are considered to be of high adaptability, reasonable tolerance, high recoverability, and of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during site surveys.

Construction phase

MAGNITUDE OF IMPACT

AUDITORY INJURY - PTS

11.9.7.13 The following section provides the assessment of the impact of PTS-onset from site surveys (geophysical and geotechnical) on marine mammals. Further detail with regards to the PTS-onset thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.9.7.14 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for non-impulsive geophysical survey sound sources (MBES, SSS and SBP) injury in the form of cumulative PTS could occur up to 517 m from the sound source, depending on the survey equipment and the FHG being assessed. For the MBES, the greatest predicted impact range for cumulative PTS is 25 m, for harbour porpoise, bottlenose dolphin, Risso's dolphin, and common dolphin (VHF and HF cetaceans) (Seiche Ltd., 2022). The threshold for cumulative PTS is not predicted to be exceeded for minke whale (LF cetaceans) (Seiche Ltd., 2022). For the SSS, the greatest predicted range for cumulative PTS is 25 m, for harbour porpoise, bottlenose dolphin, Risso's dolphin, and common dolphin (Seiche Ltd., 2022). For the SBP, the greatest predicted range for cumulative PTS is 517 m, for harbour porpoise (Seiche Ltd., 2022). USBL were not included in the Subsea Noise Assessment (Seiche Ltd., 2022) however, CSA Ocean Sciences Inc. (2020) estimated that the maximum distance to the weighted Level A threshold (cumulative PTS) is 1.7 m for VHF cetaceans (harbour porpoise).

11.9.7.15 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for impulsive geophysical survey sound sources (seismic refraction and sparker) injury in the form of instantaneous PTS could occur up to 22 m from the source and cumulative PTS could occur up to 130 m from the sound source (Seiche Ltd., 2022). For the seismic refraction surveys, the greatest predicted impact range for instantaneous PTS is 22 m and for cumulative PTS is 130 m, for harbour porpoise (Seiche Ltd., 2022). For sparker surveys, the greatest predicted impact range for cumulative PTS is 14 m, for harbour porpoise (Seiche Ltd., 2022) The instantaneous PTS thresholds are not exceeded for any of the FHGs for the sparker surveys.

11.9.7.16 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for geotechnical surveys (seismic CPT and vibrocore sampling) injury in the form of instantaneous PTS could occur up to 15 m from the source and cumulative PTS could occur up to 62 m from the sound source (Seiche Ltd., 2022). For the seismic CPT, the greatest predicted impact range for cumulative PTS is 62 m, for harbour porpoise (Seiche Ltd., 2022). For vibrocore sampling, cumulative PTS only occurs

for VHF cetaceans (harbour porpoise) and is predicted to occur within 2 m of the source (Seiche Ltd., 2022).

11.9.7.17 In addition, the Factored In Measures (see Table 11.15) which includes the implementation of a project-specific mitigation protocol during the geophysical surveys will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance.

11.9.7.18 The impact of PTS-onset to all marine mammal species from site surveys is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively frequently throughout the construction phase, although the effect is unlikely to occur given implementation of Factored In Measures and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

TTS

11.9.7.19 The following section provides the qualitative assessment of the impact of TTS-onset from site surveys (geophysical and geotechnical) on marine mammals. Further detail with regards to the TTS-onset thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.9.7.20 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for non-impulsive geophysical survey sound sources (MBES, SSS and SBP), cumulative TTS could occur up to 3,150 m from the sound source. For the MBES, the greatest predicted range for cumulative TTS is 33 m for harbour porpoise (VHF cetaceans). For the SSS, the greatest predicted range for cumulative TTS is 97 m, for harbour porpoise (Seiche Ltd., 2022). For the SBP, the greatest predicted range for cumulative TTS is 3,150 m for harbour porpoise (Seiche Ltd., 2022). USBL were not included in the Subsea Noise Assessment (Seiche Ltd., 2022) however, CSA Ocean Sciences Inc. (2020) estimated that the maximum distance to the Level B threshold (TTS[5]) is 50 m for all marine mammal hearing groups.

11.9.7.21 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for impulsive geophysical survey sound sources (seismic refraction and sparker), instantaneous TTS could occur up to 40 m from the source and cumulative TTS could occur up to 1,524 m from the sound source (Seiche Ltd., 2022). For the seismic refraction surveys, the greatest predicted impact range for instantaneous TTS is 40 m and for cumulative TTS is 1,524 m, for harbour porpoise (Seiche Ltd., 2022). For sparker surveys, the greatest predicted impact range for instantaneous TTS is 32 m and for cumulative TTS is 68 m, for harbour porpoise (Seiche Ltd., 2022).

11.9.7.22 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for geotechnical surveys (seismic CPT and vibrocore sampling), instantaneous TTS could occur up to 33 m from the sound source and cumulative TTS could occur up to 856 m from the sound source (Seiche Ltd., 2022). For the seismic CPT, the greatest predicted impact range for instantaneous TTS is 33 m and for cumulative TTS is 856 m for harbour porpoise (Seiche Ltd., 2022). For vibrocore sampling, the greatest predicted impact range for cumulative TTS is 607 m for harbour porpoise (Seiche Ltd., 2022).

11.9.7.23 It is important to note that the Factored In Measures (see Table 11.15) which will include the implementation of a project-specific mitigation protocol during the geophysical surveys, will reduce the risk of marine mammal experiencing TTS although the focus of this will be to minimise the risk of PTS. As a minimum it will adhere to international best practice, including DAHG (2014) guidance.

[5] Level B harassment impacts include TTS and behavioural responses (CSA Ocean Science Inc, 2020)

BEHAVIOURAL DISTUBANCE

11.9.7.24 The following section provides the assessment of the impact of behavioural disturbance from site surveys (geophysical and geotechnical) on marine mammals. For impulsive noise sources, the threshold for mild disturbance is 140 dB re 1 µPa (rms) and the threshold for strong disturbance is 160 dB re 1 µPa (rms). For continuous/non-impulsive noise the threshold for disturbance is 120 dB re 1 µPa (rms). Further detail with regard to the thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.9.7.25 The Subsea Noise Assessment (Seiche Ltd., 2022) concluded that for non-impulsive geophysical survey sound sources, disturbance could occur for all FHGs up to 4,950 m from the sound source. USBL were not included in the Subsea Noise Assessment (Seiche Ltd., 2022) however, CSA Ocean Sciences Inc. (2020) estimated that the maximum distance to the Level B threshold (disturbance[5]) is 50 m for all marine mammal hearing groups.

11.9.7.26 For impulsive sound sources, disturbance could occur out to 700 m for a sparker and out to 1,324 m for seismic refraction for all FHGs (Seiche Ltd., 2022).

11.9.7.27 The Subsea Noise Assessment concluded that for geotechnical surveys, disturbance could occur for all FHGs out to 10 km for vibrocore surveys and 1.5 km for seismic CPT surveys for strong disturbance (Seiche Ltd., 2022).

11.9.7.28 Therefore, the impact of disturbance to all marine mammal species from site surveys is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

AUDITORY INJURY – PTS

11.9.7.29 For all marine mammal species, the impact of PTS-onset from underwater noise during site surveys has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS-onset to all marine mammal species from underwater noise during site surveys is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.9.7.30 For all marine mammal species, the impact of behavioural disturbance from underwater noise during site surveys has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during site surveys is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.7.31 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during site surveys is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.7.32 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). The Developer has conducted an Annex IV Species Risk Assessment (RPS, 2023) for species listed under Annex IV of the Habitats Directive and EPS to determine if the proposed surveys could have the potential risk of auditory

injury or disturbance to these species and outlines proposed mitigation within the risk assessment report to further reduce the risk of injury and disturbance. Within this document, the Developer has committed to a project-specific mitigation protocol during the geophysical surveys that will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance (see RPS, 2023).

Operations and Maintenance phase

11.9.7.33 Routine geophysical surveys will be undertaken of the inter-array cables, inter-connector cables, and export cables throughout the operations and maintenance phase. Surveys will occur every six months during the first two years and annually thereafter (Table 11.9).

11.9.7.34 The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore an illustrative assessment has been conducted by assuming that equipment will be the same as that proposed in the FLA. The conclusions of this assessment should be interpreted with a high level of precaution given the lack of information regarding the equipment types that will be used.

MAGNITUDE OF IMPACT

AUDITORY INJURY – PTS

11.9.7.35 Based on the results of the Subsea Noise Assessment (Seiche Ltd., 2022) conducted for site surveys during the construction phase as part of the FLA, and CSA Ocean Sciences Inc (2020), it is assumed that the magnitude of impact of PTS-onset from surveys during the operations and maintenance phase will be similar, assuming the same equipment is used.

11.9.7.36 Therefore, the impact of PTS-onset to all marine mammal species from site surveys is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively frequently throughout the construction phase, although the effect is unlikely to occur given implementation of Factored In Measures and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

TTS

11.9.7.37 The impact ranges for TTS-onset from site surveys on marine mammals are expected to be similar to those presented in Seiche Ltd. (2022) and CSA Ocean Science Inc. (2020), assuming the same equipment is used in both the construction and operations and maintenance phases (see paragraphs 11.9.7.20 to 11.9.7.22)

11.9.7.38 It is important to note that the Factored In Measures (see Table 11.15) which will include the implementation of a project-specific mitigation protocol during the geophysical surveys, will reduce the risk of marine mammal experiencing TTS although the focus of this will be to minimise the risk of PTS. As a minimum it will adhere to international best practice, including DAHG (2014) guidance.

BEHAVIOURAL DISTURBANCE

11.9.7.39 Based on the results of the Subsea Noise Assessment (Seiche Ltd., 2022) conducted for site surveys during the construction phase as part of the FLA, and CSA Ocean Science Inc. (2020), it is assumed that the magnitude of impact of behavioural disturbance from surveys during the operations and maintenance phase will be similar, assuming the same equipment is used.

11.9.7.40 Therefore, the impact of disturbance to all marine mammal species from site surveys is considered to result in a small proportion of the population affected, occur frequently throughout

the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

AUDITORY INJURY – PTS

11.9.7.41 For all marine mammal species, the impact of PTS-onset from underwater noise during site surveys has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS-onset to all marine mammal species from underwater noise during site surveys is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.9.7.42 For all marine mammal species, the impact of behavioural disturbance from underwater noise during site surveys has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during site surveys is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.7.43 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during site surveys is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.8 Impact 8 – Injury and/or disturbance to marine mammals from dredging and trenching

11.9.8.1 As part of seabed preparation for construction, seabed lowering and feature clearance may be required by dredging. Additional dredging activities may be required during the operation and maintenance phase for scour protection repair and maintenance of WTG and OSP foundations, as well as maintenance of inter-array cables, interconnector cables and offshore export cables.

11.9.8.2 Trenching will be required during the offshore cable installation; it is expected that the majority of the cable will be buried via the use of jet trenching.

11.9.8.3 The key parameters for assessment of this pathway for Project Design Option 1 are presented in Table 11.9. Activities of relevance are those that produce underwater non-impulsive noise such as backhoe dredging, grab or clamshell dredging, mass flow excavation, water injection dredging, suction hopper dredging, jet trenching, mechanical trenching and vertical injector tools.

11.9.8.4 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.18) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised (Table 11.20; Southall *et al.*, 2019). The source levels for dredging and trenching are presented in Table 11.43. Full details of the underwater noise modelling methodology, assumptions, and resulting impact ranges for dredging (backhoe), dredging (suction) and trenching are detailed in Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026). Source levels for TSHD are presented in McQueen *et al.,* (2019).

Table 11.43 Estimated source levels for dredging and trenching

Activity	SPL_{pk} (dB re 1µPa @ 1 m)
Dredging (backhoe)	165
Dredging (suction)	186
TSHD	186
Trenching	172

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY – PTS

11.9.8.5 Non-piling construction activities such as dredging and trenching produce a continuous and non-impulsive noise which is generally considered to be very unlikely to result in PTS in marine mammals (Todd *et al.*, 2015; Southall *et al.,* 2019). The main energy of non-piling construction activities such as dredging and trenching, is listed as being below 1 kHz (Todd *et al.*, 2015). This is within the estimated peak sensitivity range of minke whales (LF cetacean) but out of the peak hearing ranges of harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW).

11.9.8.6 If PTS were to occur as a result of these construction activities, there would be little impact to vital rates in harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW), as the hearing sensitivity of these receptors is relatively poor below 1 kHz (Southall *et al.*, 2019).

11.9.8.7 Cetaceans with a low frequency hearing range, such as minke whales (Southall *et al.*, 2019), are likely to be more sensitive to a PTS in this frequency range if it were to occur. Communication signals between minke whales have been found to be below 2 kHz (Edds-Walton, 2000; Mellinger *et al.*, 2000; Gedamke *et al.*, 2001; Risch *et al.*, 2013; 2014). While knowledge about the hearing ranges of baleen whales is not fully understood, it is assumed that the hearing frequency ranges of cetaceans are similar to the sounds they produce (White and Todd, 2024). Tubelli *et al.* (2012) estimated the hearing frequency range in minke whales to be approximately between 30 Hz and 7.5 kHz or between 100 Hz and 25 kHz depending on the stimulation location. As demonstrated by the above studies, the hearing ranges of these LF receptors are more likely to overlap with the non-impulsive noise produced during these construction activities.

11.9.8.8 Although PTS is a permanent auditory effect, exposure to noise levels capable of inducing TTS is more likely to elicit behavioural avoidance rather than injury (Southall *et al.,* 2007). Evidence from other studies demonstrates that harbour porpoises exposed to similar continuous noise sources typically move away from the source, thereby leaving the zone where PTS onset could occur (Hermannsen *et al.,* 2015). In addition, vessel presence itself is expected to act as a deterrent, further reducing the likelihood of animals remaining in the immediate vicinity at the onset of construction activities (Benhemma-Le Gall *et al.,* 2023).

11.9.8.9 Therefore, it is unlikely that PTS from trenching and dredging would significantly impact the survival of reproductive rates of marine mammal species. As a result, they are considered to be of high adaptability, reasonable tolerance, and are of high value, though recovery from PTS is not expected should it occur. Therefore, all marine mammal species are assessed as having a Low sensitivity to auditory injury from dredging and trenching.

BEHAVIOURAL DISTURBANCE

11.9.8.10 Limited information is currently available regarding the sensitivity of marine mammals to other construction activities such as dredging and trenching, though the few studies currently available primarily focus on the impact of disturbance from dredging. These studies have confirmed that underwater noise from dredging activities can cause displacement and disturbance to marine mammals (Culloch *et al.*, 2016; Pirotta *et al.*, 2013). However, it is difficult to determine the sensitivity specifically to disturbance from dredging activities in isolation from the disturbance from vessel presence required for the activity (Todd *et al.*, 2015).

11.9.8.11 Dredging activities have been shown to cause harbour porpoise displacement within a radius of 5 km around the dredging location (Verboom, 2014). Diederichs *et al.* (2010) noted there was short term avoidance (around 3 hours) at distances of up to 600 m from a TSHD, but no significant long-term impacts. Modelling potential impacts of dredging of a port expansion predicted a disturbance range of 400 m, with a more conservative approach predicting avoidance of harbour porpoise up to 5 km (McQueen *et al.* 2020). The presence of vessels has been shown to deter and disturb harbour porpoise out of the area before any non-piling construction activities start (Brandt *et al.*, 2018). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity at the start of any dredging or trenching activity.

11.9.8.12 A study analysing the impacts of dredging on bottlenose dolphins, observed a decrease in bottlenose dolphin presence in foraging areas of Aberdeen harbour with an increase in intensity of dredging activity, with bottlenose dolphins absent from the vicinity for five weeks during the initial dredge operations (Pirotta *et al.*, 2013). The presence of shipping activity in this area is high all year round, with dolphins in the region considered to be habituated to high levels of vessel presence as a result. Therefore, in this instance, it was concluded that displacement was a direct result of dredging. In western Australia, Marley *et al.* (2017a), reported varied responses to dredging between sites. No bottlenose dolphins were sighted during backhoe dredging activities at one site, while dolphins remained using the other site despite the same dredging activities occurring. This suggests that the response may be context specific. A study conducted in northwest Ireland, construction related activity (including dredging and trenching) did not result in any evidence of a negative impact to common dolphins (Culloch *et al.*, 2016).

11.9.8.13 As outlined in Paragraph11.9.1.36, minke whales show short-term avoidance of construction and vessel noise, including reduced occurrence during disturbance events (Culloch *et al.,* 2016) and movement away from elevated acoustic stimuli (McGarry *et al.,* 2017; Boisseau *et al.,* 2021). Despite these responses, minke whales are highly mobile and exhibit flexible foraging strategies. Tracking studies show that they routinely shift distribution in response to prey availability across broad spatial scales (MacDougall and Robinson, 2025), exploiting a variety of prey types and adjusting feeding behaviour seasonally (Friedlaender *et al.,* 2014; Cade *et al.,* 2023). They also undertake large-scale seasonal movements across diverse habitats (Eerkes-Medrano *et al.,* 2021).

11.9.8.14 Collectively, the available evidence indicates that minke whales exhibit substantial flexibility in their foraging behaviour and are capable of shifting to alternative prey patches across wide spatial areas. Their large body size, significant energetic reserves, and extensive movement capacity mean they are well adapted to cope with temporary displacement from preferred feeding grounds. As such, short-term disruptions to foraging are unlikely to result in meaningful impacts on vital rates, and minke whales are expected to withstand such disturbances far more effectively than smaller cetaceans such as harbour porpoise.

11.9.8.15 A study on the effects of dredging sound on aquatic life, demonstrated using acoustic modelling for pinnipeds that displacement could be caused to individuals up to 5 km from site (depending on equipment specification) (McQueen *et al.*, 2020).

11.9.8.16 Based on evidence available, all marine mammal species within this assessment are considered to be of high adaptability, reasonable tolerance, high recoverability, and of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to behavioural disturbance from dredging and trenching.

Construction phase

MAGNITUDE OF IMPACT

AUDITORY INJURY- PTS

11.9.8.17 The following section provides the assessment of the impact of PTS-onset from dredging and trenching on marine mammals. Further detail with regards to the PTS-onset thresholds used and the predicted impact ranges are presented in Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026).

11.9.8.18 Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026) concluded that for non-impulsive other construction activities (including dredging and trenching), injury in the form of cumulative PTS could occur up to 50 m from the sound source. For trenching, backhoe dredging and suction dredging the impact range for cumulative PTS for all marine mammal groups is <50 m (see Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026)). For TSHD the maximum impact range for cumulative PTS for all marine mammal groups is <50 m (SLR, 2024).

11.9.8.19 The impact of PTS-onset to all marine mammal species from site surveys is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively frequently throughout the construction phase, although the effect is unlikely to occur given the natural avoidance response of marine mammals to vessels (prior to commencing dredging or trenching), and any effect is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

TTS

11.9.8.20 Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026) concluded that for non-impulsive other construction activities (dredging and trenching), cumulative TTS could occur up to 820 m from the sound source. For trenching and dredging the impact range for cumulative TTS for all marine mammal groups except VHF cetaceans (harbour porpoise) is <50 m (see Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026)). For harbour porpoise (VHF cetacean), whilst backhoe dredging has a maximum impact range for cumulative TTS of <50 m, suction dredging indicates a maximum impact range for cumulative TTS as 250 m, and for trenching the maximum impact range is 820 m. For TSHD the maximum impact range for cumulative TTS is <1 km (SLR, 2024). However, as outlined in paragraph 11.7.5.6, there is no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given.

BEHAVIOURAL DISTURBANCE

11.9.8.21 The following section provides the assessment of the impact of behavioural disturbance from dredging and trenching on marine mammals. The main energy of noise from dredging and trenching is largely below 1 kHz, which is within the peak hearing range of minke whales but outside of the peak hearing sensitivity of porpoise, dolphin and seal species.

11.9.8.22 Should any disturbance occur it is expected that the disturbance from dredging would be limited to a maximum of 5 km impact radius and that any animals that are displaced would be expected

to return once the dredging works had ceased (McQueen *et al.*, 2020). There are no known data sources available for the effect of trenching on marine mammals. Therefore, it has been assumed that deterrence ranges would be similar to those from dredging and, as such, would be within 5 km, and it is expected that any animals that are displaced would be expected to return once the works had ceased.

11.9.8.23 Therefore, the impact of disturbance to all marine mammal species from trenching and dredging is considered to result in highly localised effects, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

AUDITORY INJURY - PTS

11.9.8.24 For all marine mammal species, the magnitude of PTS-onset from underwater noise from dredging and trenching has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS-onset to all marine mammal species from underwater noise from dredging and trenching is **Not Significant,** which is **not significant** in EIA terms

BEHAVIOURAL DISTURBANCE

11.9.8.25 For all marine mammal species, the impact of behavioural disturbance from underwater noise from dredging and trenching has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during site surveys is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.8.26 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during dredging and trenching is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operations and Maintenance phase

11.9.8.27 Routine maintenance will take place on the inter-array cables, interconnector cables and offshore export cables throughout the operations and maintenance phase. Scour protection repair, removal of excess sediment and reburial or exposed cables will take place once every five years.

MAGNITUDE OF IMPACT

AUDITORY INJRUY- PTS

11.9.8.28 Based on the results of the Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026) and SLR (2024), it is assumed that the magnitude of impact of PTS-onset from dredging and trenching (including TSHD) during the operations and maintenance phase will be similar to the construction phase, assuming the same equipment is used.

