Geophysical Surveys, Cenos Floating Offshore Windfarm – Marine Mammal and Basking Shark Risk Assessment

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Contents

1 Introduction

This Marine Mammal and Basking Shark Risk Assessment has been produced to support an European Protected Species (EPS) licence application to Marine Directorate Licensing Operation Team (MD-LOT) to disturb cetaceans. The licence is required to allow sub-bottom profiling (SBP) to be undertaken in the Central North Sea (CNS) as part of the geophysical survey campaign for the Cenos Floating Offshore Windfarm.

Geophysical survey work for the project is planned for both the windfarm array area and prospective cable route in offshore waters (i.e. beyond 12 nautical miles (nm)), as shown in Figure 1.1. There is potential for underwater noise produced during a portion of the offshore SBP survey works to propagate into inshore waters (i.e. within 12 nm from shore).

This risk assessment document has been updated on the basis of advice received from NatureScot and MD-LOT as part of the EPS licensing process and refinements made to the proposed survey areas. For avoidance of doubt, advice received to date has confirmed that:

- An EPS Licence for disturbance in the offshore region is not required;
- An EPS Licence for disturbance in the inshore region is required, as granted under licence EPS/BS-00010419; and
- A licence for disturbance of basking shark is not required.

1.1 Background

The CNS is known to support several species of marine megafauna, including marine mammals and, less regularly, basking sharks (see Section 3: Marine Mammal and Basking Shark Baseline). Marine mammal species present in this area are sensitive to anthropogenic underwater noise and the project's geophysical survey activities have the potential to generate disturbance or injury impacts to these hearing-sensitive species.

All United Kingdom (UK) cetacean species are listed under Annex IV of the European Habitats Directive and Schedule 2 of the Habitat Regulations 1994 as EPS, which has been transposed into Scottish Law through the Wildlife and Countryside Act 1981 and The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

Within inshore waters, Regulation 39 (1) of The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), makes it an offence to deliberately or recklessly capture, kill, injure, disturb or harass an EPS. Regulation 39 (2) makes further provision specifically for cetaceans, making it an offence to deliberately or recklessly disturb any dolphin, porpoise or whale. This provides protection to EPS within the inshore region, up to the 12nm limit. NatureScot have confirmed that an inshore EPS licence is required for the Cenos Floating Offshore Windfarm geophysical survey, and this has been granted by MD-LOT for the Route B and B.1 survey areas (EPS/BS-00010419).

In the offshore region, beyond 12nm, EPS are protected under The Conservation of Offshore Marine Habitats and Species Regulations 2017 (referred to as the 'Offshore Regulations'). Specifically, Regulation 45 (1) makes it an offence to deliberately capture, kill, injure or disturb an EPS. Advice provided by NatureScot upon consultation by MD-LOT has confirmed that EPS Licence under the Offshore Regulations is not required for the Cenos Floating Offshore Windfarm geophysical surveys (B Campbell MD-LOT, personal communication via email, 13th June 2023).

Pinnipeds are not listed as Annex IV EPS species under the Habitats Directive however, both common and grey seals are included in Annex II, meaning that their core habitat must be protected under the Natura 2000 Network and managed in accordance with their ecological requirements. Under the Marine (Scotland) Act 2010, it is an offence to kill, injure or take a seal, as well as to harass a seal, deliberately or recklessly, at a significant haul out site.

This document lays out the relevant information to support the licence application, including:

- Consideration of alternatives;
- The baseline information on marine mammals in the CNS;
- The activities taking place which may cause injury and/or disturbance without mitigation;
- The likelihood of risk and potential impacts;
- The effects on the protected species of concern without mitigation; and
- The mitigation and management strategies implemented to prevent harms i.e. the Marine Mammal Mitigation Plan.

Basking shark are also considered as part of this risk assessment, as they may be affected by underwater noise. As advised by NatureScot via MD-LOT, in accordance with telemetry and sightings data, basking shark are expected to be present in very low numbers within the survey area, and are not likely to be significantly affected by geophysical survey noise (B Campbell MD-LOT, personal communication via email, 13th June 2023). On this basis, NatureScot have confirmed that a basking shark licence for disturbance under the Wildlife and Countryside Act 1981 (as amended) is not required for the Cenos Floating Offshore Windfarm.

1.2 Scope of Work

1.2.1 Original Scope

Acoustic surveys will be carried out within and around the Cenos Floating Offshore Windfarm area and along the potential cable routes to shore. The surveys will provide an understanding of the seabed conditions, potential archaeological features and habitats present to inform design, cable routing and the project Environmental Impact Assessment. The surveys will use several techniques including multibeam echosounder (MBES), single beam echosounder (SBES), side scan sonar (SSS), 2D ultra high-resolution seismic (UHR) and sub-bottom profiler (SBP).