11.9.8.29 Therefore, the impact of PTS-onset to all marine mammal species from dredging and trenching is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively infrequently throughout the operational phase, and the effect is very unlikely to occur given natural avoidance behaviour of vessels by marine mammals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

TTS

11.9.8.30 The impact ranges for TTS-onset from site surveys on marine mammals are expected to be similar to those presented in Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026) and SLR (2024). It is assumed that the TTS-onset impact range from dredging and trenching during the operations and maintenance phase will be similar to construction phase, assuming the same equipment is used. And, as outlined in paragraph 11.7.5.6, there is no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given.

BEHAVIOURAL DISTURBANCE

11.9.8.31 Based on the information within the literature, disturbance from dredging would be limited to a maximum of 5 km impact radius and any animals that are displaced would be expected to return once the dredging works had ceased (McQueen *et al.*, 2020) with the same deterrence range assumed for trenching due to the lack of data available.

11.9.8.32 Therefore, the impact of disturbance to all marine mammal species from trenching and dredging is considered to result in a small proportion of the population affected, occur infrequently throughout the operational phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

AUDITORY INJURY- PTS

11.9.8.33 For all marine mammal species, the magnitude of PTS-onset from underwater noise from dredging and trenching has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS-onset to all marine mammal species from underwater noise from dredging and trenching is **Not Significant**, which is **not significant** in EIA terms

BEHAVIOURAL DISTURBANCE

11.9.8.34 For all marine mammal species, the impact of behavioural disturbance from underwater noise from dredging and trenching has been assessed as **Low** adverse, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during site surveys is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.8.35 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during dredging and trenching is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered

necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10 Assessment of Project Design Option 2

11.10.1 Impact 1 – Injury and/or disturbance to marine mammals from underwater noise during pile driving

11.10.1.1 This impact assessment focusses on elevations in underwater noise and vibration as a result of pile driving during construction.

11.10.1.2 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.20) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised (Table 11.18; Southall *et al.*, 2019).

11.10.1.3 Impacts to marine mammals from underwater noise range from changes in behaviour and masking that affect communication and listening space, and/or locating prey (Basran *et al.*, 2020; Dunlop, 2016; Erbe *et al.*, 2016; Heiler *et al.*, 2016; Pine *et al.*, 2019; Pirotta *et al.*, 2012; Wisniewska *et al.*, 2018), displacement and disturbance (Brandt *et al.*, 2011; Culloch *et al.*, 2016; Graham *et al.*, 2019; Pirotta *et al.*, 2014; Stone *et al.*, 2017), injury and mortality (Reichmuth *et al.*, 2019; Schaffeld *et al.*, 2019).

11.10.1.4 The potential for auditory injury is related to the level of the underwater sound, its frequency relative to the hearing bandwidth of the animals, and by the duration of exposure. Exposure to loud, underwater noise can lead to a reduction in hearing sensitivity (a shift in hearing threshold) which may be temporary (TTS) or permanent (PTS).

11.10.1.5 TTS has been included in the assessment as a precautionary measure because it has the potential to have negative effects on an animal's ability to use natural sounds, including communication, navigation, and prey location, and consequently, could lead to a reduction in the fitness of the animal.

11.10.1.6 This impact assessment will be divided into an assessment of auditory injury (PTS), TTS and behavioural disturbance to underwater noise during pile driving.

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY – PTS

11.10.1.7 All species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al.*, 2007). The ecological consequences of PTS (a permanent and irreversible hearing impairment) are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al.*, 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.10.1.8 At a Department of Business, Energy, and Industrial Strategy (BEIS_-funded expert elicitation workshop in 2018, experts discussed the nature, extent, and potentially consequences of PTS to marine mammal species in the UK (Booth and Heinis, 2018). Using the best and most recent data available on the effects of PTS on marine mammals, the experts concluded that PTS did not mean animals were deaf, and the magnitude and frequency band in which PTS occurs is critical to assessing the effect on vital rates.

11.10.1.9 The onset of PTS was defined by Southall *et al.* (2007) as a non-recoverable elevation of the hearing threshold of 6 dB. It has been assumed that PTS-onset occurs after TTS has grown to 40 dB, based on TTS growth rates obtained from scientific literature. Studies of auditory injury in relation to a typical piling sequence have suggested that hearing impairment caused by exposure to piling noise is likely to occur where the source frequencies overlap the range of peak sensitivity for the receptor species rather than across the whole frequency hearing spectrum (Kastelein *et al.*, 2013a). For piling noise, most energy is between ~30 – 500 Hz, with a peak between 100-300 Hz and energy extending above 2 kHz (Kastelein *et al.*, 2015; Kastelein *et al.*, 2016). Studies have shown that exposure to impulsive pile driving noise induces TTS in a relatively narrow frequency band in both harbour porpoise and harbour seals (Finneran, 2015), with statistically significant TTS occurring at 4 and 8 kHz, respectively (Kastelein *et al.*, 2016) and centred at 4 kHz (Kastelein *et al.*, 2012a; Kastelein *et al.*, 2012b; Kastelein *et al.*, 2013b; Kastelein *et al.*, 2017). As a result, at an expert elicitation workshop, it was agreed that any threshold shifts to hearing caused by pile driving would manifest in the range of 2 – 10 kHz (Kastelein *et al.*, 2017). It was also agreed that a PTS of 6 – 18 dB in a narrow frequency band in the 2 – 10 kHz region is unlikely to significantly affect the ability of individuals to survive and reproduce (Kastelein *et al.*, 2017).

HARBOUR PORPOISE (VERY HIGH FREQUENCY CETACEANS)

11.10.1.10 During an expert elicitation workshop, experts discussed the nature, extent, and potentially consequences of PTS to harbour porpoises; concluding that the probability of PTS significantly affecting the survival and reproduction of harbour porpoises was very low (Booth and Heins, 2018).

11.10.1.11 Furthermore, data collected during the construction of offshore windfarms have shown that harbour porpoise detections around the pile driving area decline for several hours prior to the commencement of pile driving (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018; Graham *et al.*, 2019). For example, during the installation campaigns of both Beatric and Moray East offshore windfarms, harbour porpoise acoustic detections gradually declined by up to 33% during the 48-hour period prior to piling (Benhemma-Le Gall *et al.*, 2023). It is assumed that this is due to an increase in other construction-related activities and the presence of vessels in advance of pile driving which act as a deterrent to harbour porpoise, therefore reducing the risk of auditory injury (Benhemma-Le Gall *et al.*, 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity of the pile driving at the start of the activity. Consequently, the assessment of underwater noise in relation to pile driving, which assumes harbour porpoises will be present in the immediate vicinity during pile driving, is extremely precautionary.

11.10.1.12 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of harbour porpoise. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

DOLPHIN SPECIES (HIGH FREQUENCY CETACEANS)

11.10.1.13 The ecological consequences of PTS for bottlenose dolphin, Risso's dolphin, and common dolphin are uncertain but could result in effects that influence survival and reproductivity, as discussed in paragraph 11.10.1.7.

11.10.1.14 As described for harbour porpoise, studies have shown that there are frequency-specific differences in the onset and growth of noise-induced threshold shifts in relation to the characteristics of the noise source and hearing sensitivity of the receiving species. At a BEIS-funded export elicitation workshop in 2018, experts concluded that the probability of PTS

significantly affecting the survival and reproduction of bottlenose dolphins was very low, assuming an impact a 6 dB PTS in the 2 – 10 kHz range (Booth and Heinis, 2018).

11.10.1.15 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of dolphin species. As a result, bottlenose dolphins, Risso's dolphins, and common dolphins are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, bottlenose dolphins, Risso's dolphins, and common dolphins are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

MINKE WHALE (LOW FREQUENCY CETACEANS)

11.10.1.16 The low frequency noise produced during pile driving may be more likely to overlap with the hearing range of low frequency cetacean species such as minke whales. Although very little is known about minke whale hearing, it is likely that they use sound for communication and are thought to be capable of hearing sounds through their skull bones (Cranford and Krysl, 2015).

11.10.1.17 As for other FHGs above, it is assumed that animals experiencing PTS would suffer a biological effect that could impact on the health and vital rates of the animal (Erbe *et al.*, 2018) and could ultimately lead to reduced birth rate in females or mortality of individuals.

11.10.1.18 Tubeli *et al.* (2012) estimated the most sensitive hearing range for minke whales to extend from 30 to 100 Hz up to 7.5 to 25 kHz. This suggests that a 6 dB PTS in the 2 – 10 kHz range would only affect a small region of their hearing. Furthermore, several studies have demonstrated that minke whale communication signals are below 2 kHz (Edds-Walton, 2000; Gedamke *et al.*, 2001; Mellinger *et al.*, 2006; Risch *et al.*, 2013; 2014).

11.10.1.19 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of minke whale as only a small region of their hearing would be potentially affected. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, minke whales are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

GREY AND HARBOUR SEAL (PHOCIDS IN WATER)

11.10.1.20 Seals use sound both in air and water for communication, predator avoidance, and reproductive interactions, and are less dependent on hearing for foraging than cetaceans (Deecke *et al.*, 2002). Seals have very well developed tactile sensory systems that are used for foraging, but in certain conditions they may also listen to sounds produced by vocalising fish whilst hunting for prey (Dehnhardt *et al.*, 2001; Shulte-Pelkum *et al.*, 2007).

11.10.1.21 Any threshold shifts in hearing caused by pile driving would manifest in the range of 2 – 10 kHz (Kastelein *et al.*, 2017). At a BEIS-funded export elicitation workshop in 2018, experts concluded that the probability of PTS significantly affecting the survival and reproduction of grey and harbour seals was very low, assuming a 6 dB PTS in the 2 – 10 kHz range (Booth and Heinis, 2018).

11.10.1.22 Calculations of SELs of tagged seals during the construction of the Lincs offshore windfarm (Southern North Sea, UK) estimated that at least 50% of tagged seals would have received a dose of sound greater than published thresholds for PTS (Hastie *et al.*, 2015), although it is important to note that published thresholds have since been updated in Southall *et al.* (2019) and therefore this estimate is now expected to be lower. For example, Whyte *et al.* (2020) found that the percentage of tagged seals predicted to experience PTS-onset varied from 0 to 17% depending on the onset threshold applied. The extent of offshore windfarm construction within the Wash over the last decade and the degree of overlap with foraging ranges of harbour seals

in this region would suggest that a large number of individuals within the Wash population may have experienced levels of sound that have the potential to cause PTS (Russell *et al.*, 2016). However, the increase in the Wash harbour seal population during this period suggests that either the survival and fitness of individuals is not affected or that seals are not developing PTS despite predictions of exposure that indicate that they should be.

11.10.1.23 PTS is a permanent effect which cannot be recovered from, although, seals do not generally use hearing as the primary sensory function for locating prey and evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of seals. As a result, they are considered highly adaptable, reasonably tolerant, have no recoverability, and are of high value. Therefore, grey and harbour seals are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

BEHAVIOURAL DISTURBANCE

HARBOUR PORPOISE

11.10.1.24 Harbour porpoises are particularly vulnerable to disturbance because they are small cetaceans which makes them susceptible to heat loss and as a result, requires them to forage frequently in order to maintain a high metabolic rate with little energy remaining for fat storage (Rojano-Doñate *et al.*, 2018; Wisniewska *et al.*, 2016). Therefore, there is a risk of changes to their overall fitness if they are displaced from high-quality foraging grounds or if their foraging efficiency is disturbed, and they are unable to find alternative suitable foraging grounds that will provide sufficient food to meet their metabolic needs. However, results from studies using DTAGs suggest that harbour porpoises are able to respond to short-term reductions in food intake and may have some resilience to disturbance (Wisniewska *et al.*, 2016).

11.10.1.25 Several studies have shown that harbour porpoises are displaced during periods of pile driving (Benhemma-Le Gall *et al.*, 2021; Brandt *et al.*, 2016; Graham *et al.*, 2019;). For example, monitoring of harbour porpoise during piling at Beatrice offshore windfarm in northeast Scotland indicated that porpoises were displaced from the immediate vicinity of the piling activity with a 50% probability of response occurring at approximately 7 km at the first piled location (Graham *et al.*, 2019). However, the 50% probability of response reduced to 1.3 km by the final piling location, suggesting that the response of harbour porpoise diminished over the construction period (Graham *et al.*, 2019).

11.10.1.26 This is further supported by studies at eight offshore windfarms in the German North Sea where declines in porpoise detection of >90% were recorded at noise levels above 170 dB compared to a baseline period of 24 to 48 hours (Brandt *et al.*, 2016). A decline in detections of 25% at noise levels between 145 and 150 dB showed a decrease in effect with increase in distance from the piling location (Brandt *et al.*, 2016). Furthermore, the detection rates showed that animals were only displaced from the area for a short period (one to three days) (Brandt *et al.*, 2011; Brandt *et al.*, 2016; Brandt *et al.*, 2018; Dähne *et al.*, 2013).

11.10.1.27 Recent studies at two offshore windfarms in Scotland showed that detections of clicks, associated with echolocation, and buzzing, associated with prey capture, in the short range (2 km) did not cease in response to piling, suggesting that porpoises were not completely displaced from the piling area (Benhemma-Le Gall *et al.*, 2021). Furthermore, the study suggests that animals that experience displacement may be able to compensate for missed foraging opportunities and increased energy expenditure of fleeing the piling area as detections of both clicks and buzzing were positively related to the distance from the piling activity (Benhemma-Le Gall *et al.*, 2021) which could be due to an increase in foraging activities beyond the piling impact range.

11.10.1.28 At an expert elicitation workshop in 2018, experts agreed that juvenile and adult survival were unlikely to be significantly affected by missed foraging opportunities as a result of disturbance from piling (Booth *et al.*, 2019). As a result, harbour porpoises are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

BOTTLENOSE DOLPHIN

11.10.1.29 A study of bottlenose dolphin response to impulsive noise (including the piling campaigns of Beatrice offshore windfarm and Moray East offshore windfarm, northeast Scotland), suggest that these activities did not cause displacement of the species from the southern coast of the Moray Firth (Fernandez-Betelu *et al.*, 2021). At the small temporal scale, dolphin detections increased, and the species remained within the predicted impacted area close to the offshore activities, for a median of two hours per day, on days with impulsive noise. This could be due to modifications in group size and/or behaviour, or changes in vocalisation rate or amplitude in response to impulsive noise generated by offshore activities. It is also important to note that bottlenose dolphin occurrence is largely influenced by various natural drivers, such as prey abundance, which could be deemed of higher importance in affecting their occurrence. Other studies in the Cromarty Firth, northeast Scotland have suggested small spatial and temporal scale disturbance of bottlenose dolphins from piling activities have occurred previously, as evidenced by a slight reduction of the presence, detection positive hours, and the encounter duration in the vicinity of construction works, although dolphins were not excluded entirely from the area (Graham *et al.*, 2017a).

11.10.1.30 There is potential for behavioural disturbance due to underwater noise to result in disruption in foraging and resting activities and an increase in travel and energetic costs (Marley *et al.*, 2017b; Pirotta *et al.*, 2015), although evidence suggests that this will occur on a small spatial and temporal scale. Furthermore, New *et al.* (2013) showed that while there is potential for disturbance to affect bottlenose dolphin behaviour and health, which will then impact vital rates and population dynamics, individuals are able to compensate for immediate behavioural responses to disturbances caused by vessel activity. This suggests that they have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance. As a result, bottlenose dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, bottlenose dolphins are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

RISSO'S DOLPHIN

11.10.1.31 Limited information on the response of Risso's dolphin to pile driving exists and there are few studies to investigate the effects of other impulsive noise sources, such as seismic surveys. The frequency range of seismic airguns may be similar to that of low-frequency noise produced by pile driving, although its duration and cumulative acoustic energy levels will differ. A study on the effects of seismic operations in UK waters showed no response by Risso's dolphin to seismic airguns (Stone *et al.*, 2017). During controlled experiments where Risso's dolphin were exposed to simulated military sonar (SPLs of 135 dB re 1µPa), no clear behavioural response was recorded (Southall *et al.*, 2011).

11.10.1.32 The limited information available for the impacts of pile driving, construction-related activity and seismic surveys on Risso's dolphins make it challenging to assess the risk for this species. Based on evidence available, Risso's dolphin are considered to be of high adaptability, reasonable tolerance, high recoverability, and of high value. Therefore, Risso's dolphin are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

COMMON DOLPHIN

11.10.1.33 Limited information on the response of common dolphins to pile driving exists, with few studies investigating impacts of any impulsive sound source on this species. The majority of evidence for the response of common dolphins to seismic surveys (an impulsive sound source) shows no change in occurrence or sighting densities of common dolphin during active surveys (Kavanagh *et al.*, 2019; Stone *et al.*, 2017). Similarly, a monitoring study in northwest Ireland investigating the effects of construction-related activity, including but not limited to seismic surveys, multi-beam surveys, ROV surveys, dredging, back filling, rock trenching, rock placement, rock breaking, pipe laying and umbilical laying, during the construction of a gas pipeline found no changes in occurrence of common dolphin as a result of these construction - related activities in the area (Culloch *et al.*, 2016).

11.10.1.34 The limited information available for the impacts of pile driving, construction-related activity and seismic surveys on common dolphins make it challenging to assess the risk to this species. However, there is evidence to suggest that common dolphins are able to adjust their whistle characteristics to account for masking as a result of anthropogenic noise (Papale *et al.*, 2015), suggesting some tolerance and adaptability. As a result, common dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, common dolphins are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during pile driving.

MINKE WHALE

11.10.1.35 Limited information on the behavioural responses of minke whales to underwater noise is available. A study on the behavioural sensitivity of minke whale reactions to sonar signals showed that they displayed prolonged avoidance, increase in swim speed directly away from the source, and cessation of feeding for a received SPL of 146dB re 1µPa and long-term (6 hour) avoidance of the area for a received SPL of 158dB re 1µPa (Sivle *et al.*, 2015). A study detailing minke whale responses to the Lofitech 'seal scarer' ADD showed minke whales within 500 m and 1,000 m of the source (source level of 204dB re 1 µPa @1 m) exhibiting responses of increased swim speeds and movement away from the source (McGarry *et al.*, 2017). Marine mammal monitoring showed that fine-scale temporal occurrence of minke whales was reduced by the presence of construction related activity (which did not include pile driving but did assess vessel presence as a proxy for other activities, including seismic surveys and multi-beam surveys) in Broadhaven Bay, northwest Ireland (Culloch *et al.*, 2016).

11.10.1.36 Minke whale are seasonal migrants to Irish (and UK) waters, where they forage on pelagic schooling fish during the summer months (Whooley, 2016). While information on the behavioural responses of minke whales to underwater noise is limited, it is anticipated that minke whales will be able to tolerate temporary displacement from foraging areas due to their large size and capacity for energy storage. As a result, minke whales are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, minke whales are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

GREY SEAL

11.10.1.37 Limited information on the behavioural responses of grey seals to underwater noise is available. Studies in the Netherlands collected telemetry data from 20 grey seals in 2014 during the during the construction of the Luchterduinen windfarm and from 16 grey seals in 2015 during the construction of the Gemini windfarm (Aarts *et al.*, 2018). The most common response suggested a change in behaviour from foraging to horizontal movement, although various other responses were recorded including, altered surfacing and diving behaviour, changes in swim

direction, and no response (Aarts *et al.*, 2018). Data from this study also showed that seals returned to the area on subsequent trips, despite receiving multiple exposures.

11.10.1.38 During an expert elicitation workshop in 2018, it was concluded that grey seals were considered to have a reasonable ability to compensate for missed foraging opportunities due to disturbance from underwater noise given their generalist diet, adequate fat stores, mobility, and life history (Booth *et al.*, 2019). In general, experts agreed that grey seals would be more robust to the effects of disturbance than harbour seals as they have larger energy store and are more generalist in their diet and more adaptable in their foraging strategies (Booth *et al.*, 2019). Experts also agreed that moderate-high levels of repeated disturbance would be required for any effect on grey seal fertility rates (Booth *et al.*, 2019).

11.10.1.39 Grey seals are highly adaptable to a changing environment. They can adjust their metabolic rate and foraging strategies and can compensate for lost opportunities due to their generalist diet, mobility, and adequate fat stores (Smout *et al.*, 2014; Stansbury *et al.*, 2015). They are also able to tolerate periods of fasting as part of their life history because of their large body size and thick layer of blubber (i.e. more energy reserve) (Pomeroy *et al.*, 1999). In addition, they are wide ranging and can travel large distances (up to 488 km) between different haul out and foraging regions, although on average, distances tend to be approximately 65 km (McConnell *et al.*, 1999). As a result, grey seals are considered to be of high adaptability, reasonable to high tolerance, have high recoverability, and are of high value. Therefore, grey seals are assessed as having a Negligible sensitivity to behavioural disturbance from underwater noise during piling driving.

HARBOUR SEAL

11.10.1.40 Behavioural disturbance of harbour seals as a result of underwater noise during pile driving could have an effect on both survival if it results in the separation of a pup from its mother, and reproduction via body condition if it results in the animal spending less time feeding or conserving energy by resting (Booth *et al.*, 2019).

11.10.1.41 A study of telemetry tagged harbour seals in the Wash, showed displacement during piling with a 19 to 83% reduction in abundance compared to during piling breaks (Russell *et al.*, 2016). The study shows that abundance was significantly reduced up to 25 km from the piling activity (Russell *et al.*, 2016). However, seals within the area returned to usage levels similar to non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term.

11.10.1.42 It is possible that displacement of harbour seals could result in an increase energetic cost if they are required to travel greater distances to compensate for missed foraging opportunities, which could potentially affect the reproductive success of a small number of individuals. However, during an expert elicitation workshop in 2018, the experts considered it unlikely that an individual would repeatedly return to an area where it had been previously displaced, and therefore unlikely to result in reduced foraging opportunities over a number of days that would be required to reduce body condition or fertility (Booth *et al.*, 2019).

11.10.1.43 Harbour seals have been reported to travel up to 273 kilometres from a haul-out whilst foraging, although they tend to remain within 50 km of their haul-out site and show high site fidelity (Carter *et al.*, 2022). The identified harbour seal haul-outs at Wexford Harbour, north Bull Island and Lambay island are situated approximately 50 km, 55 km and 62 km away from the Proposed Development, respectively, which suggests there is a low likelihood of harbour seals from these haul-outs using waters within the Proposed Development.

11.10.1.44 During the expert elicitation workshop in 2018, the experts also agreed that harbour seals have a reasonable ability to compensate for missed foraging opportunities from disturbance (from exposure to low frequency broadband pulsed noise such as piling driving) due to their generalist

diet, adequate fat stores, mobility, and life-history traits (Booth *et al.*, 2019), for example, they have a thick layer of blubber for energy storage that enables them to tolerate periods of fasting when hauled out between foraging trips or during breeding and moulting periods. Therefore, they are likely to have capacity to tolerate short-term displacement from foraging grounds during piling activity. As a result, harbour seals are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour seals are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

Construction phase

MAGNITUDE OF IMPACT: RAMP-UP MITIGATION SCENARIO

AUDITORY INJURY – PTS: RAMP-UP MITIGATION SCENARIO

11.10.1.45 The following section provides the quantitative assessment of the impact of PTS from pile driving on marine mammals. The predicted areas and maximum impact ranges for auditory injury (PTS-onset) from pile driving for each marine mammal species are also presented in Table 11.44 to Table 11.48.This includes the prediction of impact for each of the five modelling locations. A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.10.1.46 For harbour porpoise, the maximum instantaneous PTS-onset impact range was 680 m for the installation of a 11 m monopile at the C WTG location (Table 11.45). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) using the site-specific DAS density estimate. Using the cumulative PTS-onset thresholds, the maximum impact range was 1,700m (1.7 km) for the installation of a 11 m monopile at the C WTG location (Table 11.45). This equates to a maximum of two animals experiencing auditory injury (<0.01% of the reference population) using the site-specific DAS density estimate. Using the density estimate from SCANS-IV, which covers a larger spatial scale, this would be <1 animal (<0.01% of the reference population) that would experience auditory injury due to instantaneous PTS-onset, and <1 animal (<0.01% of the reference population) that would experience auditory injury due to cumulative PTS-onset (Table 11.45).

11.10.1.47 For dolphin species, the maximum instantaneous PTS-onset impact range was <50 m at all piling locations. This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) for all dolphin species. Using the cumulative PTS-onset thresholds, the maximum impact range for dolphin species was <50 m at all piling locations, and as such, a maximum of one animal experiencing auditory injury (<0.01% of the reference population) for all dolphin species.

11.10.1.48 For minke whale the maximum instantaneous PTS-onset impact range was 60 m for the installation of a 11 m monopile at the C WTG location (Table 11.45). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) using both the Rogan *et al.* (2018) and Hammond *et al.* (2021) density estimates. Using the cumulative PTS-onset thresholds, the maximum impact range was 7,100 m (7.1 km) for the installation of a 11 m monopile at the C WTG location (Table 11.45). This equates to a maximum of three animals experiencing auditory injury (<0.01% of reference population), using the density estimate from Rogan *et al.* (2018).

11.10.1.49 For seals, the maximum instantaneous PTS-onset impact range was 70 m for the installation of a 11 m monopile at the C WTG location (Table 11.45) This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population). Using the cumulative PTS-onset thresholds, the maximum impact range was <50 m at all piling locations. This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population).

11.10.1.50 The impact is restricted to active piling days during the construction phase and is reasonably expected to occur. It is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. As part of an expert elicitation workshop, experts in the relevant fields of marine mammal science discussed the nature, extent, and consequence of hearing threshold shifts on marine mammal arising from repeated exposures to low-frequency impulsive noise (Booth and Heinis, 2018). It was acknowledged that energy from piling noise primarily concentrates between about 30 and 500 Hz, and peaks between 100 and 300 Hz with extension to above 2 kHz (Kastelein *et al.*, 2015a, Kastelein *et al.*, 2016). The experts agreed that PTS and TTS as a result of piling would occur between the frequency range of 2 to 10 kHz (Kastelein *et al.*, 2017), with PTS of 6 to 18 dB within this narrow range. They concluded that such change is not likely to adversely and significantly impact the survival and reproductive rates of marine mammals, including minke whales, which have a hearing range in the lower frequencies (paragraphs 11.10.1.18 and 11.10.1.19).Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoise and minke whale as between one and three animals may be impacted. For dolphin and seal species, a maximum of one animal (<1 as presented in Table 11.44 to Table 11.48) is predicted to experience auditory injury (PTS), therefore the magnitude of impact is assessed as Negligible adverse.

Table 11.44: PTS-onset from pile driving at the N WTG location based on the ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})					
Harbour porpoise	0.38	1.0	580	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	50	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01

[6] Further information on the density estimates here can be found in Table 11.7

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Grey seal	0.08	0.01	60	<1	<0.01
Harbour seal	0.0003	0.01	60	<1	<0.01
Cumulative PTS-onset (weighted SEL_{cum})					
Harbour porpoise	0.38	0.6	820	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	16	4,100	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Harbour seal	0.0003	<0.01	<50	<1	<0.01

Table 11.45: PTS-onset from pile driving at the C WTG location based on the ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})					
Harbour porpoise	0.38	1.3	680	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	60	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	0.01	70	<1	<0.01
Harbour seal	0.0003	0.01	70	<1	<0.01
Cumulative PTS-onset (weighted SEL_{cum})					

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Harbour porpoise	0.38	3.3	1,700	2	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	57	7,100	3	0.01
	0.017			1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

Table 11.46: PTS-onset from pile driving at the SW WTG location based on the ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})					
Harbour porpoise	0.38	0.9	580	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	50	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	0.01	60	<1	<0.01
Harbour seal	0.0003	0.01	60	<1	<0.01
Cumulative PTS-onset (weighted SEL_{cum})					

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Harbour porpoise	0.38	2.8	1,500	1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	37	5,800	2	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

Table 11.47: PTS-onset from pile driving at the N-OSP location based on the ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})					
Harbour porpoise	0.38	0.8	520	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	50	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	60	<1	<0.01
Harbour seal	0.0003	<0.01	60	<1	<0.01
Cumulative PTS-onset (weighted SEL_{cum})					

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Harbour porpoise	0.38	0.23	520	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	7.1	3,000	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

Table 11.48: PTS-onset from pile driving at the S-OSP location based on the ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})					
Harbour porpoise	0.38	0.4	380	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	<50	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01
Cumulative PTS-onset (weighted SEL_{cum})					

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Harbour porpoise	0.38	0.09	370	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	0.28	790	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

TTS: RAMP-UP MITIGATION SCENARIO

11.10.1.51 The following section provides the qualitative assessment of the impact of TTS from pile driving on marine mammals. The predicted areas and maximum impact ranges for TTS-onset from pile driving at each of the five modelling locations are presented in Table 11.49. As outlined in section 11.7.4, no assessment of the number of animals, magnitude, sensitivity, or significance of effect has been undertaken because there are no thresholds to determine a biologically significant effect from TTS-onset.

11.10.1.52 For harbour porpoises, the maximum instantaneous TTS-onset impact range was 1,600 m (1.6 km) for the installation of a 11 m monopile at the C WTG location (Table 11.49). Using the cumulative TTS-onset thresholds, the maximum impact range for harbour porpoise was 35,000 m (35 km) for the installation of a 11 m monopile at the C WTG location (Table 11.49).

11.10.1.53 For dolphin species, the maximum instantaneous TTS-onset impact range was <50 m at all piling locations (Table 11.49). Using the cumulative TTS-onset thresholds, the maximum impact range for dolphin species was <50 m at all piling locations (Table 11.49).

11.10.1.54 For minke whale, the maximum instantaneous TTS-onset impact range was 140 m for the installation of a 11 m monopile at the C WTG location (Table 11.49). Using the cumulative TTS-onset thresholds, the maximum impact range for minke whale was 60,000 m (60 km) for the installation of a 11 m monopile at the C WTG location (Table 11.49).

11.10.1.55 For seals, the maximum instantaneous TTS-onset impact range was 160 m for the installation of a 11 m monopile at the C WTG location (Table 11.49). Using the cumulative TTS-onset thresholds, the maximum impact range for seals was 16,000 m (16 km) for the installation of a 11 m monopile at the C and SW WTG location (Table 11.49).

Table 11.49: TTS-onset from pile driving at WTG and OSP locations based on the ramp-up mitigation scenario

Species	Impact	Piling location				
		N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
Instantaneous TTS-onset (unweighted SPL_{peak})						
Harbour porpoise (VHF cetacean)	Area (km^2)	4.9	5.8	4.6	3.8	1.7
	Maximum range (m)	1,400	1,600	1,400	1,200	880
Bottlenose dolphin, Risso's dolphin, common dolphin (HF cetacean)	Area (km^2)	<0.01	<0.01	<0.01	<0.01	<0.01
	Maximum range (m)	<50	<50	<50	<50	<50
Minke whale (LF cetacean)	Area (km^2)	0.05	0.06	0.04	0.04	0.02
	Maximum range (m)	120	140	120	110	80
Grey seal, harbour seal (PCW)	Area (km^2)	0.06	0.07	0.06	0.05	0.03
	Maximum range (m)	140	160	140	130	100
Cumulative TTS-Onset (weighted SEL_{cum})						
Harbour porpoise (VHF cetacean)	Area (km^2)	1,000	1,600	1,600	900	1,000
	Maximum range (m)	30,000	35,000	34,000	29,000	28,000
Bottlenose dolphin, Risso's dolphin, common dolphin (HF cetacean)	Area (km^2)	<0.01	<0.01	<0.01	<0.01	<0.01
	Maximum range (m)	<50	<50	<50	<50	<50
	Area (km^2)	3,100	4,500	4,100	2,500	1,900

Species	Impact	Piling location				
		N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
Minke whale (LF cetacean)	Maximum range (m)	53,000	60,000	59,000	49,000	41,000
Grey seal, harbour seal (PCW)	Area (km^2)	200	340	370	160	180
	Maximum range (m)	13,000	16,000	16,000	12,000	11,000

BEHAVIOURAL DISTURBANCE: RAMP-UP MITIGATION SCENARIO

11.10.1.56 The number of each marine mammal species predicted to experience behavioural disturbance as a result of pile driving is presented in Table 11.50 and Table 11.51 and assessed as the proportion of the respective reference population (as presented in Table 11.7). For dolphin species and minke whale, numbers of animals predicted to experience behavioural disturbance have been calculated using both the dose-response method (Graham *et al.,* 2017b) (see Table 11.50) and Level B harassment thresholds (NMFS, 2005) (see Table 11.51). The predictions for the C WTG, N WTG, SW WTG, N-OSP, and S-OSP modelling locations are presented separately. Disturbance from concurrent piling has not been assessed as piling is limited to one installation per day for Project Design Option 2 (see Table 11.10). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.10.1.57 iPCoD modelling was conducted to determine whether the level of disturbance is expected to result in population level impacts. The results of the iPCoD modelling show that there is no significant effect of disturbance resulting from pile driving at the Proposed Development to harbour porpoise, bottlenose dolphin, minke whale, grey seal, and harbour seal. Furthermore, for minke whale, grey seal, and harbour seal, impacted population is predicted to continue at a stable trajectory at exactly the same size as the un-impacted population. For further information see Volume III, Appendix 11.3: Phase 1 Irish Offshore Windfarms: Cumulative iPCoD Modelling.

Table 11.50: Predicted impact of disturbance to marine mammals from pile driving using dose-response curves based on the ramp-up mitigation scenario; # = number of animals disturbed; % = the percentage of the reference population[6]

Species	Density	Impact	Piling location				
			N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
Harbour porpoise	0.38	#	1,456	1,908	1,753	1,270	1,109
		%	2.33	3.05	2.80	2.03	1.77
	0.2803	#	1,074	1,408	1,293	937	818
		%	1.72	2.25	2.07	1.50	1.31
	Grid-cell specific	#	447	586	538	390	340
		%	0.72	0.94	0.86	0.62	0.54
Bottlenose dolphin[7]	0.0201	#	78	101	93	68	59
		%	26.62	34.47	31.74	23.21	20.14
	0.2352	#	902	1,181	1,085	786	687
		%	307.85	403.07	370.31	268.26	234.47

[7] The variation in the number of bottlenose dolphins predicted to be disturbed by pile driving reflects differences in the spatial scales and survey methodologies used to derive density estimates. The variation of these methodologies, and their implications for the assessment, are outlined in paragraphs 11.10.1.63 to 11.10.1.6911.9.1.72.

Species	Density	Impact	Piling location				
			N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
		%[8]	10.84	14.19	13.04	9.45	8.26
	Grid-cell specific	#	760	995	914	662	578
		%	259.39	339.59	311.95	225.94	197.27
		%[8]	9.13	11.96	10.98	7.96	6.95
Risso's dolphin	0.031	#	119	156	143	104	91
		%	0.97	1,27	1.17	0.85	0.74
Common dolphin	0.0272	#	105	137	126	91	80
		%	0.10	0.13	0.12	0.09	0.08
	Grid-cell specific	#	227	297	273	198	173
		%	0.22	0.29	0.27	0.19	0.17
Minke whale	0.045	#	173	226	208	151	132
		%	0.86	1.12	1.03	0.75	0.66

[8] There is a substantial difference between the SCANS-III and SCANS-IV density and abundance estimates for bottlenose dolphins in the Irish Sea. SCANS-IV estimates 8,326 animals in blocks CS-D and CS-E (Gilles *et al.,* 2023), whereas SCANS-III estimated 288 animals for the equivalent survey blocks, from which the current MU population size of 293 animals is derived (IAMMWG, 2023). When assessing impacts on bottlenose dolphins using SCANS-IV density estimates (both the block-wide uniform densities (0.2352/km^2) and the grid-cell-specific density), it is therefore more appropriate and robust to compare the resulting number of animals impacted against a population estimate that aligns with SCANS-IV, which is 8,326 animals. Hence, a second impact % has been presented to reflect this.

Species	Density	Impact	Piling location				
			N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
	0.017	#	66	86	79	57	50
		%	0.33	0.43	0.39	0.28	0.25
	Grid-cell specific	#	18	23	22	16	14
		%	0.09	0.11	0.11	0.08	0.07
Grey seal	0.08	#	89	132	118	76	65
		%	5.35	7.94	7.10	4.57	3.91
Harbour seal	0.0003	#	1	1	1	1	1
		%	0.55	0.55	0.55	0.55	0.55

Table 11.51: Predicted impact of disturbance to marine mammals from pile driving using level B harassment threshold based on the ramp-up mitigation scenario; # = number of animals disturbed; % = the percentage of the reference population[6]

Species	Density	Impact	Piling location				
			N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
Bottlenose dolphin[7]	0.0201	#	16	23	23	14	12
		%	5.46	7.85	7.85	4.78	4.10
	0.2352	#	179	259	259	153	132
		%	61.09	88.40	88.40	52.22	45.05
		%[8]	2.15	3.11	3.12	1.84	1.59
	Grid-cell specific	#	151	218	218	129	111
		%	51.54	74.40	74.40	44.03	37.88
		%[8]	1.82	2.62	2.62	1.55	1.34
Risso's dolphin	0.031	#	24	35	35	21	18
		%	0.20	0.29	0.29	0.17	0.15
Common dolphin	0.0272	#	21	30	30	18	16
		%	0.02	0.03	0.03	0.02	0.02
	Grid-cell specific	#	45	65	65	39	34
		%	0.04	0.06	0.06	0.04	0.03
Minke whale	0.045	#	35	50	50	30	26

Species	Density	Impact	Piling location				
			N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
		%	0.17	0.25	0.25	0.15	0.13
	0.017	#	13	19	19	12	10
		%	0.06	0.09	0.09	0.06	0.05
	Grid-cell specific	#	4	6	6	3	3
		%	0.02	0.03	0.03	0.01	0.01

HARBOUR PORPOISE

11.10.1.58 Using the site-specific density estimate of 0.38 animals/km^2 from the DAS, it was estimated that a maximum of 1,908 animals (3.05% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50). This is considered to be highly conservative because it assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea of which the noise contours extend across. As a result, alternative estimates have also been presented.

11.10.1.59 Using the uniform density estimate of 0.2803 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 1,408 animals (2.25% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50). While this is considered to be a more realistic estimate of density across the wider disturbance area compared to the estimated density from the site-specific DAS, it assumes a uniform density of animals across the Irish Sea which is not realistic.

11.10.1.60 In order to account for the non-uniform density of harbour porpoise across the Irish Sea, the number of animals disturbed was also presented using the modelled density surfaces derived from SCANS-IV. Using this approach, it was estimated that a maximum of 586 animals (0.94% of the reference population) will experience behavioural disturbance as a result of pile driving at the C WTG location (Table 11.50).

11.10.1.61 At its furthest point from the source, the 120 SEL_{ss} dB re 1µPa^2$_s$ disturbance contour reaches the Welsh coastline, extending northwards to approximately 68 km north of the north coast of Wales, and southwards to approximately 87 km south of the south coast of Wales (Figure 11.5). This suggests that behavioural response from harbour porpoise may not be localised and could extend across the Irish Sea, although extremely low numbers (21 animals from pile driving of the 11 m monopile at the C WTG location) of harbour porpoise are expected to respond at this received level.

11.10.1.62 The impact on harbour porpoises is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoises.

BOTTLENOSE DOLPHIN

11.10.1.63 Using the uniform density estimate of 0.0201 animals/km^2 from the ObSERVE surveys, it was estimated that a maximum of 101 animals (34.47% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50). This is considered to be conservative because it assumes that the density within stratum 5 (western Irish Sea) is the same across the wider extent of the Irish Sea of which the noise contours extend across.

11.10.1.64 Using the uniform density estimate of 0.2352 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 1,181 animals (403.07% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50). This is not considered to be realistic as it assumes a uniform density and does not capture the variability in coastal and offshore population densities and distributions within the Irish Sea.

11.10.1.65 In order to account for the non-uniform density of bottlenose dolphin across the Irish Sea, modelled density surfaces derived from SCANS-IV were also used to calculate the number of animals disturbed. Using this approach, it was estimated that a maximum of 995 animals (339.59% of the reference population) will experience behavioural disturbance as a result of pile

driving of the 11 m monopile at the C WTG location (Table 11.50). Both of these approaches are over-predicting the number of animals available in the area that could be disturbed by pile driving as the number of animals calculated exceeds the reference population size of 293. Therefore, these calculations are not considered to be robust.

11.10.1.66 The noise contours extend to cover the majority of the Irish Sea MU (Figure 11.5), which is used as the reference population for bottlenose dolphin (Table 11.50). Therefore, it is anticipated that the majority of the reference population of 293 dolphins will be within the disturbance contours. However, the number and proportion of bottlenose dolphin disturbed during pile driving was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b), as there is no corresponding species-specific data available for bottlenose dolphin. However, studies suggest that bottlenose dolphins are typically less sensitive to behavioural disturbance than harbour porpoise (Culloch *et al.*, 2016; Kastelein *et al.*, 2006; Stone *et al.*, 2017). Therefore, it is expected that the probability of response to underwater noise from pile driving would be lower. To demonstrate this, the number and proportion of bottlenose dolphin disturbed during pile diving have also been calculated using the Level B harassment threshold and presented in Table 11.51. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, for example, a maximum of 259 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C and SW WTG location and using the uniform density estimate of 0.2352 animals/km^2 from the wider SCANS-IV surveys (Table 11.51) compared to 1,181 animals estimated at the C WTG location using the dose-response curve (Table 11.50). This suggests that the dose-response method results in a very conservative calculation of the number and proportion of bottlenose dolphins disturbed.

11.10.1.67 Furthermore, the reference population does not take into account the connectivity of the reference population with other areas. Studies have shown large scale movement of bottlenose dolphins around Ireland and indicated connectivity with the population on the west coast of the RoI (O'Brien *et al.*, 2010). Long distance movements from the Atlantic to the North Sea between populations in the UK and Ireland have also been reported by Robinson *et al.* (2012). Therefore, the size of the reference population used from the Irish Sea MU is likely to be an under-representation of the number of bottlenose dolphins that may be present in the MU Study Area. Equally, the most recent abundance estimates from the semi-resident population at Cardigan Bay in West Wales (which is within the Irish Sea MU) alone were 147 individuals (95% CI: 127 to 194; NRW, 2018). The design of broad scale surveys, such as SCANS, used to derive MU population estimates are not able to capture localised, coastal populations such as that of Cardigan Bay, providing further evidence to suggest that the reference population size has been under-estimated.

11.10.1.68 Furthermore, it is important to highlight the significant difference between the SCANS-III and SCANS-IV abundance estimates of bottlenose dolphins in the Irish Sea. The SCANS-IV abundance estimate for the Irish Sea (blocks CS-D and CS-E) is 8,326 animals (Gilles *et al.,* 2023) whereas the MU population is derived from the lower SCANS-III abundance estimates, resulting in a population size of 293 (IAMMWG, 2023). As a result, the number of animals predicted to be disturbed using the density estimate from SCANS-IV is not compatible with the MU population size, resulting in a highly unrealistic proportion of the MU population estimated as impacted given that the population size is under-estimated. If the population size is taken to be 8,326 animals, the percentage of the population predicted to be disturbed reduces to 14.19%, when assuming 1,181 animals are disturbed using the dose-response curve, and 3.11% when using the Level B harassment threshold.