Operable frequencies for SBPs are between 85 – 115kHz, while UHRs are between 40Hz – 1.5kHz. Geophysical surveys using UHR and SBP techniques have the potential to impact upon marine mammals due to their frequency range and source level (SL) output. A more detailed description of the geophysical surveys is provided in Section 2: Description of Proposed Survey Operations. The operable frequencies of MBES, SBES and SSS are generally inaudible to the taxa identified in Section 3: Marine Mammal and Basking Shark Baseline and are therefore not assessed in Section 4: Risk Assessment, of this document.

1.2.2 Updated Scope

The proposed survey methodology (MBES, SBES, SSS, UHR and SBP) and objective to characterise the Cenos Floating Offshore Windfarm area and potential cable routes to shore remains as per the original scope. An additional pre-survey activity, utilising Ultra Short Baseline (USBL) for the calibration of positioning equipment, is included in this updated risk assessment. USBL operates at frequencies of 19 – 34kHz, within the operable range of geophysical survey equipment, and audible to some marine mammals. Further details on USBL Calibration are provided in Section 2: Description of Proposed Survey Operations.

As works to define the cable route to shore have progressed since the original submission of this risk assessment, an updated cable survey area is also included. The updated proposal takes account of factors including initial survey results and analysis of existing data. A full description of the revised cable survey area is provided in Section 1.3.2.2: Updated Cable Survey Area.

1.3 Survey Areas

The proposed survey areas include the windfarm array area and potential cable routes where the windfarm infrastructure (i.e., cables, mooring systems, and electrical hub) will be placed. It is not appropriate to survey outside these areas as the sediment and seabed structure may not be representative of the locations in which the windfarm and associated assets will be positioned. The locations presented in this risk assessment are placed to best inform the design and development of the windfarm, including micro-siting to minimise impacts on sensitive benthic habitats.

1.3.1 Windfarm Survey Area

The Cenos Floating Offshore Windfarm array area is 333km^2, surveys will be carried out covering the full windfarm area and a sufficient buffer (2km) to allow for routing of cables from the windfarm hub towards oil and gas assets[1] and turning of the vessel. The total windfarm survey area is therefore 506 km^2. The survey area is shown on Drawing FLO-CEN-GIS-MAP0002-Windfarm Survey Area-Rev001, the bounding coordinates of the survey area are provided in Appendix 1.

The survey line spacing within the windfarm array area is planned to be 100m.

1.3.2 Cable Survey Area

To allow the EPS application to be submitted in sufficient time to allow determination prior to survey, a cable corridor search area approach has been taken. This has allowed areas within which survey work will take place to be defined for inclusion with the application submissions. Works to refine the cable routing were ongoing in parallel with the EPS Licensing process, such that by the time surveying is undertaken it is expected that the area requiring survey will be much reduced. Ongoing works include discussions with the owners of assets that would need to be crossed. Note sections of the Cenos Floating Offshore Windfarm route to shore utilise the consented NorthConnect cable route (including the complete inshore section) which has already been surveyed, and hence they are not included in the survey areas.

1.3.2.1 Original Cable Survey Area

The concept cable routes to shore are shown in Figure 1.1; two main Routes A and B have initially been considered[1]. Route B could be varied to Route B.1; survey data has already been collected for the majority of Route B.1 hence survey of the full B.1 route is not allowed for within this document. As outlined above, works to refine rout options are ongoing, and as a result the actual routes could vary from those shown in Figure 1.1.

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[1] Note the remainder of the cable route to oil and gas assets will be subject to separate survey in the future.

The original cable corridor search area is shown on Drawing FLO-CEN-GIS-MAP001-Survey Areas-Rev002. The bounding coordinates provided for the purpose of the original EPS application are given in Appendix 1.

The total original cable corridor search area is 1,696km^2, however less than 11% of this would be subject to survey. The intent is to survey a 500m wide corridor for the majority of the route. Where assets are crossed or an area unsuitable for cable installation is encountered, additional survey lines will be undertaken for those sections of the route. The areas envisaged to require survey for Routes A, B and B.1 are approximately 75, 100 and 5 km^2 respectively.

As outlined in Section 1.1: Background, the identified cable survey areas are entirely within the offshore region in marine consenting terms (beyond 12nm). However, the western end of the Route B survey could give rise to noise in the inshore area.

1.3.2.2 Updated Cable Survey Area

Since the original risk assessment was completed and EPS Licence application submitted, the decision has been made to survey Routes B and B1 only. Furthermore, a change in the cable survey area for Route B has been identified, with a widening of sections at the west end and mid-section, as shown in Drawing FLO-CEN-GIS-MAP020-Cenos Survey Area-Rev001, the coordinates of which are included in Appendix 3. These updates have been made in response to initial survey data which suggests potential presence of *Sabellaria spinulosa* reef at the western end of Route B and hence potential need to gather data in a wider area, and requirement to avoid a third-party asset. The intent is to survey 5 main survey lines, with 100m spacing, and cross-lines approximately every 10km. For the purpose of this risk assessment, a total survey area in the region of 750km^2 is anticipated for the amended Route B and Route B.1.

Note it is not proposed that the entire cable survey area be included within the EPS licensing process, as only a proportion of the area will result in noise affecting the inshore area. This is detailed in Drawing FLO-CEN-GIS-MAP020-Cenos Survey Area-Rev001, with coordinates provided in Appendix 4, and further discussed in Section 7: Variation to EPS License.

Figure 1.1: Concept Cable Routes to Shore

1.4 Schedule of Works

The bulk of the survey works are proposed to be complete in summer/autumn 2023, however, it is noted that the geophysical surveys shall not be allowed to commence without the award of an EPS licence. If necessary additional geophysical surveys will be completed in the first half of 2024 to fill in any data gaps. Overall, there will be up to 120 days of geophysical survey of which around 95 days will include both SBP and UHR, and 25 days of just SBP in the cable survey area. Note these predicted days exclude mobilisation, demobilisation, grab or geotechnical sampling, visual assessments and adverse weather days, when no SBP or UHR surveys are being undertaken.

1.5 Physical Environment

The North Sea is a shallow sea surrounded by several land masses, including low-lying areas of northern Europe, the complex coastlines of western Norway and the eastern coast of the UK. Once a land bridge between Denmark and the UK, the North Sea has an average depth of 90m and has a typically uniform bathymetry and substrate of fine mud and sand (Walday & Kroglund, 2008). It is open to the wider North Atlantic from the north and from the south where the English Channel opens into the Celtic Sea. The non-tidal current direction within the North Sea is anti-clockwise.

2 Description of Proposed Survey Operations

2.1 Sub-Bottom Profiling

A geophysical survey of the area will be undertaken over a period of up to 120 days to map the shallow geology to 10m below the seabed, otherwise known as sub-bottom profiling. The SBP will be conducted utilising seismic reflection techniques and an acoustic boomer sub-bottom system. The outputs will seek to determine the depths to all significant seismic reflectors, particularly those that can be correlated to changes in geological strata but will not quantify any strata (i.e. till, gravel, sand, mud, etc.). This is required to inform the design options for the windfarm and cable burial risk assessment.

It is proposed that a high-frequency single-channel SBP system such as the Innomar SES-2000 or similar be used to conduct the surveys within the windfarm survey area and along cable routes. The entire SBP system will be towed behind a survey vessel and will consist of an insulated metal plate and rubber diaphragm adjacent to a flat wound electrical coil, normally mounted on a towed catamaran. A short duration, high power electrical pulse, generated by the shipboard power supply and capacitor banks, will discharge to the electrical coil and the resultant magnetic field explosively repels the metal plate, generating a broad band acoustic pressure pulse in the water column. A percentage of the acoustic energy is reflected from the sea floor, dependent upon the composition of the seabed materials. The remaining energy penetrates the seabed and is reflected from layers of contrasting acoustic impedance. Acoustic impedance is the product of the density and seismic velocity of a material. The character of the sub-bottom records is therefore dependent upon the way in which the acoustic signal is reflected. This is used to interpret the conditions present. The reflections are detected by a multi-element hydrophone which is typically towed parallel to the source catamaran, astern of the vessel. This configuration is used to minimise the direct source-receiver signal. The reflections detected by the hydrophone are converted to an electrical signal and passed to a geophysical data acquisition system. This allows the data to be amplified, filtered, presented graphically, and recorded.

SBP acoustic boomers for use in geophysical surveys typically have a source level of 240 – 250dB re 1μPa @ 1m (Innomar, 2023). The frequency of each pulse is in the range 85kHz to 115kHz with a primary frequency of 100kHz. Firing rate can vary between 10 to 50 pulses per second (pps).

2.2 2D Ultra High-Resolution Seismic Survey

The use of an UHR single or multi-channel system will be required to image the uppermost 50 – 100m of the seabed, this is required to inform anchor designs for the floating turbines. The preferred system to be used is a sparker source, similar or equivalent to the GeoSparker 200 (Geo Marine Survey Systems). The UHR survey will take place within the windfarm survey area and will not be required along cable survey routes.

Sparkers emit an omnidirectional broadband acoustic pulse into the water column by first creating an electrical pulse between electrodes located on the tip of the device, and a grounding point located on the body. The resulting acoustic pulse penetrates into the seabed and is dispersed by the sediment. Dispersion varies with the thickness of sediment layers, grain size and position, and the energy reflected back to the sparker system hydrophones creates a profile of the seabed (Ruppel *et al*., 2022). This method is useful for visualising the boundaries within marine sediment layers and the internal structures which can help inform design and placement of infrastructure.

The GeoSparker 200 system has an operable frequency between 40Hz and 1.5kHz at a SL between 200 – 230dB re 1μPa @ 1m. Pulses are fired at 1pps with an energy output between 100 – 1000J, with the SL increasing non-linearly with the power level (Ruppel *et al*., 2022).

2.3 Ultra Short Baseline Calibration

Ultra Short Baseline (USBL) will be utilised for the calibration of positioning equipment to be utilised in the surveys. The calibration process involves the temporary deployment of a Sonardyne 8370-1111 USBL transponder or similar on the seabed at the eastern side of the windfarm survey area, at a depth of approximately 90-100m. Duration of the calibration exercise is expected to be less than one day, and is only to take place as part of the initial geophysical survey planned for 2023.