11.10.1.69 The impact on bottlenose dolphins is considered to result in a temporary change to most individuals, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is unlikely to have long-term

consequences that would affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for bottlenose dolphins.

RISSO'S DOLPHIN

11.10.1.70 Using the uniform density estimate of 0.031 animals/km^2 from the wider SCANS-III surveys as the most conservative density estimate available, it was estimated that a maximum of 156 animals (1.27% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50). While it is it unrealistic to assume a uniform density of animals across the Irish Sea, modelled density surfaces could not be derived for Risso's dolphin due to insufficient data (Lacey *et al.*, 2022; Gilles *et al.*, 2025).

11.10.1.71 Limited information on the response of Risso's dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of Risso's dolphin disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b; Figure 11.5) and is therefore likely to be an over-estimate (section 11.9). Due to the lack of species-specific data to apply to the dose-response curve for Risso's dolphin, the number and proportion of Risso's dolphin disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.51. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 35 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C and SW WTG location (Table 11.51) compared to 156 animals estimated at the C WTG location using the dose-response curve (Table 11.50). This suggests that the dose-response method results in a very conservative calculation of the number and proportion of Risso's dolphins disturbed.

11.10.1.72 The impact on Risso's dolphins is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for Risso's dolphins.

COMMON DOLPHIN

11.10.1.73 Using the uniform density estimate of 0.0272 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 137 animals (0.13% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50).

11.10.1.74 In order to account for the non-uniform density of common dolphin across the Irish Sea, modelled density surfaces derived from SCANS-IV were also used to calculate the number of animals disturbed. Using this approach, it was estimated that a maximum of 297 animals (0.29% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50).

11.10.1.75 Limited information on the response of common dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of common dolphin disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b; Figure 11.5) and is therefore likely to be an over-estimate (section 11.9). Due to the lack of species-specific data to apply to the dose-response curve for common dolphin, the number and proportion of common dolphin disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.51. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 65 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C and SW WTG location and using the non-uniform density of common dolphin

across the Irish Sea, modelled density surfaces derived from SCANS-IV (Table 11.51) compared to 297 animals estimated using the dose-response curve (Table 11.50). This suggests that the dose-response method results in a very conservative calculation of the number and proportion of common dolphins disturbed.

11.10.1.76 The impact on common dolphins is considered to result in a very small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for common dolphins.

MINKE WHALE

11.10.1.77 Using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys, it was estimated that a maximum of 226 animals (1.12% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50).

11.10.1.78 Using the wider SCANS-III density estimate of 0.017 animals/km^2, it was estimated that a maximum of 86 animals (0.43% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50).

11.10.1.79 In order to account for the non-uniform density of minke whale across the Irish Sea, modelled density surfaces derived from SCANS-IV were also used to calculate the number of animals disturbed. Using this approach, it was estimated that a maximum of 23 animals (0.11% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50).

11.10.1.80 Limited information on the response of minke whale to behavioural disturbance to pile driving is available. Therefore, the number and proportion of minke whale disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b; Figure 11.5) and is therefore likely to be an over-estimate (section 11.9). Due to the lack of species-specific data to apply to the dose-response curve for minke whale, the number and proportion of minke whale disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.51. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 50 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C and SW WTG location and using the uniform density estimate of 0.045 animals/km^2 (Table 11.51) compared to 226 animals estimated at the C WTG location using the dose-response curve (Table 11.50). This suggests that the dose-response method results in a very conservative calculation of the number and proportion of minke whales disturbed.

11.10.1.81 It is also important to note that minke whales are expected to be mostly if not entirely absent in autumn and winter, and therefore any pile driving that occurs within these months is expected to have negligible impact on minke whales.

11.10.1.82 The impact on minke whale is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory and is only applicable to spring and summer months due to the seasonal presence of minke whales. Therefore, the magnitude of impact is assessed as Low adverse for minke whale.

GREY SEAL

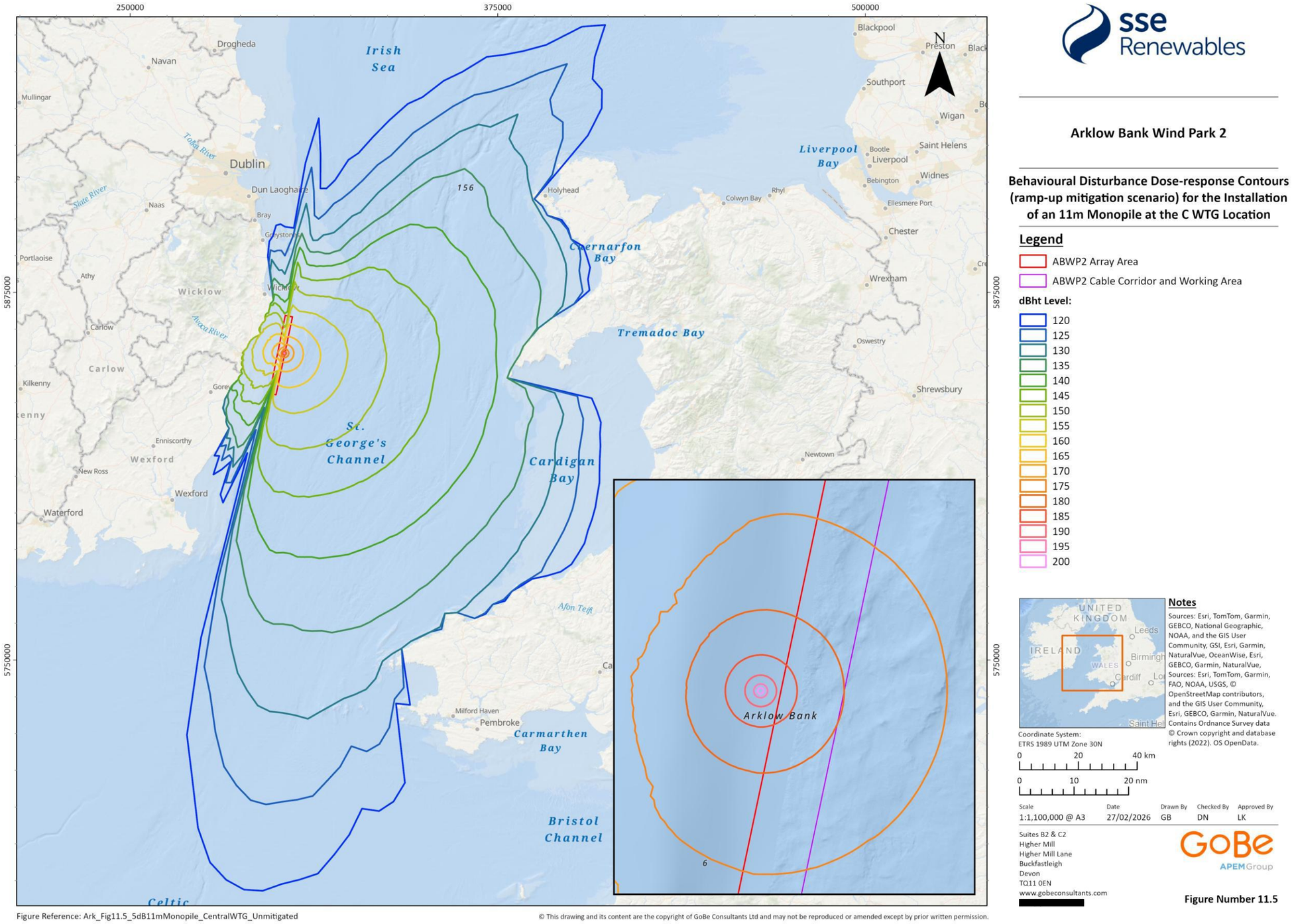
11.10.1.83 Using the averaged grid-cell specific densities derived from Carter *et al.* (2020), it was estimated that a maximum of 132 animals (7.94% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the C WTG location (Table 11.50).

11.10.1.84 The impact on grey seal is considered to result in a small to medium proportion of the population affected with change expected to be recoverable, occur frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low to Medium adverse for grey seal.

HARBOUR SEAL

11.10.1.85 Using the averaged grid-cell specific densities derived from Carter *et al.* (2020), it was estimated that a maximum of 1 animal (0.55% of the reference population) will experience behavioural disturbance as a result of pile driving in any location (Table 11.50).

11.10.1.86 The impact on harbour seal is considered to result in a very small number and proportion of the population affected with change expected to be recoverable, occur frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for harbour seal.



sse Renewables

Arklow Bank Wind Park 2

Behavioural Disturbance Dose-response Contours (ramp-up mitigation scenario) for the Installation of an 11m Monopile at the C WTG Location

Legend

- ABWP2 Array Area
- ABWP2 Cable Corridor and Working Area

dBht Level:

- 120
- 125
- 130
- 135
- 140
- 145
- 150
- 155
- 160
- 165
- 170
- 175
- 180
- 185
- 190
- 195
- 200

Notes

Sources: Esri, TomTom, Garmin, GEBCO, National Geographic, NOAA, and the GIS User Community, GSI, Esri, Garmin, NaturalVue, OceanWise, Esri, GEBCO, Garmin, NaturalVue, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, GEBCO, Garmin, NaturalVue. Contains Ordnance Survey data © Crown copyright and database rights (2022). OS OpenData.

Coordinate System:
ETRS 1989 UTM Zone 30N

0 20 40 km

0 10 20 nm

Scale	Date	Drawn By	Checked By	Approved By
1:1,100,000 @ A3	27/02/2026	GB	DN	LK

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Figure Number 11.5

Figure Reference: Ark_Fig11.5_5dB11mMonopile_CentralWTG_Unmitigated

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Figure 11.5: Behavioural disturbance dose-response contours (ramp-up mitigation scenario) for the installation of an 11 m monopile at the C WTG location

SIGNIFICANCE OF EFFECT: RAMP-UP MITIGATION SCENARIO

AUDITORY INJURY – PTS: RAMP-UP MITIGATION SCENARIO

11.10.1.87 For harbour porpoise, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour porpoise from underwater noise during pile driving **is Slight adverse**, which is **not significant** in EIA terms.

11.10.1.88 For bottlenose dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to bottlenose dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.89 For Risso's dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to Risso's dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.90 For common dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to common dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.91 For minke whale, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to minke whale from underwater noise during pile driving **is Slight adverse**, which is **not significant** in EIA terms.

11.10.1.92 For grey and harbour seal, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to grey and harbour seal from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE: RAMP-UP MITIGATION SCENARIO

11.10.1.93 For harbour porpoise, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to harbour porpoise from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.94 For bottlenose dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Medium adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to bottlenose dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.95 For Risso's dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to Risso's dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.96 For common dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to common dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.97 For minke whale, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to minke whale from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.98 For grey seal, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low to Medium adverse**, with the sensitivity of the receptor being **Negligible**. Therefore, the significance of effect from disturbance to grey seal from underwater noise during pile driving is **Imperceptible**, which is **not significant** in EIA terms.

11.10.1.99 For harbour seal, magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to grey seal from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECTS ASSESSMENT: EXTENDED RAMP-UP MITIGATION SCENARIO

11.10.1.100 The ramp-up mitigation scenario concluded no significant effects in EIA terms from injury and/or disturbance to marine mammals from underwater noise during pile driving. Nevertheless, the Applicant has committed to additional mitigation to further reduce the potential significance of the effect. The additional mitigation committed to by the Applicant is the extended ramp-up mitigation scenario outlined in Section 11.7.4.

11.10.1.101 Therefore, the assessment of residual effects has used the extended ramp-up mitigation scenario in the modelling and other quantitative aspects to inform the assessment of potential effects.

11.10.1.102 Impact piling for the WTG and OSP foundations was modelled for the extended ramp-up mitigation scenario at the same five representative locations modelled for the ramp-up mitigation scenario presented above, allowing direct comparison of potential impacts and informing the assessment conclusions.

MAGNITUDE OF IMPACT: EXTENDED RAMP-UP MITIGATION SCENARIO

AUDITORY INJURY – PTS: EXTENDED RAMP-UP MITIGATION SCENARIO

11.10.1.103 For harbour porpoise, the maximum instantaneous PTS-onset impact range was 680 m for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.53). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) using both the site-specific DAS and SCANS-IV density estimates. Using the cumulative PTS-onset thresholds, the maximum impact range was <50 m at all piling locations under the extended ramp-up mitigation scenario (Table 11.52 to Table 11.56). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) for both density estimates. However, as the Developer has committed to additional mitigation in combination with the extended ramp-up mitigation scenario (see Volume III, Appendix 25.2: Marine Mammal Mitigation Plan (Revised March 2026)), the predicted injury range of 680 m is within the R_{safe} distance of 1,000 m. Therefore, the extended ramp-up mitigation approach and implemented mitigation measures will provide effective mitigation of this distance. Hence, it is considered to result in complete displacement of animals from the impact range leading to no animals experiencing auditory injury.

11.10.1.104 For dolphin species, the maximum instantaneous PTS-onset impact range was <50 m at all piling locations under the extended ramp-up mitigation scenario (Table 11.52 to Table 11.56). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) for all dolphin species. Using the cumulative PTS-onset thresholds, the maximum

impact range for dolphin species was <50 m at all piling locations under the extended ramp-up mitigation scenario, and as such, a maximum of one animal experiencing auditory injury (<0.01% of the reference population) for all dolphin species (Table 11.52 to Table 11.56). However, as the Developer has committed to additional mitigation in combination with the extended ramp-up mitigation scenario (see Volume III, Appendix 25.2: Marine Mammal Mitigation Plan (Revised March 2026)), the predicted injury range of >50 m is within the R_{safe} distance of 1,000 m. Therefore, the extended ramp-up mitigation approach and implemented mitigation measures will provide effective mitigation of this distance. Hence, it is considered to result in complete displacement of animals from the impact range leading to no animals experiencing auditory injury.

11.10.1.105 For minke whale, the maximum instantaneous PTS-onset impact range was 60 m for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.53). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) using both the Rogan *et al.* (2018) and Hammond *et al.* (2021) density estimates. Using the cumulative PTS-onset thresholds, the maximum impact range was 870 m for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.53). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) for both density estimates. However, as the Developer has committed to additional mitigation in combination with the extended ramp-up mitigation scenario (see Volume III, Appendix 25.2: Marine Mammal Mitigation Plan (Revised March 2026)), the predicted injury range of 60 m is within the R_{safe} distance of 1,000 m. Therefore, the extended ramp-up mitigation approach and implemented mitigation measures will provide effective mitigation of this distance. Hence, it is considered to result in complete displacement of animals from the impact range leading to no animals experiencing auditory injury.

11.10.1.106 For seals, the maximum instantaneous PTS-onset impact range was 70 m for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.53). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population). Using the cumulative PTS-onset thresholds, the maximum impact range was <50 m at all piling locations under the extended ramp-up mitigation scenario (Table 11.52 to Table 11.56). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population). However, as the Developer has committed to additional mitigation in combination with the extended ramp-up mitigation scenario (see Volume III, Appendix 25.2: Marine Mammal Mitigation Plan (Revised March 2026)), the predicted injury range of 70 m is within the R_{safe} distance of 1,000 m. Therefore, the extended ramp-up mitigation approach and implemented mitigation measures will provide effective mitigation of this distance. Hence, it is considered to result in complete displacement of animals from the impact range leading to no animals experiencing auditory injury.

Table 11.52: PTS-onset from pile driving at the N WTG location based on the extended ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
		Instantaneous PTS-onset (unweighted SPL_{peak})			
Harbour porpoise	0.38	1.0	580	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	50	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	0.01	60	<1	<0.01
Harbour seal	0.0003	0.01	60	<1	<0.01

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
		Cumulative PTS-onset (weighted SEL$_{cum}$)			
Harbour porpoise	0.38	<0.01	<50	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	0.04	170	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
The predicted number of individuals exposed to PTS-onset (both instantaneous and cumulative) from pile driving is fewer than one animal for all species assessed. Importantly, the maximum PTS-onset ranges for all species falls entirely within the 1,000 m R_{safe} distance. Therefore, the extended ramp-up procedure and implemented mitigation measures will ensure that all marine mammals are displaced from the impact area. Consequently, no animals are expected to experience auditory injury.					

Table 11.53: PTS-onset from pile driving at the C WTG location based on the extended ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
		Instantaneous PTS-onset (unweighted SPL_{peak})			
Harbour porpoise	0.38	1.3	680	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	60	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	0.01	70	<1	<0.01
Harbour seal	0.0003	0.01	70	<1	<0.01

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
		Cumulative PTS-onset (weighted SEL$_{cum}$)			
Harbour porpoise	0.38	<0.01	<50	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	0.58	870	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

The predicted number of individuals exposed to PTS-onset (both instantaneous and cumulative) from pile driving is fewer than one animal for all species assessed. Importantly, the maximum PTS-onset ranges for all species falls entirely within the 1,000 m R_{safe} distance. Therefore, the extended ramp-up procedure and implemented mitigation measures will ensure that all marine mammals are displaced from the impact area. Consequently, no animals are expected to experience auditory injury.

Table 11.54: PTS-onset from pile driving at the SW WTG location based on the extended ramp-up mitigation scenario[6]

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})					
Harbour porpoise	0.38	0.9	580	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352				
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	50	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	0.01	60	<1	<0.01
Harbour seal	0.0003	0.01	60	<1	<0.01
Cumulative PTS-onset (weighted SEL_{cum})					

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Harbour porpoise	0.38	<0.01	<50	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	0.08	330	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

The predicted number of individuals exposed to PTS-onset (both instantaneous and cumulative) from pile driving is fewer than one animal for all species assessed. Importantly, the maximum PTS-onset ranges for all species falls entirely within the 1,000 m R_{safe} distance. Therefore, the extended ramp-up procedure and implemented mitigation measures will ensure that all marine mammals are displaced from the impact area. Consequently, no animals are expected to experience auditory injury.

Table 11.55: PTS-onset from pile driving at the N-OSP location based on the extended ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})					
Harbour porpoise	0.38	0.8	520	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	50	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	60	<1	<0.01
Harbour seal	0.0003	<0.01	60	<1	<0.01
Cumulative PTS-onset (weighted SEL_{cum})					

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Harbour porpoise	0.38	<0.01	<50	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	0.02	120	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

The predicted number of individuals exposed to PTS-onset (both instantaneous and cumulative) from pile driving is fewer than one animal for all species assessed. Importantly, the maximum PTS-onset ranges for all species falls entirely within the 1,000 m R_{safe} distance. Therefore, the extended ramp-up procedure and implemented mitigation measures will ensure that all marine mammals are displaced from the impact area. Consequently, no animals are expected to experience auditory injury.

Table 11.56: PTS-onset from pile driving at the S-OSP location based on the extended ramp-up mitigation scenario[6]

Species	Density (animals/km²)	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})					
Harbour porpoise	0.38	0.4	380	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	<50	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01
Cumulative PTS-onset (weighted SEL_{cum})					

Species	Density (animals/km^2)	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Harbour porpoise	0.38	<0.01	<50	<1	<0.01
	0.2803			<1	<0.01
	Grid-cell specific			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	<1	<0.01
	0.2352			<1	<0.01
	Grid-cell specific			<1	<0.01
Risso's dolphin	0.031	<0.01	<50	<1	<0.01
Common dolphin	0.0272	<0.01	<50	<1	<0.01
	Grid-cell specific			<1	<0.01
Minke whale	0.045	<0.01	70	<1	<0.01
	0.017			<1	<0.01
	Grid-cell specific			<1	<0.01
Grey seal	0.08	<0.01	<50	<1	<0.01
Harbour seal	0.0003	<0.01	<50	<1	<0.01

The predicted number of individuals exposed to PTS-onset (both instantaneous and cumulative) from pile driving is fewer than one animal for all species assessed. Importantly, the maximum PTS-onset ranges for all species falls entirely within the 1,000 m R_{safe} distance. Therefore, the extended ramp-up procedure and implemented mitigation measures will ensure that all marine mammals are displaced from the impact area. Consequently, no animals are expected to experience auditory injury.

TTS: EXTENDED RAMP-UP MITIGATION SCENARIO

11.10.1.107 For harbour porpoises, the maximum instantaneous TTS-onset impact range was 1,600 m (1.6 km) for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.57). Using the cumulative TTS-onset thresholds, the maximum impact range for harbour porpoise was 30,000 m (30 km) for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.57).

11.10.1.108 For dolphin species, the maximum instantaneous TTS-onset impact range was <50 m at all piling locations under the extended ramp-up mitigation scenario (Table 11.57). Using the cumulative TTS-onset thresholds, the maximum impact range for dolphin species was <50 m at all piling locations under the extended ramp-up mitigation scenario (Table 11.57).

11.10.1.109 For minke whale, the maximum instantaneous TTS-onset impact range was 140 m for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.57). Using the cumulative TTS-onset thresholds, the maximum impact range for minke whale was 51,000 m (51 km) for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.57).

11.10.1.110 For seals, the maximum instantaneous TTS-onset impact range was 160 m for the installation of a 11 m monopile at the C WTG location under the extended ramp-up mitigation scenario (Table 11.57). Using the cumulative TTS-onset thresholds, the maximum impact range for seals was 12,000 m (12 km) for the installation of a 11 m monopile at the C and SW WTG location under the extended ramp-up mitigation scenario (Table 11.57).

11.10.1.111 As outlined in section 11.7.5, no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given because there are no thresholds to determine a biologically significant effect from TTS-onset.