The Sonardyne USBL unit has a primary operating frequency of 19 – 34kHz and a SL of 184 dB re 1μPa@1m. The operating frequency of the USBL is within that of the UHR and SBP geophysical survey systems outlined in 2.1 & 2.2. Furthermore, the sound pressure level of the USBL is less than SBP and UHR, and hence for the purposes of this assessment USBL is considered to be covered by the appraisal undertaken in relation to geophysical survey activity. As such, USBL has not been considered separately within this risk assessment, and any mitigation developed in relation to SBP and UHR will be applicable to USBL and will ensure any potential effects are minimised.

3 Marine Mammal and Basking Shark Baseline

Out of the 25 species of marine mammal observed in UK waters, 17 can be found within the North Sea (Reid, 2003). Both grey and harbour seals (*Haliochoerus grypus* and *Phoca vitulina,* respectively) are found within the region, while several species of odontocete (toothed whales) are also present. One mysticete species, the minke whale (*Balaenoptera acutorostrata*), is commonly observed in both coastal and more offshore areas within the North Sea. Basking sharks have also been recorded on the east coast of Scotland and in offshore waters. For the purposes of the risk assessment the available information on spatial & temporal distribution, abundance/density and known behaviours of the most frequently observed cetacean species within the CNS, and therefore within the project area and associated cable routes, are examined. The Cenos windfarm area straddles Small Cetaceans in European Atlantic Waters and the North Sea (SCANS-III) survey blocks R and Q as detailed in Hammond *et al*. (2017), shown in Figure 3.1. The Cable Routes pass through Block R. The abundance and density (animals per km^2) from the SCANS-III aerial surveys for various mammals in the relevant block is summarised in Table A.1, Appendix 2 (Hammond *et al*., 2017).

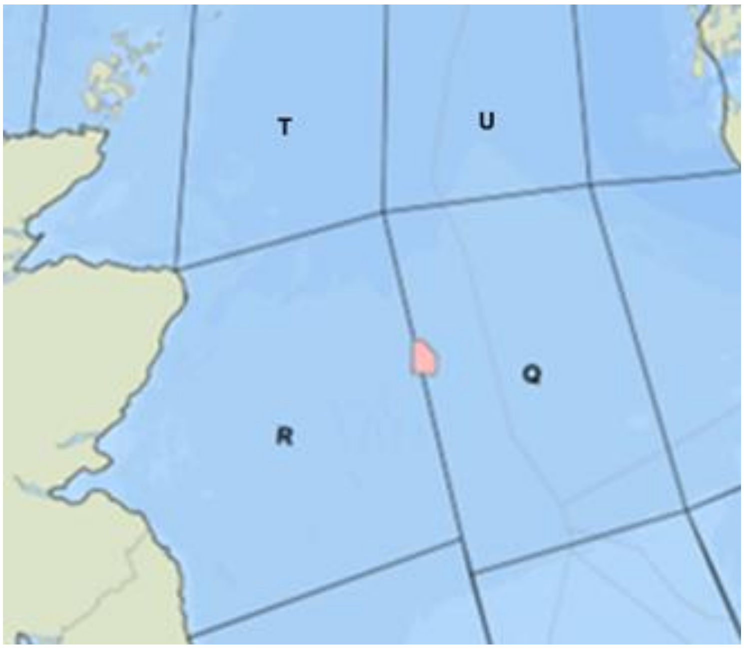

Figure 3.1: Survey Blocks Q, R, from the SCANS-III aerial surveys with the Cenos Floating Offshore Windfarm area highlighted in pink.

For the purposes of the risk assessment, the available information on spatial and temporal distribution, abundance and density estimates and, known behaviours of the most frequently observed cetacean species and basking sharks within the coastal and CNS, and therefore within the project area and associated cable routes, are examined.

Cetacean species most likely to be encountered within the project area and cable routes include harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale. While other species have been recorded in the region, the baseline data available indicate that their abundance and density are considered low (see Appendix 2, Table A.1). Some other species, such as sperm whales (*Physeter macrocephalus*), beaked whales, and other mysticetes are occasional visitors, and as such are not considered in this risk assessment.

3.1 Harbour Porpoise

The harbour porpoise (*Phocoena phocoena*) is distributed throughout temperate and subarctic waters of the North Pacific and North Atlantic oceans and is the most abundant cetacean to occur in northwest European shelf waters (Evans *et al*., 2003). They are the UK's smallest and most abundant cetacean, with higher densities occurring within the North Sea, around the Northern Isles and the Outer Hebrides (Reid *et al*., 2003). Harbour porpoises are found within Scottish waters throughout the year (Hague *et al*., 2020; HWDT, 2022), and show evidence for seasonal movements (Reid *et al*., 2003).

Since the 1990s, porpoise range and occurrence in the North Sea has shifted from more northerly latitudes to southern areas, with significant densities now found within the Wadden Sea, German North Sea, and around the Danish archipelago (Hammond *et al*., 2013). It is thought that changing prey availability and distribution has driven such range shifts (Ransijn *et al.,* 2019). However, population trends within southern regions of the North Sea may be in decline (Nachtsheim *et al.,* 2021).

In general, porpoise occurrence is strongly mediated by prey availability, and in the North Sea sandeels (Ammodytidae) are reported to be the most common prey item (Santos *et al*., 2004). Gobies, Atlantic herring (*Clupea harengus*), and European sprat (*Sprattus sprattus*) are also important prey species (Ransijn *et al.,* 2019). The proposed Cenos Floating Offshore Windfarm area is predicted to lie within relatively high winter and summer densities of whiting (*Merlangius merlangus*) and high summer densities of Atlantic herring (Ransijn *et al*., 2019). Waggitt *et al.* (2020) predicted higher porpoise densities within the areas of interest in the summer than the winter months which may be related to prey distribution.

The estimated abundance of harbour porpoises within these areas can be found in Table 9.1, Appendix 2. The highest densities are within Block R, which also includes Scottish north-east coastal waters, where porpoises are typically the most commonly occurring cetacean (Weir *et al*., 2007). In general, across the entire North Sea, Hague *et al*. (2020) predicted porpoise density was estimated at >0.5 animals per km^2, emphasising the importance of this region for the species.

In addition to the aforementioned studies, the Cenos Floating Offshore Windfarm project is supported by monthly site-specific aerial cetacean surveys, with results available for the first of two consecutive years of data collection. Surveys were conducted around the windfarm area and not along the proposed cable survey routes. Harbour porpoises were the dominant species sighted during the first year of the HiDef (2022) surveys, comprising c. 88 % of the cetaceans observed (n= 125 sightings). Porpoises occurred in nine of the 12 months surveyed, with most sightings in November 2021, followed by April 2021 and June 2021 (Figure 3.2). These data indicate slight differences in peak species occurrence compared to Reid *et al.* (2003), who predicted seasonal increases in presence between June and September. In addition, the HiDef surveys suggest porpoises exhibit temporal distribution changes within the survey area, where increased sightings in April 2021 occurred to the east and then to the west in June 2021. In November 2021, when most individuals were sighted, distribution was more widely spread throughout the survey area.

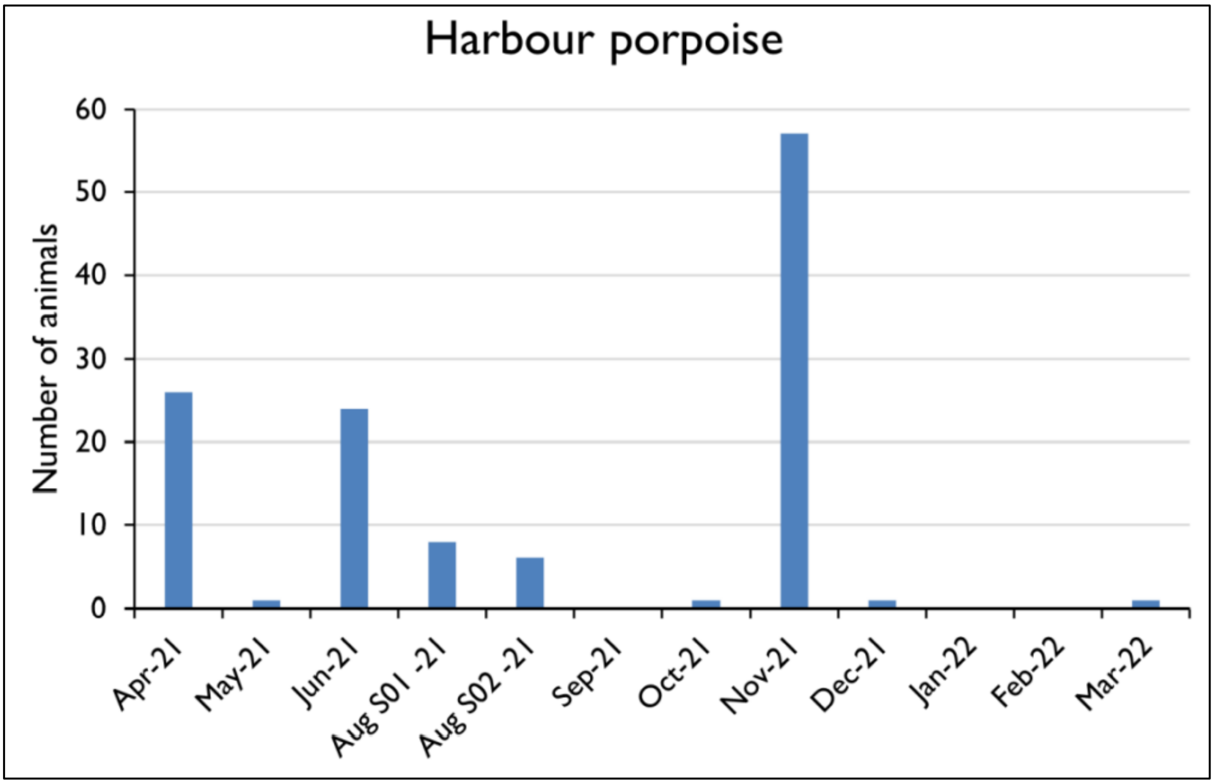

Figure 3.2: Number of harbour porpoises recorded between April 2021 and March 2022 in the Cenos Windfarm Project (HiDef, 2022).