Table 11.57: TTS-onset from pile driving at WTG and OSP locations based on the extended ramp-up mitigation scenario

Species	Impact	Piling location				
		N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
Instantaneous TTS-onset (unweighted SPL_{peak})						
Harbour porpoise (VHF cetacean)	Area (km^2)	4.9	5.8	4.6	3.8	1.7
	Maximum range (m)	1400	1600	1400	1200	880
Bottlenose dolphin, Risso's dolphin, common dolphin (HF cetacean)	Area (km^2)	<0.01	<0.01	<0.01	<0.01	<0.01
	Maximum range (m)	<50	<50	<50	<50	<50
Minke whale (LF cetacean)	Area (km^2)	0.05	0.06	0.04	0.04	0.02
	Maximum range (m)	120	140	120	110	80
Grey seal, harbour seal (PCW)	Area (km^2)	0.06	0.07	0.06	0.05	0.03
	Maximum range (m)	140	160	140	130	100
Cumulative TTS-Onset (weighted SEL_{cum})						
Harbour porpoise (VHF cetacean)	Area (km^2)	690	1100	1100	570	670
	Maximum range (m)	25000	30000	29000	24000	24000
Bottlenose dolphin, Risso's dolphin, common dolphin (HF cetacean)	Area (km^2)	<0.01	<0.01	<0.01	<0.01	<0.01
	Maximum range (m)	<50	<50	<50	<50	<50

Species	Impact	Piling location				
		N-WTG	C-WTG	SW-WTG	N-OSP	S-OSP
Minke whale (LF cetacean)	Area (km^2)	2100	3200	2900	1600	1100
	Maximum range (m)	44000	51000	50000	41000	33000
Grey seal, harbour seal (PCW)	Area (km^2)	78	170	180	58	61
	Maximum range (m)	8800	12000	12000	7900	7400

BEHAVIOURAL DISTURBANCE: EXTENDED RAMP-UP MITIGATION SCENARIO

11.10.1.112 As the dose-response relationship for behavioural disturbance and Level B harassment assessment are based on single-strike sound exposure level (SEL_{ss}), only the maximum hammer energy has been considered in the disturbance assessment. This approach reflects the fact that SEL_{ss} is based on the highest energy strike rather than cumulative energy over time. Therefore, the maximum hammer energy (3,500 kJ) is the same for the extended ramp-up mitigation scenario and the ramp-up mitigation scenario, and therefore, the predicted behavioural disturbance under the extended ramp-up mitigation scenario are consistent with those identified for the precautionary assessment (see Table 11.50; Table 11.51; Figure 11.5). Significance of Effect: extended ramp-up mitigation scenario

AUDITORY INJURY – PTS: EXTENDED RAMP-UP MITIGATION SCENARIO

11.10.1.113 Implementation of the extended ramp-up mitigation scenario results in a reduction in the number of animals predicted to experience PTS, leading to a material change in conclusions for some receptors, compared to the ramp-up mitigation scenario.

11.10.1.114 For harbour porpoise, the magnitude of the impact of PTS from underwater noise during pile driving under the extended ramp-up mitigation scenario has been assessed as **Negligible,** with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to harbour porpoise from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.115 For bottlenose dolphin, the magnitude of the impact of PTS from underwater noise during pile driving under the extended ramp-up mitigation scenario has been assessed as **Negligible,** with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to bottlenose dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.116 For Risso's dolphin, the magnitude of the impact of PTS from underwater noise during pile driving under the extended ramp-up mitigation scenario has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to Risso's dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.117 For common dolphin, the magnitude of the impact of PTS from underwater noise during pile driving under the extended ramp-up mitigation scenario has been assessed as **Negligible,** with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to common dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.118 For minke whale, the magnitude of the impact of PTS from underwater noise during pile driving under the extended ramp-up mitigation scenario has been assessed as **Negligible** , with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to minke whale from underwater noise during pile driving is **Not Significant,** which is **not significant** in EIA terms.

11.10.1.119 For grey and harbour seal, the magnitude of the impact of PTS from underwater noise during pile driving under the extended ramp-up mitigation scenario has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to grey and harbour seal from underwater noise during pile driving is **Not Significant,** which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE: EXTENDED RAMP-UP MITIGATION SCENARIO

11.10.1.120 As outlined in paragraph 11.10.1.112, as the maximum hammer energy (3,500 kJ) is the same for both the precautionary and the extended ramp-up mitigation scenario, the predicted behavioural disturbance effects are unchanged between scenarios. Accordingly, under the extended ramp-up mitigation scenario, the magnitude and the significance of behavioural disturbance effects range are the same as those reported for the ramp-up mitigation scenario (ranging from **Imperceptible** to **Slight adverse**; paragraph 11.10.1.93 to 11.10.1.99), all of which are not significant in EIA terms.

RESIDUAL EFFECTS ASSESSMENT CONCLUSION: EXTENDED RAMP-UP MITIGATION SCENARIO

11.10.1.121 The significance of the residual effect from underwater noise and vibration during piling is not significant in EIA terms and, therefore, no further mitigation measures are required for the purposes of the EIA assessment to avoid a significant effect.

11.10.1.122 However, the Developer has committed to the implementation of a MMMP (Volume III, Appendix 25.2: Marine Mammal Mitigation Plan (Revised March 2026)) which will further reduce any risk of disturbance to marine mammals.

11.10.2 Impact 2 – Injury and/or disturbance to marine mammals from vessel activities

11.10.2.1 Increased vessel movement during the construction, operations and maintenance, and decommissioning phases of the Proposed Development has the potential to result in a range of impacts on marine mammal receptors. These include injury or death due to collision with vessels, avoidance behaviour or displacement, and masking of vocalisations or changes in vocalisation rate.

11.10.2.2 The area surrounding the Proposed Development experiences a relatively low level of vessel traffic due to the presence of the shallow Arklow Bank sandbank, with higher traffic in the coastal areas and immediate surrounding waters (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026)).

11.10.2.3 The shipping and navigation baseline study (Volume III, Appendix 15.1: Navigational Risk Assessment (Revised March 2026)) recorded 29 days of vessel traffic data between 7th July and 14th August 2023. There was an average of 36 to 37 unique vessels per day recorded within the shipping and navigation Study Area (which is defined as Array Area and a 10 nm buffer). The busiest day recorded 59 unique vessels within the shipping and navigation Study Area. The main vessel types within the shipping and navigation Study Area were cargo vessels (40%), recreational vessels (31%) and fishing vessels (10%).

SENSITIVITY OF THE RECEPTOR

INJURY FROM VESSEL ACTIVITIES

11.10.2.4 During construction of the windfarm, a potential source of impact from increased vessel activity is physical trauma from collision with a boat or ship. In general, three consequences of vessel collision are defined: direct (injuries to the animals that are the immediate result of collision), long-term (a decrease in the fitness of the animal over time), and population consequences (Schoeman *et al.*, 2020). With regards to injuries, both fatal and non-fatal injuries between marine mammals and vessels have been documented (Laist *et al.*, 2001; Vanderlaan *et al.*, 2008; Cates *et al.*, 2017). Fatal collisions have been evidenced via carcasses washing up on beaches (Laist *et al.*, 2001; Peltier *et al.*, 2019); carcasses caught on vessel bows (Laist *et al.*, 2001; Peltier *et al.*, 2019); and floating carcasses which have strong evidence of ship strike, such as propeller cuts,

significant bruising, oedema, internal bleeding radiating from a specific impact site, fractures and ship paint marks (Jensen and Silber, 2003; Douglas *et al.*, 2008). Fatalities from ship strikes, however, often go unreported (Authier *et al.*, 2014). For non-fatal injuries, evidence of animals which have survived ship strikes with non-fatal injuries from propellers has been widely documented (Wells *et al.*, 2008; Luksenburg, 2014).

11.10.2.5 Although many species of marine mammals are able to detect and avoid vessels, it is unclear why some individuals do not always move out of the path of an approaching vessel (Schoeman *et al.*, 2020), although it has been suggested that behaviours such as resting, foraging, nursing, and socialising could distract animals from detecting the risk posed by vessels (Dukas, 2002). It is also possible that animals do not hear vessels when they are near the surface. Collisions between cetaceans and vessels, however, are not necessarily lethal on all occasions (Wells *et al.*, 2008; Luksenburg, 2014).

11.10.2.6 Harbour porpoises, dolphins, and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. For example, several studies have shown that harbour porpoise typically avoid vessels (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018; Heinänen and Skov, 2015).

11.10.2.7 The risk of collision between marine mammals and vessels is directly influenced by the type of vessel and the speed with which it is travelling (Laist *et al.*, 2001), and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in There is currently a lack of information on the frequency of occurrence of vessel collisions with marine mammals in Irish waters, and there is little evidence from marine mammals stranded in the Irish Sea to suggest that injury from vessel collisions is a significant cause of marine mammal mortality. In the UK, the Cetacean Strandings Investigation Programme (CSIP) documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. According to the most recent CSIP report, post-mortems were conducted on 69 out of the 532 reported harbour porpoise strandings in 2018. A cause of death was established in 60 examined individuals and, of these, one individual died from physical trauma due to vessel strike and two individuals had died from physical trauma of an unknown cause, which could have been due to vessel strike (CSIP, 2019). For bottlenose dolphin, post-mortems were conducted on one out of the nine reported strandings in 2018; the cause of death was not associated with vessel collision (CSIP, 2019). For Risso's dolphin, post-mortems were conducted on two out of the 15 reported strandings in 2018; the cause of death was not associated with vessel collision (CSIP, 2019). For common dolphin, post-mortems were conducted on 45 out of the 191 reported strandings in 2018 and a cause of death was established for 43 individuals. Of these, two individuals had died from physical trauma of an unknown cause, which could have been due to vessel strike (CSIP, 2019). For minke whale, post-mortems were conducted on three out of the 28 reported strandings in 2018. Of these, one individual had died due to vessel strike (CSIP, 2019). Overall, the CSIP data shows that very few strandings have been attributed to vessel collisions, therefore, while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a significant cause of mortality in RoI and UK waters.

11.10.2.8 Collision risk for seals is less understood than for cetaceans. However, trauma ascribed to collisions with vessels has been identified in a small proportion of both live stranded (Goldstein *et al.*, 1999) and dead stranded seals in the US (Swails, 2005). In these cases, however, less than 2% of all dead necropsied seals had vessel collision attributed to cause of death. A study in the Moray Firth showed that seals use the same areas as vessels during trips between haul-outs and foraging sites but that seals tended to remain beyond 20 m from vessels (only three instances over 2,241 days of seal activity resulted in passes at less than 20 m) (Onoufriou *et al.*, 2016), suggesting that the possibility of a risk of collision is very low.

11.10.2.9 Overall, these studies suggest that there is a high likelihood that marine mammals will avoid vessels and therefore, collision suggesting a low vulnerability. It is important to note that not all collisions that do occur are lethal, and there is a potential for recovery from injury. Furthermore, vessel collision is not considered to be a significant cause of marine mammal mortality (CSIP, 2019), but does have the potential to kill animals. As a result, all marine mammal species within this assessment are considered to be of reasonable adaptability, limited to no tolerance, have medium-term to no recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a High sensitivity to injury from vessel activities.

DISTURBANCE FROM VESSEL ACTIVITIES

HARBOUR PORPOISE

11.10.2.10 Harbour porpoises are particularly sensitive to high frequency noise and it is well documented that they typically avoid vessels (Culloch *et al.*, 2016; Benhemma-Le Gall *et al.*, 2021). During the construction of Beatrice and Moray East offshore windfarms in the Moray Firth, harbour porpoise occurrence decreased with increasing vessel presence, with the magnitude of decrease depending on the distance to the vessel (Benhemma-Le Gall *et al.*, 2021). As such, the probability of harbour porpoise occurrence at a mean vessel distance of 2 km decreased by up to 95% to 0.02 for the highest vessel intensity (Benhemma-Le Gall *et al.*, 2021). At a mean vessel distance of 3 km, the probability decreased by up to 57% to 0.16 for the highest vessel intensity, and no apparent response was observed at 4 km (Benhemma-Le Gall *et al.*, 2021).

11.10.2.11 Additional studies conducted during offshore windfarm construction demonstrated that harbour porpoise detections in the vicinity of the pile driving location decline prior to a piling event (Benhemma-Le Gall *et al.* 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018). For example, during a study conducted at seven offshore windfarms in the German Bight, a decline in harbour porpoise detections was observed within 2 km of the construction site and continued to be reduced for 1 to 2 days after (Brandt *et al.*, 2018). This was attributed to the increased vessel activity and traffic associated with construction-related activities (Brandt *et al.*, 2018).

11.10.2.12 In a large-scale study of harbour porpoise density in UK waters, increased vessel activity was generally associated with lower harbour porpoise densities (Heinänen and Skov, 2015). Furthermore, Wisniewska *et al.*, (2018) collected telemetry data to study the change in foraging rates of harbour porpoise in response to vessel noise in highly trafficked coastal waters in the inner Danish waters and Belt seas. The results show that occasional high-noise levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 µPa (16 kHz third-octave) (Wisniewska *et al.*, 2018).

11.10.2.13 Land-based surveys were conducted to examine the surfacing behaviour of harbour porpoise in relation to vessel traffic in Swansea Bay (Oakley *et al.*, 2017). The study found a significant correlation between harbour porpoise sightings and the number of vessels present, with 26% of interactions observed considered to be negative (animals moving away or prolonged diving) when vessels were up to 1 km away (Oakley *et al.*, 2017). The proximity of the vessel was found to be an important factor, with the greatest response occurring at 200 m from the vessel (Oakley *et al.*, 2017). Smaller motorised vessels (jet ski, speed boat, small fishing vessels) were associated with more negative behaviours than large cargo ships, although larger ships were less common in the area (Oakley *et al.*, 2017).

11.10.2.14 Behavioural responses of harbour porpoises to vessel noise have also been observed in more controlled conditions. For example, behavioural responses of four harbour porpoise in a semi-natural net pen were observed during exposure to low levels of medium to high frequency vessel noise (Dyndo *et al.*, 2015). 'Porpoising' (a stereotypical disturbance behaviour) was observed during 27.5% of recordings of boat noise (Dyndo *et al.*, 2015).

11.10.2.15 These studies discussed above evidence some changes in harbour porpoise behaviour and presence as a result of disturbance from vessel activity. Behavioural responses include increased fluking, interrupted foraging, change to vocalisations, prolonged dives and directed movement away from the sound source (Oakley *et al.*, 2017; Wisniewska *et al.*, 2018). Several studies have also evidenced an increase in vessel presence correlates with a decrease in harbour porpoise presence (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018). However, harbour porpoises occur widely throughout the Irish Sea (Berrow *et al.*, 2010; Rogan *et al.*, 2018a; Wall *et al.*, 2013) and therefore it is assumed (since they have a requirement to feed regularly) that there is suitable foraging habitat across their range. Therefore, relatively short-term localised disturbance within the vicinity of the Proposed Development is unlikely to lead to any population-level effects on harbour porpoise. As a result, harbour porpoises are considered to be of reasonable adaptability, limited tolerance, have high recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

BOTTLENOSE DOLPHIN

11.10.2.16 Studies on the interactions of bottlenose dolphins with vessels have shown various responses. In the Moray Firth, a passive acoustic monitoring study showed that the presence of vessels resulted in a short-term reduction in foraging activity by 49%, with animals resuming foraging after the vessel had travelled through the area, suggesting that disturbance was limited to the time the vessel was physically present (Pirotta *et al.*, 2015). As a result, the study concluded that the physical presence of vessels plays a larger role in disturbance, as vessel noise was not taken into consideration (Pirotta *et al.*, 2015).

11.10.2.17 In a modelling study by Lusseau *et al.* (2011), it was predicted that increased vessels movements associated with offshore wind development in the Moray Firth did not have a negative effect on the local population of bottlenose dolphins, although it did note that foraging may be disrupted by disturbance from vessels. Mathematical modelling was also conducted by New *et al.* (2013) to simulate the complex interactions of the bottlenose dolphin population in the Moray Firth and determine whether an increased rate of disturbance from vessel traffic from proposed offshore developments was biologically significant. The study statistically modelled an increase in vessel traffic from 70 to 470 vessels per year and found that an increase in commercial vessel traffic alone will not result in a biologically significant increase in disturbance, because dolphins have the ability to compensate for their immediate behavioural response. Therefore, their health and vital rates were predicted to be unaffected (New *et al.*, 2013).

11.10.2.18 Bottlenose dolphins have also been observed tolerating vessel disturbance, particularly in areas where vessel traffic has always been high (Pirotta *et al.* 2013). Similarly, the presence of bottlenose dolphin was positively correlated with overall vessel number during the construction works of an oil pipeline in Broadhaven Bay, northwest Ireland (Anderwald *et al.*, 2013). However, it was unclear whether the bottlenose dolphins were attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time (Anderwald *et al.*, 2013).

11.10.2.19 A study of Indo-Pacific bottlenose dolphin habitat occupancy along the coast of Western Australia found dolphin density to be negatively affected by vessels at one site, but no significant impact at the other (Marley *et al.*, 2017a). It is hypothesised that the quality of the habitat impacts the behavioural response to disturbance as the latter habitat is a known foraging area. Other studies along the coast of Western Australia have found that increased vessel presence was associated with significantly increased swim speeds for individuals when resting or socialising (Marley *et al.*, 2017b). Animals exposed to high levels of shipping traffic were also found to spend more time travelling and less time resting or socialising. The study also found that the whistle characteristics changed with increased broadband exposure, with the greatest variation occurring in the presence of low frequency noise (Marley *et al.*, 2017b). Other studies have reported similar

findings, for example, common bottlenose dolphins in Galveston Ship Channel, US, found that the presence of vessels was associated with significantly less foraging and socialising activity (Piwetz, 2019). For this population, a significant increase in swimming speeds was observed during the presence of recreational and tourism vessels, and shrimp trawlers (Piwetz, 2019).

11.10.2.20 Bottlenose dolphins have also been known to exhibit different behavioural responses to different vessel types. A study conducted in New Zealand showed that bottlenose dolphin resting behaviour decreased as the number of dolphin-watching tour boats increased (Constantine *et al.*, 2004). In a study conducted in Italy, dolphins exhibited an avoidance response to motorboats, but changed their acoustic behaviour in response to trawler vessels, presumably to compensate for masking (La Manna *et al.*, 2013). This study also found that bottlenose dolphins would tolerate vessel presence within certain levels and were more likely to leave an area if disturbance was persistent (La Manna *et al.*, 2013). Therefore, the degree to which an individual is disturbed is likely linked to their baseline level of tolerance (Bejder *et al.*, 2009).

11.10.2.21 These studies show that vessel disturbance can result in a variety of responses in bottlenose dolphins including changes to foraging behaviour, swim speed, behavioural state, and acoustic behaviour, and can cause avoidance responses (Constantine *et al.*, 2004; La Manna *et al.*, 2013; Marley *et al.*, 2017a; Marley *et al.*, 2017b; Pirotta *et al.*, 2015). However, where behavioural changes in bottlenose dolphins occur, predictive modelling of high levels of vessel disturbance has concluded that this is not biologically significant to a small population of bottlenose dolphins in the Moray Firth (New *et al.*, 2013). As a result, bottlenose dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, bottlenose dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

RISSO'S DOLPHIN

11.10.2.22 Limited information is available on the behavioural responses of Risso's dolphins to vessel disturbance. However, several studies have shown that vessel traffic can affect the behaviour, activity, energy budgets, habitat use, and reproductive success of dolphin species (Bejder *et al.*, 2006; Lusseau, 2003; 2004). A study on the behavioural responses of Risso's dolphins to vessel traffic in Pico, Azores suggested a disruption of resting behaviour by cetacean watching vessels (Visser *et al.*, 2006). In the Ionian Sea, a study on the impacts of cetacean watching vessels on behavioural activities of Risso's dolphins observed a neutral response to the presence of the vessel during 81.3% of sightings (Bellomo *et al.*, 2021).

11.10.2.23 As limited information exists on the behavioural response of Risso's dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on Risso's dolphin behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction and O&M vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups. As a result, Risso's dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, Risso's dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

COMMON DOLPHIN

11.10.2.24 Limited information is available on the behavioural responses of common dolphins to vessel disturbance. Marine mammal monitoring in Broadhaven Bay, northwest Ireland showed that an increase in vessel numbers resulted in a reduction in common dolphin presence (Culloch *et al.*, 2016).

11.10.2.25 Studies on disturbance effects from cetacean watching vessels reports that common dolphins spent significantly less time foraging when interacting vessels were present (Meissner *et al.*, 2015). Once disrupted, dolphins took at least twice as long to return to foraging when compared to control conditions (vessels >300 m away from dolphins) (Meissner *et al.*, 2015). The study also found that the probability of common dolphins starting to forage while engaged in travelling in the presence of cetacean watching vessels decreased by two thirds (Meissner *et al.*, 2015). Common dolphin foraging tactics include cooperative herding of prey (Neumann and Orams, 2003), therefore it is possible that the behavioural changes of some individuals within a group, as a result of approaching vessels, could compromise the success of the overall foraging event (Meissner *et al.*, 2015).

11.10.2.26 As limited information exists on the behavioural response of common dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on common dolphin behaviour have also been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction, O&M and decommissioning vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups. As a result, common dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, common dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

MINKE WHALE

11.10.2.27 Limited information is available on the behavioural responses of minke whales to vessel disturbance. A study into the response of minke whales to construction-related vessel traffic in Broadhaven Bay, northwest Ireland found a significant negative correlation between the presence of minke whale and both the number of overall vessels and the number of utility vessels (those emitting lower frequency noise but moving around more than construction vessels), suggesting that minke whale were displaced from the area, most likely due to vessel presence and/or disturbance (Anderwald *et al.*, 2013).