Based on the data available, harbour porpoise are expected to be the cetacean most likely to be encountered during proposed geophysical surveys in both the windfarm and cable survey areas.

3.2 Bottlenose Dolphin

Bottlenose dolphins (*Tursiops truncatus*) are present in UK waters all year round and can often be seen close to shore. Bottlenose dolphin populations within Europe and the UK are separated into two distinct ecotypes. 'Offshore' dolphins are wide-ranging, and typically found >4 km away from the coast in deeper shelf edge waters (Cheney *et al*., 2013; Oudejans *et al*., 2015). Offshore bottlenose dolphins have received little study and there are key knowledge gaps surrounding their population dynamics, prey preferences, life history, behaviour, range and abundance. Offshore dolphins within the North Sea area are within the Greater North Sea (GNS) Management Unit as defined by the Joint Nature Conservancy Committee (JNCC) (2023). Numbers of offshore bottlenose dolphins have been estimated within the thousands (Cheney et al., 2013), but a more precise understanding of population size is difficult to achieve.

Research by Waggitt *et al*. (2020) suggested that offshore bottlenose dolphin presence is concentrated mainly in the western waters off the Scottish and Irish shelf-edge. During the SCANS-III surveys, bottlenose presence was only documented in Block R (Table A.1, Appendix 2) and estimated at an abundance of 1,924 animals with a density of 0.030 animals per km^2 (Hammond *et al*., 2017). No bottlenose dolphins were positively identified during the aerial surveys within the Cenos windfarm area; however, one unidentified dolphin was observed in August 2021 (HiDef, 2022).

‘Inshore’ coastal groups of bottlenose dolphins are distributed around the UK and display greater site fidelity and residency. Three populations are identified within Scottish waters and in total number between 200-300 individuals (Cheney *et al.*, 2013). Two populations are found on the west coast (the ‘Inner Hebrides’ and ‘Sound of Barra’ communities), while the better known ‘East coast’ community can be found largely within the Moray Firth in the northeast. Inshore bottlenose dolphins in the North Sea are known as the Coastal East Scotland Management Unit (MU) (JNCC, 2023). This population has received extensive study since the 1990s, one of the longest running studies on a free-ranging mammal population in the world.

Extensive and long-term use of the Inner Moray Firth by the east coast population led to its designation as a Special Area of Conservation (SAC) in 2005. However, studies indicate that subsets within the larger population utilise other areas within the Moray Firth, such as the Outer Firth coastline, as well as the Aberdeenshire, Tayside and Northumberland coastlines (Arso Civil *et al.*, 2019; Culloch & Robinson, 2008; Hackett, 2022). Dolphin presence along these coastlines and within the Moray Firth is year-round.

For the purposes of the risk assessment, both ecotypes are considered. However, it is only potential cable route geophysical surveys conducted towards the 12 nm boundary on cable Route B (see Drawing FLO-CEN-GIS-MAP020-Cenos Survey Area-Rev001) that would potentially impact the inshore bottlenose dolphin community.

3.3 White-beaked dolphin

The white-beaked dolphin (*Lagenorhynchus albirostris*) is distributed throughout cool temperate and subarctic waters (Culik, 2011). The species is mainly found in offshore regions in areas of water depth between 50 and 100m, however they are also often sighted along coastal regions of the North Sea (Kinze, 2009; Canning *et al.*, 2008; Weir *et al.*, 2007).

While this species is common in UK waters, little is known about its biology and behaviour. Dietary analysis by Canning *et al.* (2008) on stranded individuals from around Scotland revealed a heavily piscivorous diet, with haddock (*Melanogrammus aeglefinus*) and whiting the most important prey species. Like many other dolphin species, they have been shown to form long-term associations within a fission-fusion social dynamic group structure (Bertulli *et al.*, 2021).

In the North Sea, high species density has been estimated for the summer months however, it is likely they are present year-round (Waggitt *et al.*, 2020). The species was only sighted in relevant SCANS-III survey Block R (see Table A.1, Appendix 2), with particularly high densities within Block R (Table 3.2). During aerial surveys conducted within the Cenos windfarm area between April 2021 and March 2022, two sightings of white-beaked dolphins were made. One sighting involved a group containing ten individuals in April 2021, with the other sighting contained two individuals in November 2021. In addition, one sighting of an unidentified dolphin was made in August 2021 (HiDef, 2022).