11.10.2.28 A study by Christiansen *et al.* (2013) showed that minke whales change their diving patterns and behaviour in response to disturbance from whale watching vessels. Analysis of respiration rates found that energy expenditure of minke whales was 28% higher during vessel interactions (regardless of swim speed) and swim speed was found to increase with vessel presence (Christiansen *et al.*, 2013). These combined physiological and behavioural changes are considered to represent a stress response. The study also suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success (Christiansen *et al.*, 2013). It is important to note that noise levels were not measured in this study, therefore behavioural responses are considered to be related to vessel presence.

11.10.2.29 Christiansen *et al.* (2015) considered the spatial and temporal rates of minke whale exposure of the entire whale watching season and found no potential for a population-level effect as a result of disturbance.

11.10.2.30 The bioenergetic effects of disturbance from whale watching vessels on foetal growth were examined by Christiansen and Lusseau (2015) using a mechanistic model and found that the presence of whale watching vessels resulted in an immediate reduction in net energy intake by 63.5%. However, the impact of disturbance was negligible because it was considered below the threshold value for which whale watching vessels would have a significant impact on foetal growth, as the number of interactions with vessels was low during the foraging season (Christiansen and Lusseau, 2015).

11.10.2.31 It is expected that minke whales are more sensitive to low frequency sounds (Nowacek *et al.*, 2007) such as those produced by slow moving vessels, although limited information exists on

the behavioural response of minke whales to construction-related vessels. Studies on the impact of whale watching vessels on minke whale behaviour have therefore been presented as a proxy to inform this assessment, although it is important to note that disturbance effects from whale watching vessels are direct, whilst those from construction and O&M vessels would be indirect. As a result, minke whales are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, minke whale are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

GREY SEAL

11.10.2.32 Seals are particularly sensitive to disturbance in regions where vessel traffic overlaps with productive coastal waters (Robards *et al.*, 2016). Vessel disturbance may be particularly detrimental to grey seal if it changes their haul-out patterns or reduces the time they are able to spend resting or nursing pups during the breeding season. When disturbed, seals that are hauled-out typically 'flush' (enter) into the water which could be detrimental during pupping season (Terhune and Almon, 1983; Johnson and Acevedo-Gutiérrez, 2007). Key haul-outs for grey seal in proximity to the Proposed Development are at Arklow, co. Wicklow, along the coast of co. Dublin, and around Wexford Harbour (Duck and Morris, 2013; Morris and Duck, 2019).

11.10.2.33 Britton (2012) recorded a significant correlation between boat speed and the distance at which hauled-out grey seals on the Isle of Man showed alert behaviour. A similar association was also observed between boat speed and movement and flushing response (entering the water) although this was not tested. The duration of the boat interaction was, however, found to be important, with flushing occurring in all vessel interactions lasting four minutes or longer (Britton, 2012).

11.10.2.34 A study of grey seal pup tracks in the Celtic Sea and adult grey seals in the English Channel found that no animals were exposed to cumulative shipping noise that exceeded thresholds for TTS (using the Southall *et al.* (2019) thresholds) (Trigg *et al.*, 2020).A study of vessel traffic and marine mammal presence at Broadhaven Bay, northwest Ireland found grey seals sightings decreased with increased vessel activity in the surrounding area, though the effect size was small, and the relationships between sightings and vessel numbers were weaker than those with environmental variables such as sea state (Anderwald *et al.*, 2013).

11.10.2.35 Grey seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, grey seals are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

HARBOUR SEAL

11.10.2.36 Seals are particularly sensitive to disturbance in regions where vessel traffic overlaps with productive coastal waters (Robards *et al.*, 2016). Vessel disturbance may be particularly detrimental to harbour seal if it changes their haul-out patterns or reduces the time they are able to spend resting or nursing pups during the breeding season. When disturbed, seals that are hauled-out typically 'flush' (enter) into the water which could be detrimental during pupping season (Johnson and Acevedo-Gutiérrez, 2007). Key haul-outs for harbour seal in proximity to the Proposed Development are at Arklow, co. Wicklow, along the coast of co. Dublin, and around Wexford Harbour (Duck and Morris, 2013; Morris and Duck, 2019).

11.10.2.37 Avoidance behaviour or alert reactions have been reported in harbour seal when vessels approach within 100 m of a haul-out (Richardson *et al.*, 1995). A study in which 37 harbour seals were telemetry tagged on the east coast of Scotland did not show any apparent response of seals at sea to close passing vessels (they neither moved towards nor away from them) (Onoufriou *et al.*, 2016).

11.10.2.38 Another telemetry study that included the tagging of 28 harbour seals in the UK found high exposure levels of harbour seals to shipping noise, and as a result 20 individuals may have experienced a TTS due to cumulative SELs exceeded the TTS-threshold for pinnipeds exposed to continuous underwater noise (183dB re 1 μPa^2_s) (Jones *et al.*, 2017). The overlap between seals and vessel activity most frequently occurred within 50 km of the coast and in proximity to seal haul-outs. The study concluded that there was no evidence of reduced harbour seal presence as a result of vessel traffic, despite the spatial overlap and cumulative SELs (Jones *et al.*, 2017).

11.10.2.39 Harbour seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour seals are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

Construction phase

MAGNITUDE OF IMPACT

11.10.2.40 During the construction phase, a maximum of 66 installation vessels will be present within the Array Area at any one time, resulting in a maximum of 4,150 vessel return trips over the five-year construction period, and a maximum of 1,797 vessel return trips per year (Table 11.10). Vessels that will be used during the construction phase include jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels, and other support vessels (Table 11.10).

INJURY FROM VESSEL ACTIVITIES

11.10.2.41 Vessel traffic associated with the Proposed Development has the potential to lead to an increase in vessel movements within the Marine Mammal Study Area. This increase in vessel movement could lead to an increase in interactions between marine mammals and vessels during offshore construction. Whilst a broad range of vessel types have been involved in collisions with marine mammals (Laist *et al.*, 2001), vessels travelling at higher speeds pose a higher risk because of the potential for a stronger strike impact (Schoeman *et al.*, 2020). For example, a study by Laist *et al.* (2001) found that in 89% of collisions in which the whale was killed or seriously injured vessels were travelling at speeds of 14 Kn (7 m/s) or more, and the vessel exceeded a length of 80 m. Therefore, larger vessels travelling at 7 m/s or faster are those most likely to cause death or serious injury to marine mammals (Laist *et al.*, 2001). The majority of vessels used during the construction phase are likely to be large vessels that will either be travelling considerably slower than 7 m/s or will be stationary for significant periods of time. Therefore, the actual increase in vessel traffic moving within the Proposed Development and to/from port will occur over short periods of the offshore construction activity. Smaller vessels involved in construction activities (i.e. tug/anchor handlers, guard vessels, survey vessels, and crew transfer vessels) are able to move to avoid marine mammals (when detected), even when an animal is close and the vessel is going at high speed, due to better manoeuvrability compared to larger vessels (Schoeman *et al.*, 2020). In contrast, large vessels, such as jack-up vessels, have low manoeuvrability and may require larger distances to avoid an animal, but travel at slower speeds. In addition, the Factored In Measures (see Table 11.15) which include an EVMP, will ensure that vessel traffic will move along predictable routes, which is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.*, 2001; Lusseau 2003; 2006). The EVMP provides best practice guidance to minimise interactions with marine mammals and define how vessels should behave in the presence of them.

11.10.2.42 It is also likely that the noise emissions from vessels involved in the construction phase will be detectable by marine mammals and therefore will deter animals from the areas of potential

impact. Whilst construction of the Proposed Development will lead to an uplift in vessel activity, vessel movements will be largely restricted to within the Array Area or along the offshore Cable Corridor and Working Area routes and will follow existing shipping routes to/from ports. Due to the volume of vessel traffic around the Marine Mammal Study Area already, the introduction of additional vessels during the construction phase of the Proposed Development will not be a novel impact for marine mammals present in the area. Therefore, it is not expected that vessel activities during the construction phase would increase the risk of injury due to vessel collision.

11.10.2.43 The impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the construction phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.44 Disturbance to marine mammals by vessels will be driven by a combination of underwater noise and the physical presence of the vessel itself (Pirotta *et al.*, 2015). It is not simple to disentangle these drivers, therefore, disturbance from vessels is assessed within this Chapter in general terms, covering disturbance driven by both vessel presence and underwater noise.

11.10.2.45 Noise levels from construction vessels will result in an increase in non-impulsive, continuous sounds primarily from propellers, thrusters, and various rotating machinery in the vicinity of the Proposed Development. The main drivers influencing the magnitude of potential impact with respect to noise disturbance from vessels are vessel type, speed and ambient noise levels (Wilson *et al.*, 2007). Disturbance from vessel noise is likely to occur only when vessel noise associated with the construction of the Proposed Development exceeds the background ambient noise level.

11.10.2.46 Vessel noise levels are typically in the range of 10 to 100 Hz (Erbe *et al.*, 2019) with an estimated source level of 168 SEL_{cum} dB re 1 µPa @ 1 m (Root Mean Square (RMS)) for large construction vessels and 161 SEL_{cum} dB re 1 µPa @ 1 m (RMS) for medium construction vessels, travelling at a speed of 10 knots (see Volume III, Appendix 11.1: Underwater Noise Assessment (Revised March 2026)). In general, support and supply vessels (50-100 m) are expected to have broadband source levels in the range 165-180 dB re 1µPa, with the majority of energy below 1 kHz (OSPAR, 2009). Large commercial vessels (>100 m) produce relatively loud and predominately low frequency sounds, with the strongest energy concentrated below several hundred Hz (OSPAR, 2009).

11.10.2.47 As stated in paragraphs 11.10.2.2 and 11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for marine mammals present in the area.

11.10.2.48 Thomsen *et al.* (2006) estimated that harbour porpoises will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. In addition, a study on the impacts of construction-related activities at Beatrice and Moray East offshore windfarms showed that harbour porpoises are displaced by offshore windfarm construction vessels (Benhemma-Le Gall *et al.*, 2021). Types of construction-related vessels that were assessed in this study included offshore service vessels for pile driving and jacket/turbine installation, guard vessels, crew-transfer vessels, and port service craft (Benhemma-Le Gall *et al.*, 2021). The median construction-related vessel density across the Moray Firth during the study period was 1.4 vessels/km^2. PAM data recorded at the site showed that the hourly occurrence of porpoise detections declined within 2 km of construction vessels, but that no response was observed out

to 4 km, suggesting that responses declined within increasing distance to vessels (Benhemma-Le Gall *et al.*, 2021).

11.10.2.49 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026) and Volume III, Appendix 15.1: Navigational Risk Assessment (Revised March 2026)).

11.10.2.50 Throughout the construction of the Proposed Development, the EVMP (Table 11.15) will advise that vessel traffic moves along predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals.

11.10.2.51 For seals, Jones *et al.* (2017) analysed the predicted co-occurrence of ships and seals at sea which demonstrated that there is a large degree of predicted co-occurrence UK-wide, particularly within 50 km of the coast close to seal haul-outs. However, there is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and seals. In areas where seal populations are showing high levels of growth, such as southeast England), ship co-occurrences are highest (Jones *et al.*, 2017).

11.10.2.52 Although co-occurrence of vessels and seals is well documented through telemetry studies (Jones *et al.*, 2017), Thomsen *et al.* (2006) estimated that both harbour and grey seals will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. Where seals may respond, it is expected that any impact on behaviour would be short-term and localised and would return to baseline once the vessel disturbance has ended.

11.10.2.53 The implementation of an EVMP (Table 11.15) will reduce the risk of vessel disturbance by providing guidance regarding the speed and movement of vessels, resulting in slower moving vessels travelling more predictable routes which are less likely to cause disturbance. This is supported by vessel simulation modelling by Findlay *et al.* (2023) which predicted that, when animals were exposed to vessels at a given distance with both a 20% and a 50% reduction in speed, all potential noise impacts were reduced. At a 20% reduction in speed, the vessel noise swath halved, reducing the average number of animals exposed by 50% and therefore reducing the number of animals that are likely to be disturbed (Findlay *et al.*, 2023). In addition, the study demonstrated that moderate slowdowns strongly reduce vessel source levels, with a 20% reduction in speed decreasing mean source levels by 6 dB and a 50% speed reduction by 18 dB (Findlay *et al.*, 2023).

11.10.2.54 Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.10.2.55 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the construction phase has been assessed as **Negligible adverse**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.56 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the construction phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the construction phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.2.57 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operations and Maintenance phase

MAGNITUDE OF IMPACT

11.10.2.58 During the operations and maintenance phase, a maximum of 30 vessels will be present within the Array Area at any one time, resulting in a maximum of 1,359 vessel return trips per year (Table 11.10). Vessels that will be used during the operations and maintenance phase include crew transfer vessels, jack-up vessels, cable repair vessels (Table 11.10).

INJURY FROM VESSEL ACTIVITIES

11.10.2.59 Baseline information on vessel traffic during the operations and maintenance phase is outlined in section 11.10.2.58 and. The operations and maintenance phase may last for up to 36.5 years.

11.10.2.60 As stated in paragraphs 11.10.2.2 and 11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026)). Vessel movements will be within the Array Area or along the offshore Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Therefore, the introduction of additional vessels during the operations and maintenance phase of the Proposed Development is not a novel impact for marine mammals present in the area and it is not expected that vessel activities during the operations and maintenance phase would increase the risk of injury due to vessel collision.

11.10.2.61 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.10.2.41 and Table 11.15, the implementation of the Factored In Measures, including an EVMP, will advise that vessels movements follow predictable routes and provides guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout O&M activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.10.2.62 Furthermore, all marine mammal species are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality, as highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2019).

11.10.2.63 Therefore, the impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the operations and maintenance phase, the effect is unlikely to occur given

implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.64 As stated in paragraphs 11.10.2.2 and 11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity during the operations and maintenance phase is not considered a novel impact for marine mammals present in the area.

11.10.2.65 Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 ships/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026) and Volume III, Appendix 15.1: Navigational Risk Assessment (Revised March 2026)). Considering a maximum of 22 O&M vessels will be present within the Array Area at any one time, vessel traffic in the area around the Proposed Development is not likely to exceed the value presented by Heinänen and Skov (2015) even with the addition of vessels involved in the O&M phase.

11.10.2.66 As discussed in paragraph 11.10.2.41 and Table 11.15, the implementation of the Factored In Measures, including an EVMP, will advise that vessels movements follow predictable routes and provides guidance on how vessels should behave in the presence of marine mammals, which will minimise the magnitude of any impact. Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the operations and maintenance phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.10.2.67 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the construction phase has been assessed as **Negligible adverse,** with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.68 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the operations and maintenance phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the operations and maintenance phase for all marine mammal species is **Slight adverse** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.2.69 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the operations and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified Table 11.15 are considered

necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.10.2.70 Vessel traffic during the decommissioning phase is anticipated to be similar in nature, but of lower magnitude, to the construction phase (Table 11.10).

INJURY FROM VESSEL ACTIVITIES

11.10.2.71 As stated in paragraphs 11.10.2.2 and 11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a high amount of vessel traffic (see Volume II, Chapter 15: Shipping and Navigation (Revised March 2026)). Vessel movements will be within the Array Area or along the offshore Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Therefore, the introduction of additional vessels during the decommissioning phase of the Proposed Development is not a novel impact for marine mammals present in the area and it is not expected that vessel activities during the decommissioning phase would increase the risk of injury from collision.

11.10.2.72 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.10.2.41 and Table 11.15, the implementation of the Factored In Measures, including an EVMP, will advise that vessel movements follow predictable routes, and provides guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout decommissioning activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.10.2.73 Furthermore, all marine mammal species are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2019).

11.10.2.74 Therefore, the impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the decommissioning phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.75 The potential impacts during the decommissioning phase are anticipated to be similar to or less than the construction phase as the Rehabilitation Schedule confirms that no piling will be undertaken (Table 11.15).

11.10.2.76 As stated in paragraphs 11.10.2.2 and11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for marine mammals present in the area.

11.10.2.77 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation

(Revised March 2026) and Volume III, Appendix 15.1: Navigational Risk Assessment (Revised March 2026)).The EVMP (Table 11.15) will advise that vessel traffic moves along predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact.

11.10.2.78 Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the decommissioning phase, the effect is reasonably expected to occur, have short-term and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.10.2.79 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the decommissioning phase has been assessed as **Negligible**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the decommissioning phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.80 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the decommissioning phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the decommissioning phase for all marine mammal species is **Slight adverse** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.2.81 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.3 Impact 3 – Changes in fish and shellfish community affecting prey resources

11.10.3.1 Marine mammals are dependent on fish and shellfish species as prey resources, therefore there is potential for indirect effects on marine mammals to occur as a result of direct impacts on fish and shellfish and/or their supporting habitat.

11.10.3.2 The key prey species for marine mammals within this assessment are presented in Table 11.58.

Table 11.58: Key prey species for marine mammals

Species	Key prey species	Region	Reference
Harbour porpoise	Whiting, herring, poor cod	Ireland	Hernandez-Milian *et al.* (2011)
Bottlenose dolphin	Whiting, blue whiting, pollock, saithe, haddock, poor cod, European hake, horse mackerel, flatfish, pelagic squid, octopus.	Ireland	Hernandez-Milian *et al.* (2011; 2015)
Risso's dolphin	Octopus species, squid species, cuttlefish species, crustaceans, poor cod, haddock, whiting	Scotland	MacLeod *et al.* (2014)
Common dolphin	Poor cod, goby, blue whiting, whiting, cephalopods, Atlantic herring, European sprat, haddock	Ireland	Brophy *et al.* (2009)
Minke whale	Sandeel, herring, sprat, mackerel, poor cod, gobies	UK	Pierce *et al.* (2004); Whooley (2016); Robinson *et al.* (2023)
Grey seal	Poor cod, salmonids, sandeel, dragonet, whiting, bib, blue whiting, haddock, pollock, saithe, herring, rockling, Norway pout, mackerel, hake, eels, wrasse, perch, sole, halibut, dab, flatfish species, squid species, octopus species	Ireland	Gosch *et al.* (2014); Wilson and Hammond (2019)
Harbour seal	Sandeel, sole, poor cod, dragonet, whiting, rockling, Atlantic horse mackerel, crustaceans, squid species, octopus species	Ireland	Kavangah *et al.* (2010)

SENSITIVITY OF THE RECEPTOR

11.10.3.3 Impacts to prey resources will be largely restricted to the boundaries of the Proposed Development and, therefore, marine mammals occurring within this area also have the potential to be affected. However, the fish and shellfish species identified in Volume II: Chapter 10: Fish, Shellfish, and Sea Turtle Ecology (Revised March 2026) are typical of those present within the western Irish Sea, and as marine mammals are highly mobile, it is reasonable to assume that they will be able to feed on sufficient, similar prey resource that is available in the wider area.

11.10.3.4 While there may be particular prey species that comprise a high proportion of their diet, all marine mammals within this assessment are considered as generalist feeders, therefore they can exploit a variety of prey resources and are not reliant on a single prey species (Table 11.58). As a result, all marine mammal species within this assessment are considered to be of high adaptability, high tolerance, have high recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Low sensitivity to changes in fish and shellfish community affecting prey resources.

Construction phase

MAGNITUDE OF IMPACT

11.10.3.5 Potential impacts on fish and shellfish during the construction phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026) and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition;

- Injury and/or disturbance as a result of underwater noise and vibration during pile driving and cable installation activities; and
- Accidental pollution.

11.10.3.6 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026), which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the construction phase providing that Factored In Measures are implemented.

11.10.3.7 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur relatively frequently throughout the construction phase, have intermittent and/or short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the construction phase.

SIGNIFICANCE OF EFFECT

11.10.3.8 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the construction phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.3.9 The significance of effect from changes in fish and shellfish community affecting prey resources during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operations and Maintenance phase

MAGNITUDE OF IMPACT

11.10.3.10 Potential impacts on fish and shellfish during the operations and maintenance phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026) and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition;
- Accidental pollution;
- Long-term habitat loss;
- Alteration of seabed habitats arising from changes in physical processes; and
- Changes in EMF from subsea electrical cabling.

11.10.3.11 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026), which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the operations and maintenance phase.

11.10.3.12 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur continuously throughout the operations and maintenance phase, have very short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the operations and maintenance phase.

SIGNIFICANCE OF EFFECT

11.10.3.13 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the operations and maintenance phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the operations and maintenance phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.3.14 The significance of effect from changes in fish and shellfish community affecting prey resources during the operations and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.10.3.15 Potential impacts on fish and shellfish during the decommissioning phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026) and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition; and
- Accidental pollution.

11.10.3.16 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology (Revised March 2026), which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the decommissioning phase.

11.10.3.17 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur relatively frequently throughout the decommissioning phase, have intermittent and/or short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the decommissioning phase.

SIGNIFICANCE OF EFFECT

11.10.3.18 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the decommissioning phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the decommissioning phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.3.19 The significance of effect from changes in fish and shellfish community affecting prey resources during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.4 Impact 4 – Accidental pollution

11.10.4.1 There is the potential for an accidental release of pollutants to occur from vessels and equipment associated with the construction, operations and maintenance and decommissioning phases of the Proposed Development which may result in adverse effects on marine mammals. Pollutants may include diesel fuel, bentonite (from drilling activities), lubricants, grease and oils, anti-fouling biocides, and grout.

SENSITIVITY OF THE RECEPTOR

11.10.4.2 In the event of an accidental spill, given the density and distribution of marine mammals in the Marine Mammal Study Area, it is possible that individuals could come into contact with contaminants.

11.10.4.3 Direct impacts include ingestion, inhalation, and absorption. All of which may result in physiological responses with health and long-term survival and/or reproduction consequences, the most serious of which could be damage to the respiratory system (Helm *et al.*, 2015).

11.10.4.4 Indirect impacts include short- and long-term reductions in food availability, disruption to social bonds, reduced reproduction, and/or cumulative effects on individuals, populations, and the ecosystem (Helm *et al.*, 2015).

11.10.4.5 Cetaceans are at risk from oil pollution in the marine environment because they lack the ability to leave the water to avoid oil. Cetaceans are however highly mobile and wide ranging, therefore any contact with a spill would be expected to be brief. They are also capable of detecting surface slicks, for example, experiments with captive bottlenose dolphins have shown that they can visually discriminate between oil and uncontaminated water and avoid oil on the surface of the water (Geraci and St. Aubin, 1984). Dolphins appear to rely on tactile clues to detect and avoid oil and it is unlikely that they would be unknowingly subjected to prolonged or repeated exposure to oil in the wild (Helm *et al.*, 2015).

11.10.4.6 Cetaceans must surface periodically to breathe, potentially bringing them into contact with floating oil and volatile toxic components. The more extensive the slick, the more likely that an animal will surface within it (Geraci and St. Aubin, 1980). While oil does not readily penetrate cetacean skin, exposure could affect mucus membranes, eyes, and other external soft tissue areas, potentially resulting in mortality (Helm *et al.*, 2015).

11.10.4.7 In the event of an accidental spill, prey species may also become oiled. Ingestion of oil through consumption of contaminated prey may cause damage to internal organs and have long-term consequences for individuals (Helm *et al.*, 2015).

11.10.4.8 Unlike cetaceans, seals are reliant on terrestrial haul-out sites for resting, moulting, and breeding which makes them particularly vulnerable to the effects of pollution. Information on key haul-outs for grey seals and harbour seals in the vicinity of the Proposed Development is presented in section 11.5.2. Seals have been shown to develop conjunctivitis, corneal abrasion, and swollen eyelid membranes in response to exposure to crude oil (Geraci and St. Aubin, 1980). While external oiling is not expected to significantly impact the ability of adult seals to maintain their core body temperature as they rely on blubber for insulation, seal pups entering the water could be vulnerable as oil residues can reduce the thermal properties of neonate animals, increasing their susceptibility to hypothermia (Helm *et al.*, 2015).

11.10.4.9 All marine mammal species within this assessment are considered to be of reasonable adaptability, reasonable tolerance, have medium recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Medium sensitivity to accidental pollution.

Construction phase

MAGNITUDE OF IMPACT

11.10.4.10 The installation of the offshore infrastructure for the Proposed Development may lead to the accidental release of pollutants through spills and leaks from vessels and equipment. The project design parameters for Project Design Option 2 during the construction phase are outlined in Table 11.10 and include the installation of 47 WTGs, two OSPs, between 110 and 122 km of inter-array cables, between 25 and 28 km of interconnector cables, and between 35 and 40 km offshore export cables. There will also be up to 4,150 vessel round trips and 294 helicopter round trips during the construction phase (including activities at the Landfall).

11.10.4.11 The magnitude of the impact of accidental pollution will be dependent on the quantities of potential pollutants carried by construction vessels and within equipment. The release of a large inventory of fuel oil from a construction vessel is, however, considered to represent the greatest potential accidental pollution event from installation activities. In the event of an accidental spill from vessels, equipment or from construction activities, the spill would be subject to immediate dilution and rapid dispersal (Marappan *et al.,* 2022).

11.10.4.12 Given the Factored In Measures (see Table 11.15 the likelihood of accidental release is considered extremely low. The measures in the EMP include storage of chemicals in secure designated areas on vessels in line with appropriate regulations and guidelines, and double skinning of any tanks and pipes containing hazardous substances. All chemicals used will be subject to a chemical risk assessment to ensure risks are understood and minimised. The EMP also includes a MPCP which will contain key emergency contact details and response procedures in the event of a spill of any magnitude (Tier I, II or III) to ensure minimal impact. Complying with these procedures will also reduce the magnitude of any spill. Adherence to the Factored In Measures outlined in Table 11.15, including the EMP and MPCP will significantly reduce the likelihood of an accidental pollution incident occurring, and the magnitude of its impact.

11.10.4.13 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the construction phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.10.4.14 For all marine mammal species, the magnitude of the impact of accidental pollution during the construction phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the construction phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.4.15 The significance of effect from accidental pollution during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operations and Maintenance phase

MAGNITUDE OF IMPACT

11.10.4.16 There is the potential for the accidental release of pollutants during the operations and maintenance phase of the Proposed Development as a result of the presence of offshore infrastructure, associated equipment, and vessel movements. The project design parameters for Project Design Option 2 during the operations and maintenance phase are outlined in Table 11.10. This includes synthetic compound, for example from antifouling biocides, heavy metal, and hydrocarbon contamination as a result of the presence of 47 WTGs and two OSPs as well as from maintenance activities. There will also be up to 1,359 vessel round trips and 485 helicopter round trips per year during the operations and maintenance phase.

11.10.4.17 The magnitude of the impact of accidental pollution will be dependent on the quantities of potential pollutants carried by operations and maintenance vessels and within equipment. Any accidental spill from vessels or equipment or from maintenance activities would be subject to immediate dilution and rapid dispersal (Marappan *et al.,* 2022). As discussed in paragraph 11.10.4.12 and Table 11.15, the implementation of the Factored In Measures, including an EMP and MPCP, will ensure that the likelihood of accidental release occurring is extremely low and, in the event that an accidental release does occur, will limit the magnitude of the impact.

11.10.4.18 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the operations and maintenance phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.10.4.19 For all marine mammal species, the magnitude of the impact of accidental pollution during the operations and maintenance phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the operations and maintenance phase for all marine mammal species is **Slight adverse,** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.4.20 The significance of effect from accidental pollution during the operations and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.10.4.21 The magnitude of the potential impact to marine mammals from accidental pollution during the decommissioning phase is expected to be the same as described previously for the construction phase (see paragraphs 11.10.4.10 *et seq.*).

11.10.4.22 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the decommissioning phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.10.4.23 For all marine mammal species, the magnitude of the impact of accidental pollution during the decommissioning phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the decommissioning phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.4.24 The significance of effect from accidental pollution during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.5 Impact 5 – Changes in Electromagnetic Fields (EMF) from subsea electrical cabling

11.10.5.1 The conduction of electricity through subsea power cables has the potential to emit a localised EMF which could potentially affect the sensory mechanisms of marine mammal species (CMACS, 2003; Copping, 2018; Normandeau *et al.*, 2011).

11.10.5.2 There are no thresholds for assessing impacts to marine life from EMFs, therefore by necessity, this impact assessment is qualitative by nature, based on the available evidence base (a combination of laboratory experiments and field studies). An overview of the expected levels of EMF and the potential impacts associated are presented below.

SENSITIVITY OF THE RECEPTOR

11.10.5.3 The effects of EMF on marine mammals are not well understood and, more broadly, there has been a lack of studies investigating the effects of EMFs on the behaviour of magneto- and electrosensitive animals.

11.10.5.4 There is no evidence that seals can detect or respond to EMF, however there is evidence to suggest that some species of cetacean may be able to detect variations in magnetic fields, therefore it is plausible that they are magneto-sensitive (Normandeau *et al.*, 2011). Kirschvink *et al.* (1986) suggested that species that were sensitive to changes in the Earth's magnetic field and that are likely to be present within the Proposed Development include harbour porpoise, Risso's dolphin, and common dolphin. However, the majority of these have had a theoretical evidence base, coming to differing conclusions regarding species' sensitivity to changes in electric and magnetic fields (Normandeau *et al.*, 2011). The only evidence of electro-sensitivity in marine mammals to date is reported in Guiana dolphin (*Sotalia guianensis*) as they have been shown to possess an electroreceptive system which is used to detect electrical stimuli (Czech-Damal *et al.*, 2013).

11.10.5.5 Potential responses of cetaceans from EMF could include avoidance behaviour, disruption in orientation, and effects on feeding or social interaction (Normandeau *et al.*, 2011), although it is important to note that these responses are all currently hypothetical. Whilst subsea cables could create a very localised change in the geomagnetic field (Taormina *et al.*, 2018), modelling studies of EMF from cables suggests that the likelihood of such a change affecting a large enough area to elicit a significant course alteration would be low (Normandeau *et al.*, 2011).

11.10.5.6 Theoretically, there is the potential for some very localised behavioural effects, although no evidence exists at present that marine mammal species within this assessment are magneto-sensitive. All marine mammal species within this assessment are considered to be of high adaptability, high tolerance, have high recoverability, and are of high value. Therefore, all marine

mammal species in this assessment are assessed as having a Negligible sensitivity to changes in EMF from subsea electrical cabling.

Operations and Maintenance phase

MAGNITUDE OF IMPACT

11.10.5.7 EMFs are a combination of an electrical field and a magnetic field, with the electrical field generated by static charges and the magnetic field generated by moving currents.

11.10.5.8 Anthropogenic sources of EMF are primarily subsea cables used for power generation and telecommunications or submarine communications (Normandeau *et al.*, 2011; Tasker *et al.*, 2010). Therefore, the presence and operation of between 110 and 122 km of 66 kV inter-array cables, between 35 and 40 km of 220 kV offshore export cables, and between 25 and 28 km of 220 kV OSP interconnector cables during the lifetime of the Proposed Development (see Table 11.10) may lead to localised EMF effects on marine mammals.

11.10.5.9 Submarine cables can cause three different types of EMFs: electrical (E) fields, magnetic (B) fields, and induced electric (iE) fields. E-fields are measured in V/m and are generated by the voltage of the cable. B-fields are measured in µT or mG where 1 µT = 10 mG and are generated by the current of the power through the cable. They attenuate both horizontally and vertically away from the cable, with field strength directly related to the power of the current passing through the cable, rather than being specifically related to the voltage. iE-fields are measured in V/m and are generated by the fluctuation of the B-fields (in AC transmission) or by the motion of the seawater (or an organism) through the B-field. Therefore, they are dependent on the strength of the B-field, thus the strength of the iE-field is directly related to the B-field, which is strongest closest to the cable, attenuating horizontally and vertically away from it.

11.10.5.10 EMFs also occur naturally in the marine environment from a variety of sources including background levels from the Earth's magnetic field, and very small fields generated by electrical currents moving through organisms (Tricas and Gill, 2011). The Earth's static B-field is present in both terrestrial and aquatic environments and lies in the range 25 to 65 µT (Hutchison *et al.*, 2018). The B-field strength of the Irish Sea is approximately 49 µT (NOAA, 2020).

11.10.5.11 Measurements of EMF for subsea cables associated with offshore windfarms vary, with the strength of the B-field generated generally related to the wind speed captured by the turbines. A variety of design and installation factors affect EMF levels in the vicinity of the cables such as current flow, distance between cables, cable insulation, number of conductors, configuration of cable and burial depth. For example, EMFs produced by inter-array cables are smaller than those of export and OSP interconnector cables as they are lower powered in comparison. Furthermore, the B-fields generated by HVAC and HVDC cables are significantly different, with direct current (DC) cables typically generating much larger EMFs than HVAC cables (Tricas and Gill, 2011). The transmission system used for the Proposed Development will only comprise HVAC.

11.10.5.12 CMACS (2003) reported that for a 132 kV three-phase AC cable with perfect shielding, the predicted B-field in close proximity to the cable was 1.6 µT and the respective iE-field was 91.25 µV/m above the cable if buried to 1 m depth, which reduced to 10 µV m-1 8 m from the cable. Gill *et al.* (2009) measured iE-fields of 30 µV/m and 110 µV/m at two different offshore windfarm cables (both three-phase AC, 36 kV, 100 A) close to the cables and B-fields of 0.23 µT and 6.5 µT, respectively. CSA (2019) compared offshore windfarm subsea cables and found EMF levels directly over live AC undersea power cables associated with offshore wind energy projects ranged between 5 to 15 mG (0.5 to 1.5 µT) for inter-array cables and 10 to 40 mG (1 to 4 µT) for export cables, at heights of 1 m above the seabed. At lateral distances of between 3 m and 7.5 m from the cable, B-fields greatly reduced to <0.1 to 7 mG (<0.01 to 0.7 µT) for inter-array cables, and <0.1 to 12 mG (<0.01 to 1.2 µT) for export cables, at heights of 1 m above the seabed. Measurements of the iE-fields directly over live AC undersea power cables in the same study

ranged between 0.1 to 1.2 mV/m for the inter-array cables and 0.2 to 2.0 mV/m for export cables, at heights of 1 m above the seabed (CSA, 2019). At lateral distances of between 3 m and 7.5 m, iE-fields reduced to between 0.01 to 0.9 m V/m for inter-array cables and 0.02 to 1.1 mV/m for export cables at heights of 1 m above the seabed.

11.10.5.13 The strength of the B-field (and consequently, iE-fields) decreases rapidly horizontally and vertically with distance from source (Normandeau *et al.*, 2011). Burial of cables, in particular, can therefore reduce the strength of the B- and iE-fields. However, it is unlikely that cables can be buried to sufficient depths that will reduce the magnitude of the B-field, and hence the sediment-seawater interface iE-field, to the extent that these fields could not be detected by certain marine organisms on or close to the seabed (Gill *et al.*, 2005). A study conducted by CSA (2019) found that inter-array and export cables buried between depths of 1 m to 2 m reduces the magnetic field at the seabed surface four-fold. For cables that are unburied and instead protected by thick concrete mattresses or rock berms, the field levels were found to be similar to buried cables.

11.10.5.14 While there may be some change to EMFs in the vicinity of inter-array, export, and OSP interconnector cables, the studies presented above indicate that these would likely be highly localised, with the strength of EMFs dissipating quickly with increased distance from the buried cables. The impact of EMFs on marine mammals is considered to occur throughout the operations and maintenance phase, is reasonably expected to occur, and have intermittent and recoverable consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.10.5.15 For all marine mammal species, the magnitude of the impact of changes in EMFs from subsea electrical cabling has been assessed as **Low adverse**, with the sensitivity of the receptor being **Negligible**. Therefore, the significance of effect from changes in EMFs from subsea electrical cabling during the operations and maintenance phase for all marine mammal species is **Imperceptible**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.5.16 The significance of effect from changes in EMFs from subsea electrical cabling during the operations and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.6 Impact 6 – Injury and/or disturbance to marine mammals from underwater noise during UXO clearance

11.10.6.1 It is possible that UXO items with a range of charge weights (or quantity of contained explosive) are present within the boundaries of the Proposed Development, therefore there is potential for UXO clearance to be required prior to construction. While it may be possible for identified UXO to be either avoided, removed, or relocated, there is potential that underwater detonation could be required where it is deemed necessary and unsafe to remove the UXO.

11.10.6.2 Methods of UXO clearance considered for the Proposed Development may include high order and low order detonation. It is important to note that while high order detonation represents the worst-case scenario for UXO clearance, high order detonation may be avoided, and low order clearance methods (deflagration) used instead.

11.10.6.3 The number of UXO that may require clearance and duration of UXO clearance operations are currently unknown. Therefore, it is important to note that the assessments for UXO clearance presented within this Chapter are, at this stage, illustrative.

11.10.6.4 The severity of the consequences of UXO detonation will depend on several variables, including, but not limited to, the charge weight and its proximity to the receptor. Potential effects of underwater detonation of UXOs on marine mammals include auditory injury from exposure to the acoustic wave, resulting in permanent auditory injury or loss in hearing sensitivity (PTS), or temporary loss in hearing sensitivity (TTS); and behavioural disturbance which could impact on feeding, mating, breeding, and/or resting (Ketten, 2004; Richardson *et al.,* 1995; von Benda-Beckmann *et al.,* 2015).

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY – PTS

11.10.6.5 All species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al*., 2007). The ecological consequences of PTS are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al*., 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.10.6.6 The primary acoustic energy produced by a high order detonation is below the region of greatest sensitivity for most marine mammal species (harbour porpoise, dolphin species, seals) considered within this assessment (Southall *et al.,* 2019), with most acoustic energy produced below a few hundred Hz, and decreasing by SEL ~10 dB per decade above 100 Hz (von Benda-Beckmann *et al.,* 2015; Salomons *et al.,* 2021). There is also a pronounced reduction in energy levels above ~5-10 kHz (von Benda-Beckmann *et al.,* 2015; Salomons *et al.,* 2021). Furthermore, recent evidence shows that the sound produced during UXO detonation has lower frequency components (<100 Hz) than was previously assumed (Robinson *et al.,* 2022), therefore this assessment is likely to be overly precautionary for species, such as minke whale, whose hearing sensitivity was previously assumed to overlap with the primary acoustic energy produced by a high order detonation.

11.10.6.7 If PTS were to occur within this low frequency range, it is unlikely that it would result in a significant impact on the vital rates of harbour porpoise, dolphin species, and seals. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, harbour porpoise, dolphin species, and seal species are assessed as having a Low sensitivity to PTS from underwater noise during UXO clearance. Minke whales are assessed as having a Medium sensitivity to PTS from underwater noise during UXO clearance, although as discussed in paragraph 11.10.6.6, this is precautionary.

BEHAVIOURAL DISTURBANCE

11.10.6.8 JNCC (2020) states that 'a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement'. Each donation will be of short-term duration; therefore, it is not expected that behavioural disturbance from a single UXO detonation would cause a significant impact.

11.10.6.9 As a result, all marine mammal species are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, they are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during UXO clearance.

Construction phase

MAGNITUDE OF IMPACT

AUDITORY INJURY – PTS

11.10.6.10 The following section provides the quantitative assessment of the impact of PTS from UXO clearance on marine mammals. A UXO detonation is defined as a single pulse, therefore both the weighted SEL_{cum} criteria and the unweighted SPL_{peak} criteria from Southall *et al.* (2019) have been presented in Table 11.18 and the source levels (unweighted SPL_{peak} and SEL_{ss}) for each charge weight are presented in Table 11.19, whereby SEL_{cum} is equivalent to SEL_{ss}. As a result, animal fleeing assumptions do not apply to the values presented. The predicted impact ranges for auditory injury (PTS-onset) from UXO clearance for each FHG are presented in Table 11.59 and the number of animals predicted to experience PTS-onset from UXO clearance are presented in Table 11.60.

11.10.6.11 Generally, the estimated auditory injury (PTS-onset) impact ranges increased with the size of the charge for all FHGs (Table 11.59). For harbour porpoise, the maximum PTS-onset impact range was 14 km (SPL_{peak}) (Table 11.59). This equates to a maximum of 234 individuals experiencing auditory injury (0.37% of the reference population) from a high order UXO clearance using the greatest charge weight (800 kg plus donor) using the site-specific DAS density estimate (Table 11.60).

11.10.6.12 At all charge sizes, HF cetaceans (dolphin species) have the smallest predicted impact range of up to 840 m (SPL_{peak}) (Table 11.59). For bottlenose dolphin, Risso's dolphin, and common dolphin, the maximum PTS-onset impact range was 840 m (SPL_{peak}), which equates to <1 individual experiencing auditory injury from UXO clearance (Table 11.60).

11.10.6.13 For all FHGs, the unweighted SPL_{peak} impact ranges are higher than the weighted SEL_{ss} impact ranges with the exception of LF cetaceans, such as minke whale, due to the sensitivity of their hearing (Table 11.59). For minke whale, the maximum PTS-onset impact range was 11 km (SEL_{ss}) (Table 11.59). This equates to a maximum of 17 individuals experiencing auditory injury (0.09% of the reference population) from a high order UXO clearance using the greatest charge weight (800 kg plus donor) (Table 11.60).

11.10.6.14 For seals, the maximum PTS-onset impact range was 2.8 km (SPL_{peak}) (Table 11.59). This equates to two grey seals (0.12% of the reference population) and <1 harbour seal (<0.01% of the reference population) experiencing auditory injury from a high order UXO clearance using the greatest charge weight (Table 11.60).

11.10.6.15 For all FHGs, the auditory injury (PTS-onset) impact range for low order clearance is small, with a maximum range of <1.2 km (Table 11.59).

11.10.6.16 For all marine mammal species, the impact is considered to result in a very small proportion of the population affected and very unlikely to affect the population trajectory, although auditory injury (PTS) is expected to have a permanent change to the receptor. Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoise, minke whale, and grey seal. For dolphin species and harbour seal, <1 animal is predicted to experience auditory injury (PTS), therefore the magnitude of impact is assessed as Negligible.