3.4 Minke Whale

The minke whale (*Balaenoptera acutorostrata*) is the most common baleen whale species recorded in British shelf waters, and high densities are present within the North Sea, particularly within coastal waters (Risch *et al.*, 2019). However, insufficient data on population size has made it difficult to establish their conservation status and this parameter remains unknown (Marine Scotland Science, 2020). Research suggests that minke whales are most commonly observed in the North Sea between April and November, however, their presence is documented year-round (Risch *et al.*, 2019). Movement of whales to more coastal regions appear to occur in the late summer months and are greatest within the Moray Firth at this time of year (Risch *et al.*, 2019). However, the distribution of whales in offshore North Sea waters is not well understood (Macleod *et al.*, 2007).

Minke whales appear to use both fine and large-scale oceanographic features such as fronts to forage (de Boer, 2010). Offshore banks may provide predictable foraging sites, congregating whales around high densities of important prey such as sandeels, herring and mackerel (*Scomber scombrus)* (Olsen & Holst, 2001). Within the Outer Moray Firth, the Southern Trench Marine Protected Area (MPA) was designated for the presence of minke whales, where deep water and upwelling provides optimal foraging habitat for the species (NatureScot, 2019). As shown on Drawing FLO-CEN-GIS-MAP003-Cable Corridor Survey-Rev002 the western end of the Route B cable corridor search area does not enter the MPA. However, it cannot be assumed that noise will not propagate into the MPA, or that minke whale associated with the MPA will not be present in the survey areas.

Minke whale density is generally considered to be higher in northern areas of the North Sea. The species is often sighted around oil and gas facilities (Delefosse *et al.*, 2018). Waggitt *et al.* (2020) demonstrated that the species would be at high densities within the windfarm and cable route areas in both January and July. Similarly, SCANS-III surveys estimated minke whale presence in all four survey blocks relevant to the proposed geophysical surveys, identifying that Block R had the highest densities (Table A.1, Appendix 2; Hammond *et al.*, 2017). A single minke whale was identified in November 2021 during the aerial surveys conducted between April 2021 and March 2022 within the windfarm area. In addition, two sightings of unidentified cetaceans were made in April 2021 and February 2022. No aerial surveys were conducted along the proposed cable routes (HiDef, 2022).

3.5 Basking Shark

Basking sharks (*Cetorhinus maximus*) are the second largest cartilaginous fish globally and the largest found in UK waters. They can grow up to 10m in length and are filter feeders, feeding solely on plankton. Basking sharks have been recorded from around the whole of the Scottish coast with sightings peaking over the summer months (Marine Scotland, 2019). The species are included in Scotland's list of Priority Marine Features and are a protected species in Scotland under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). They are listed on the OSPAR list of Threatened and Declining Species and are classed globally as Endangered by the International Union for the Conservation of Nature (IUCN).

No agreed population assessments for basking sharks are available for Scotland, the North-East Atlantic or globally and there is little information on overall population trends. Basking sharks are known to migrate over large distances in both offshore and coastal waters at depths from the surface to over 750m. They are particularly associated with tidal fronts on the continental shelf and shelf edges where they feed in areas of high productivity (Sims, 2003). More recent research into the migration of basking sharks revealed a variety of movements with some sharks spending the colder months off the Scottish continental slope, some migrating south to the Bay of Biscay and others migrating to the Azores islands before returning the following summer (Doherty *et al.*, 2017). Basking sharks have also been recorded migrating north to colder waters with individuals travelling to the Faroe Isles (Doherty *et al*., 2017) and Norway (Dolton *et al*., 2020).

Statistical modelling of basking sharks in Scottish Territorial Waters was carried out to identify areas of importance for the species. Various environmental data were used and analysed to allow for seasonal and annual predictions about densities of animals in different locations around the country. The datasets recorded basking shark primarily in the Sea of the Hebrides and to the north of Aberdeenshire in Scottish Territorial Waters (Paxton *et al*., 2014). A study exploring underwater sightings of marine megafauna around offshore anthropogenic structures noted a basking shark within the 500m zone of an offshore installation and another swimming within 1m along the route of a pipeline (Todd *et al*., 2020). Although records exist in offshore waters, offshore areas of the CNS, including those within the project area, were not found to have high habitat suitability for basking sharks (Austin *et al*., 2019).

From the literature, it can be anticipated that basking shark numbers within the area of the cable routes and the offshore windfarm are likely to be low. However, it is possible that surveys for Cable Route B may impact basking sharks in more coastal areas of the northeast coastline.

4 Risk Assessment

In order to assess the impacts on marine mammals and basking shark due to underwater noise arising from the proposed survey operations, it is necessary to address the following aspects:

- The hearing sensitivities of the species most likely to be present within or close to the survey areas (as described in Section 4.1);
- The frequency and amplitude of the sounds that will be produced by the proposed survey operations (as described in Section 2);
- The risk of acoustic injury to marine mammals (as described in Section 4.2); and
- The risk of disturbance to marine mammals (as described in Section 4.3).