Table 11.59: Summary of auditory injury (PTS-onset) impact ranges for UXO detonation using the impulsive noise criteria from Southall *et al.* (2019) for marine mammals

Charge weight (kg)	PTS-onset (unweighted SPL_{peak})				PTS-onset (weighted SEL_{ss})			
	VHF cetacean	HF cetacean	LF cetacean	PCW	VHF cetacean	HF cetacean	LF cetacean	PCW
0.5 (low order)	1.2 km	70 m	220 m	240 m	110 m	<50 m	320 m	60 m
25 + donor	4.6 km	260 m	820 m	910 m	570 m	<50 m	2.2 km	390 m
55 + donor	6.0 km	340 m	1.0 km	1.1 km	740 m	<50 m	3.2 km	570 m
120 + donor	7.8 km	450 m	1.3 km	1.5 km	950 m	<50 m	4.7 km	830 m
240 + donor	9.8 km	560 m	1.7 km	1.9 km	1.1 km	<50 m	6.5 km	1.1 km
525 + donor	12.0 km	730 m	2.2 km	2.5 km	1.4 km	50 m	9.5 km	1.6 km
700 + donor	14.0 km	810 m	2.4 km	2.7 km	1.5 km	60 m	10.0 km	1.9 km
800 + donor	14.0 km	840 m	2.6 km	2.8 km	1.6 km	60 m	11.0 km	2.0 km

Table 11.60: Predicted impact of PTS-onset for marine mammals from UXO clearance; # = number of animals disturbed; % = the percentage of the reference population[6]

Species	Density (animals/km^2)	Impact	PTS-onset (unweighted SPL_{peak})								PTS-onset (weighted SEL_{ss})							
			0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor	0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor
Harbour porpoise	0.38	#	2	25	43	73	115	172	234	234	<1	<1	1	1	1	2	3	3
		%	<0.01	0.04	0.07	0.12	0.18	0.27	0.37	0.37	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.2803	#	1	19	32	54	85	127	173	173	<1	<1	<1	1	1	2	2	2
		%	<0.01	0.03	0.05	0.09	0.14	0.20	0.28	0.28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bottlenose dolphin	0.0201	#	0	0	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	0.00	<0.01	<0.01	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.2352	#	0	<1	<1	<1	<1	<1	<1	1	0	0	0	0	0	0	0	0
		%	0.00	0.02	0.03	0.05	0.08	0.13	0.17	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Risso's dolphin	0.031	#	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0	<1
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01
Common dolphin	0.0272	#	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0	<1
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01
Minke whale	0.045	#	<1	<1	<1	<1	<1	1	1	1	<1	1	1	3	6	13	14	17
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.03	0.06	0.07	0.09
	0.017	#	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	2	5	5	6
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.03	0.03
Grey seal	0.08	#	<1	<1	<1	1	1	2	2	2	0	<1	<1	<1	<1	1	1	1
		%	<0.01	0.01	0.02	0.03	0.05	0.09	0.11	0.12	0.00	<0.01	<0.01	0.01	0.02	0.04	0.05	0.06
Harbour seal	0.0003	#	0	0	0	0	0	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	0.00	0.00	0.00	0.00	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TTS

11.10.6.17 The following section provides the qualitative assessment of the impact of TTS from UXO clearance on marine mammals. The predicted impact ranges for TTS-onset from UXO clearance for each FHG are presented in Table 11.61. As outlined in paragraph 11.7.5.6, no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given.

11.10.6.18 Generally, the estimated TTS-onset impact ranges increased with the size of the charge for all FHGs. For harbour porpoises (VHF cetaceans), the maximum TTS-onset impact range was 26 km (SPL_{peak}) for a high order detonation using the greatest charge weight (800 kg plus donor) (Table 11.61).

11.10.6.19 For dolphin species (HF cetaceans), the maximum TTS-onset impact range was 1.5 km (SPL_{peak}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) Table 11.61).

11.10.6.20 For minke whale, the maximum TTS-onset impact range was 120 km (SEL_{ss}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.61).

11.10.6.21 For seals, the maximum TTS-onset impact range was 23 km (SEL_{ss}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.61).

11.10.6.22 For all FHGs, the TTS-onset impact range for low order clearance is small, with a range of <4.5 km.

Table 11.61: Summary of TTS-onset impact ranges for UXO detonation using the impulsive noise criteria from Southall *et al.* (2019) for marine mammals

Charge weight (kg)	TTS-onset (unweighted SPL_{peak})				TTS-onset (weighted SEL_{ss})			
	VHF cetacean	HF cetacean	LF cetacean	PCW	VHF cetacean	HF cetacean	LF cetacean	PCW
0.5 (low order)	2.3 km	130 m	410 m	450 m	930 m	<50 m	4.5 km	800 m
25 + donor	8.5 km	490 m	1.5 km	1.6 km	2.4 km	150 m	29 km	5.2 km
55 + donor	11 km	640 m	1.9 km	2.1 km	2.8 km	210 m	41 km	7.5 km
120 + donor	14 km	830 m	2.5 km	2.8 km	3.2 km	300 m	57 km	10 km
240 + donor	18 km	1.0 km	3.2 km	3.5 km	3.5 km	390 m	76 km	14 km
525 + donor	23 km	1.3 km	4.1 km	4.6 km	4.0 km	530 m	100 km	19 km
700 + donor	25 km	1.4 km	4.5 km	5.0 km	4.1 km	590 m	110 km	22 km
800 + donor	26 km	1.5 km	4.7 km	5.3 km	4.2 km	620 m	120 km	23 km

BEHAVIOURAL DISTURBANCE

11.10.6.23 This section presents the quantitative assessment for behavioural disturbance during UXO clearance using high order and low order methodologies as described in section 11.7.5.

20 KM EDR FOR HIGH ORDER CLEARANCE

11.10.6.24 The number of each marine mammal species predicted to experience behavioural disturbance as a result of high order UXO detonation using a 20 km EDR is quantified by multiplying the area of impact (assuming a 20 km EDR results in an impact area of 1,256.64 km^2) by the respective species-specific density estimate. The results are presented in Table 11.62 and assessed as the proportion of the respective reference population (as presented in Table 11.7). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

Table 11.62: Predicted impact of disturbance to marine mammals from UXO assuming a 20 km EDR[6].

Species	Density (animals/km^2)	Number of animals disturbed	Percentage of the reference population
Harbour porpoise	0.38	478	0.76
	0.2803	352	0.56
Bottlenose dolphin	0.0201	26	8.87
	0.2352	296	101.02
	0.2352	296	3.56[8]
Risso's dolphin	0.031	39	0.32
Common dolphin	0.0272	35	0.03
Minke whale	0.045	57	0.28
	0.017	22	0.11
Grey seal	0.08	101	6.08
Harbour seal	0.0003	1	0.55

11.10.6.25 The greatest estimated disturbance occurs for harbour porpoise, bottlenose dolphin, and grey seal, where up to 478 harbour porpoises, 296 bottlenose dolphins, and 101 grey seals are predicted to be disturbed (Table 11.62).

11.10.6.26 The estimated number of harbour porpoise and percentage of the reference population impacted is greatest when using the using the site-specific density estimate of 0.38 animals/km^2 from the DAS (Table 11.62). However, this assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea and is therefore considered to be highly conservative. Using the uniform density estimate of 0.2803 animals/km^2 from the wider SCANS-IV surveys, it was estimated that 352 animals will experience behavioural

disturbance as a result of UXO detonation, using the 20 km EDR (Table 11.62), which is considerably lower.

11.10.6.27 The estimated number of bottlenose dolphins and percentage of the reference population impacted is greatest when using the density estimate of 0.2352 animals/km^2 from the SCANS-IV surveys (Table 11.62). However, the percentage of the reference population impacted is not considered to be realistic as it does not account for the variability in coastal and offshore population densities and distributions within the Irish Sea. Furthermore, the design of broad scale surveys, such as SCANS, used to derive MU population estimates are not designed to capture localised, coastal populations such as that of Cardigan Bay; therefore, the reference population size has been under-estimated. Therefore, the more realistic numbers for this assessment are those using the density estimate from Rogan *et al.* (2018), or if using the SCANS-IV density estimate, using the larger reference population size derived from SCANS-IV (8,326 animals). Both methods result in <10% of the population being impacted, and this has been used in the assessment conclusion.

11.10.6.28 The estimated number of minke whale and percentage of the reference population impacted is greatest when using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys and is therefore considered to be the most conservative estimate (Table 11.62).

11.10.6.29 While it is expected that a high order UXO detonation would elicit a startle response and therefore, only a very short-term duration behavioural response is expected (JNCC, 2020); however, there is no empirical evidence of any marine mammal species' response to these events. The impact is considered to result in a small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

5 KM EDR FOR LOW ORDER CLEARANCE

11.10.6.30 The 5 km EDR has been used in this assessment for illustrative purposes and should be viewed with caution as there is no evidence to support this impact range. The number of each marine mammal species predicted to experience behavioural disturbance as a result of low order UXO detonation using a 5 km EDR is quantified by multiplying the area of impact (78.54 km^2) by the respective species-specific density estimate. The results are presented in Table 11.63 and assessed as the proportion of the respective reference population (as presented in Table 11.7). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

Table 11.63: Predicted impact of disturbance to marine mammals from UXO assuming a 5 km EDR[6].

Species	Density (animals/km^2)	Number of animals disturbed	Percentage of the reference population
Harbour porpoise	0.38	30	0.05
	0.2803	23	0.04
Bottlenose dolphin	0.0201	2	0.68
	0.2352	19	6.48
	0.2352	19	0.23[8]
Risso's dolphin	0.031	3	0.02
Common dolphin	0.0272	3	<0.01
Minke whale	0.045	4	0.02
	0.017	2	0.01
Grey seal	0.08	7	0.42
Harbour seal	0.0003	1	0.55

11.10.6.31 The greatest estimated disturbance occurs for harbour porpoise, bottlenose dolphin, and grey seal, where up to 30 harbour porpoises, 19 bottlenose dolphins, and 7 grey seals are predicted to be disturbed (Table 11.63).

11.10.6.32 The estimated number of harbour porpoise and percentage of the reference population impacted is greatest when using the using the site-specific density estimate of 0.38 animals/km^2 from the DAS (Table 11.63). However, this assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea and is therefore considered to be highly conservative.

11.10.6.33 The estimated number of bottlenose dolphins and percentage of the reference population impacted is greatest when using the density estimate of 0.2352 animals/km^2 from the SCANS-IV surveys and is therefore considered to be the most conservative estimate (Table 11.63). As in the assessment of high order UXO clearance, the number of animals predicted to be impacted using the Rogan *et al.* (2018) density estimate is considered more realistic.

11.10.6.34 The estimated number of minke whale and percentage of the reference population impacted is greatest when using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys and is therefore considered to be the most conservative estimate (Table 11.63).

11.10.6.35 The impact of low order detonation is considered to result in a very small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

AUDITORY INJURY – PTS

11.10.6.36 For harbour porpoise, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to harbour porpoise from underwater noise during UXO clearance **is Slight adverse**, which is **not significant** in EIA terms.

11.10.6.37 For bottlenose dolphin, Risso's dolphin, and common dolphin, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to bottlenose dolphin, Risso's dolphin, and common dolphin from underwater noise during UXO clearance is **Not Significant**, which is **not significant** in EIA terms.

11.10.6.38 For minke whale, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium.** Therefore, the significance of effect from PTS to minke whale from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

11.10.6.39 For grey seal, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to grey seal from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

11.10.6.40 For harbour seal, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour seal from underwater noise during UXO clearance is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.10.6.41 For all marine mammal species, the impact of behavioural disturbance from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.6.42 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during UXO clearance is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.6.43 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). Therefore, the Developer has committed to a UXO MMMP to further reduce the risk of PTS-onset, which also applies to both harbour and grey seals (which are not EPS).

11.10.7 Impact 7 – Injury and/or disturbance from underwater noise during site surveys

11.10.7.1 In 2023, the Developer submitted a Foreshore Licence Application (FLA) to carry out site surveys at the site of the Proposed Development. The details provided within this assessment are aligned

with the Arklow Bank Wind Park – Foreshore Licence Application for Site Surveys – Annex IV Species Risk Assessment (RPS, 2023), and the accompanying Schedule of Works. Surveys will be carried out before the construction phase, prior to the installation of the offshore infrastructure, and routinely during the operations and maintenance phase.

11.10.7.2 The key parameters for assessment of Project Design Option 2 considers underwater noise from site surveys (Table 11.10). Site surveys of relevance to this Chapter are those that produce underwater noise and include geophysical and geotechnical surveys. Geophysical surveys such as MBES, SSS and USBL typically produce sound sources that are sonar-based or impulsive (Table 11.64). Geotechnical surveys such as vibrocoring, typically produce non-impulsive sound sources, whilst some geotechnical surveys, such as grab sampling will not result in any measurable noise (Table 11.65). The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore examples of the different survey equipment and expected source levels are presented in Table 11.64 for geophysical equipment, and Table 11.65 for geotechnical survey equipment.

Table 11.64: Expected geophysical surveys and equipment, with indicative source levels

Survey type	Equipment type	SEL (unweighted) (dB re 1µPa^{2}s @1 m)	SPL_{rms} T90 (dB re 1µPa at1 m)	SPL_{pk} (dB re 1µPa at 1 m)
Non-impulsive sonar-based surveys / equipment				
Multibeam EchoSounder (MBES)	Konsberg EM2040 or Reson Seabat 7125	N/A	213	N/A
Side scan sonar (SSS)	Edgetech FS4200 or Klein 5000	N/A	210	N/A
Sub-bottom profiler (SBP)	Innomar SES Standard / Medium or Applied Acoustics AA251 or Egdetech 6205S	N/A	245	N/A
Ultra-Short Baseline (USBL)	Sonardyne Compatt 6 8300-3111	202	184	202
Impulsive surveys / equipment				
Seismic refraction	TI sleeve 10CU	195	214	224
Sparker (2DUHRS and 3DUHRS)	Geosource 200 – 400	182	214	219

Table 11.65: Expected geotechnical surveys and source levels

Survey type	Source level (dB re 1µPa re 1 m (peak)	Source SEL (dB re 1 µPa²s re 1 m) (unweighted)	SPL rms T90
Seismic CPT[1]	220	189	203
Vibrocore	190	223[2]	187
Grab sample	N/A	N/A	N/A

[1]Equipment is pushed into the seabed and therefore would not result in a measurable noise source.

[2]Based on one hour of operation for a single core sample.

11.10.7.3 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.18) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised (Table 11.20; Southall *et al.*, 2019). Noise levels generated from site surveys (geophysical and geotechnical) were predicted by Seiche Ltd. Full details of the underwater noise modelling methodology, assumptions, and resulting impact ranges are detailed in Seiche Ltd. (2022).

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY

11.10.7.4 Very limited information exists on the impacts of site surveys (geophysical and geotechnical) to marine mammals, with most available studies investigating the impact of seismic airguns. However, all species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al.*, 2007). The ecological consequences of PTS are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al.*, 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.10.7.5 A study by Lucke *et al.* (2009) indicated that TTS could be induced in harbour porpoise at 350 m when exposed to an airgun impulse at a peak pressure of 200 dB_{pk-pk} re 1 µPa with corresponding SEL of 164.5 dB re μPa^2_s) in shallow waters (~4 m), however this study is highly conservative as it assumes that the animal would remain stationary throughout the exposure. Evidence from other studies suggests that harbour porpoises exposed to such noise sources would likely move away from the source, and therefore leave the impact range of PTS-onset (Hermannsen *et al.,* 2015). Furthermore, it is expected that vessel presence will act as a deterrent to harbour porpoise, reducing the risk of auditory injury (Benhemma-Le Gall *et al.*, 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity at the start of any survey activity or source.

11.10.7.6 While PTS is a permanent effect which cannot be recovered from, the most likely response of a marine mammal to noise levels that could induce TTS is to flee the area (Southall *et al.,* 2007). Therefore, animals exposed to these noise levels that could induce TTS are likely to actively avoid hearing damage by moving away from the source.

11.10.7.7 The limited information available for the impacts of underwater noise from site surveys on marine mammals make it challenging to assess the risk for all species. However, it is unlikely that PTS from site surveys would significantly impact the survival of reproductive rates of marine mammal species in this assessment. As a result, they are considered to be of high adaptability, reasonable tolerance, have between no and full recoverability, and are of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to auditory injury from underwater noise during site surveys.

BEHAVIOURAL DISTURBANCE

11.10.7.8 Limited information exists on the impacts of behavioural disturbance from site surveys (geophysical and geotechnical) to marine mammals, with most available studies investigating the impact of seismic airguns.

11.10.7.9 An analysis of MMO reports found that small cetaceans (including harbour porpoise) have a tendency to swim away from seismic airguns at speed or tend to avoid survey vessels when airguns are firing up to a distance of ~1 km away (Moulton and Miller, 2005; Pirotta *et al.,* 2014; Stone, 2003). Acoustic data collected by Pirotta *et al.* (2013) showed that harbour porpoise that remained in the seismic survey impact area reduced their echolocation activity by 15% during the survey, which could be indicative of changes to foraging or social behaviour (van Beest *et al.,* 2018). Although, Thomspon *et al.* (2013) found that short-term disturbance by a seismic survey in the North Sea did not lead to long-term displacement of harbour porpoises as animals were typically detected again within a few hours following the survey works. Similarly, Hoekendijk *et al.* (2018) concluded that short-term, irregular disturbance events are unlikely to significantly affect the energetic status of harbour porpoise, particularly where surveys are conducted in shallow waters as sound cannot propagate as far.

11.10.7.10 For common dolphins, evidence suggests that there is no change in occurrence or sighting densities of common dolphin during active seismic surveys (Kavanagh *et al.*, 2019; Stone *et al.*, 2017). Similarly, Risso's dolphin showed no response to seismic airguns (Stone *et al.,* 2017) or simulated military sonar (Southall *et al.*, 2011). Whereas a study on minke whale investigating the impacts of exposure to naval sonar (with acoustic characteristics of 1.3 – 2 kHz to a maximum SL of 214dB re 1µPa @ 1 m) found that whales increased their swimming speeds to avoid the sound source (Kvadsheim *et al.,* 2017). Increases in metabolic rates associated with avoidance behaviour could have implications on energy expenditure and survival for individuals (Kvadsheim *et al.,* 2017).

11.10.7.11 Very limited studies on the effects of seismic airguns on seals, however other studies on the behavioural effects of impulsive noise sources to seals have shown varying responses of grey seals. During pile driving, grey seals were most commonly recorded changing behaviour from foraging to horizontal movement; although changes in swim speed, surfacing and diving behaviour and no response were also observed (Aarts *et al.,* 2018). A telemetry study during piling in southeast England showed that harbour seals within the area returned to usage levels similar to that of non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term (Russell *et al.,* 2016). Seals are generally considered to be relatively adaptable due to their generalist diets, wide foraging ranges, and adequate fat stores which enable them to compensate for lost foraging opportunities as a result of disturbance (Booth *et al.,* 2019; Smout *et al.,* 2014; Stansbury *et al.,* 2015).

11.10.7.12 The limited information available for the impacts of underwater noise from site surveys on marine mammals make it challenging to assess the risk for all species. Based on evidence available, all marine mammal species within this assessment are considered to be of high adaptability, reasonable tolerance, high recoverability, and of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during site surveys.

Construction phase

MAGNITUDE OF IMPACT

AUDITORY INJURY – PTS

11.10.7.13 The following section provides the assessment of the impact of PTS-onset from site surveys (geophysical and geotechnical) on marine mammals. Further detail with regards to the PTS-onset thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.10.7.14 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for non-impulsive geophysical survey sound sources (MBES, SSS and SBP) injury in the form of cumulative PTS could occur up to 517 m from the sound source, depending on the survey equipment and the FHG being assessed. For the MBES, the greatest predicted impact range for cumulative PTS is 25 m, for harbour porpoise, bottlenose dolphin, Risso's dolphin, and common dolphin (VHF and HF cetaceans) (Seiche Ltd., 2022). The threshold for cumulative PTS is not predicted to be exceeded for minke whale (LF cetaceans) (Seiche Ltd., 2022). For the SSS, the greatest predicted range for cumulative PTS is 25 m, for harbour porpoise, bottlenose dolphin, Risso's dolphin, and common dolphin (Seiche Ltd., 2022). For the SBP, the greatest predicted range for cumulative PTS is 517 m, for harbour porpoise (Seiche Ltd., 2022). USBL were not included in the Subsea Noise Assessment (Seiche Ltd., 2022) however, CSA Ocean Sciences Inc. (2020) estimated that the maximum distance to the weighted Level A threshold (cumulative PTS) is 1.7 m for VHF cetaceans (harbour porpoise).

11.10.7.15 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for impulsive geophysical survey sound sources (seismic refraction and sparker) injury in the form of instantaneous PTS could occur up to 22 m from the source and cumulative PTS could occur up to 130 m from the sound source (Seiche Ltd., 2022). For the seismic refraction surveys, the greatest predicted impact range for instantaneous PTS is 22 m and for cumulative PTS is 130 m, for harbour porpoise (Seiche Ltd., 2022). For sparker surveys, the greatest predicted impact range for cumulative PTS is 14 m, for harbour porpoise (Seiche Ltd., 2022) The instantaneous PTS thresholds are not exceeded for any of the FHGs for the sparker surveys.

11.10.7.16 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for geotechnical surveys (seismic CPT and vibrocore sampling) injury in the form of instantaneous PTS could occur up to 15 m from the source and cumulative PTS could occur up to 62 m from the sound source (Seiche Ltd., 2022). For the seismic CPT, the greatest predicted impact range for cumulative PTS is 62 m, for harbour porpoise (Seiche Ltd., 2022). For vibrocore sampling, cumulative PTS only occurs for VHF cetaceans (harbour porpoise) and is predicted to occur within 2 m of the source (Seiche Ltd., 2022).

11.10.7.17 In addition, the Factored In Measures (see Table 11.15) which includes the implementation of a project-specific mitigation protocol during the geophysical surveys will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance.

11.10.7.18 The impact of PTS-onset to all marine mammal species from site surveys is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively frequently throughout the construction phase, although the effect is unlikely to occur given implementation of Factored In Measures and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.