The risk of acoustic injury (Section 4.2) or disturbance (Section 4.3) is considered for all the species identified in the present report. Section 4.3 specifically discusses the likelihood of underwater noise to impair an individual's (i.e., marine mammals) ability to survive, breed, reproduce or raise young, or the likelihood that an individual may be displaced from an area for a longer period than would occur during normal behaviour.

4.1 Hearing Thresholds of Receptors and Auditory Injury Criteria

This section identifies the hearing thresholds of marine mammals and basking shark likely to be present. The latest marine mammal auditory injury criteria provided by Southall *et al*. (2019) groups marine mammals into functional hearing groups and applies filters to the unweighted noise to approximate the hearing response of the receptor.

4.1.1 Receptor Hearing Thresholds

The hearing groups given by Southall *et al*. (2019) for marine mammals are summarised in Table 4.1. Table 4.1 also lists the species within each group most likely to be encountered within the vicinity of the development. The hearing thresholds of the species most likely to be encountered at the project site represents all hearing groups from low to very high frequency as shown in Table 4.1. The risk assessment therefore considers the effect on any cetacean species which may be encountered at the project site.

Table 4.1: Marine Mammal Hearing Groups (Southall *et al.*, 2019)

Hearing Group	Relevant Receptors	Generalised Hearing Range
Low Frequency (LF) Cetacean	Minke whale	7Hz – 35kHz
High Frequency (HF) Cetaceans	Bottlenose dolphin	150Hz – 163kHz
	White-beaked dolphin	16kHz – 160kHz
Very High Frequency (VHF) Cetaceans	Harbour porpoise	160Hz – 275kHz

The latest 'Summary of Criteria for Physical Injury on Fish from Impact Piling Noise' (Popper *et al.*, 2014) groups the types of fish into functional hearing groups as shown in Table 4.2.

Table 4.2: Functional Hearing Groups, and Relevant Fish Receptors (Popper *et al.* 2014)

Functional Hearing Group	Relevant Fish Receptors	Sensitivity to Underwater Noise
Fish: No Swim Bladder (P-)	Basking Shark	Least Sensitive
Fish: Swim Bladder Not Involved in Hearing (P-)	None	↓
Fish: Swim Bladder Involved in Hearing (P+)	None	Most Sensitive

4.1.2 Auditory Injury Criteria for Receptors

Southall *et al.* (2019) presents acoustic injury onset-thresholds for both unweighted sound pressure level peak criteria (SPL_{peak}) and cumulative (i.e., more than a single sound impulse) weighted sound exposure level (SEL_{cum}) criteria. This is presented as the received level thresholds which onset permanent threshold shift (PTS), where unrecoverable hearing damage may occur, and temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur for marine mammal species. As marine mammals are reliant on perceiving sound to navigate, forage, communicate and avoid predators, any changes to hearing sensitivity may have detrimental effects upon individuals or populations.

Table 4.3 presents the Southall *et al.* (2019) criteria for the onset of PTS and TTS risk for each of the key marine mammal hearing groups as identified in Section 4.1.1 when considering impulsive noise sources.

Table 4.3: Impulsive Criteria for PTS and TTS in Marine Mammals (Southall *et al.*, 2019).

Functional Hearing Group	Impulsive			
	Unweighted SPL_{peak} (dB re 1μPa)		Weighted SEL (dB re 1μPa²s)	
	PTS	TTS	PTS	TTS
LF Cetaceans	219	213	183	168
HF Cetaceans	230	224	185	170
VHF Cetaceans	202	196	155	140

Table 4.4 details the threshold levels giving rise to injury and TTS for basking shark specific to Seismic Airguns. Fish have a low risk of masking at lower noise levels, but noise can cause

them to change their behaviours, the risk of this reduces with distance from source (Popper *et al,* 2014).

Table 4.4: Guidelines for Seismic Airguns on Fish: No Swim Bladder (P-) (Basking Sharks) (Popper *et al*, 2014).

Threshold	Criteria SEL_{cum} (weighted)	Criteria Peak
Mortality and potential mortal injury	>219dB re 1μPa^{2}s	>213dB peak
Recoverable injury	216dB re 1μPa^{2}s	>213dB peak
TTS	>>186dB re 1μPa^{2}s	N/A

4.2 Risk of Acoustic Injury

As the geophysical survey will be completed by means of seismic reflection techniques, the risks of acoustic injury to marine mammals from SBP and UHR have been assessed based on both acoustic output calculations and the existing literature surrounding the effects of seismic surveys on marine mammals.

Section 2 of this report has detailed the equipment to be utilised in the geophysical surveys, identified the significant noise sources and provided the frequency bands and sound pressure levels in which they operate. SBP utilises noise sources within the hearing range of HF and VHF Cetaceans, while UHR utilises a lower frequency range which can be perceived by LF Cetaceans including minke whales. As detailed in Table 4.1 (Section 4.1.1) bottlenose dolphin and harbour porpoise, although being classed as HF and VHF respectively, can perceive lower frequency noise sources and can also detect UHR.

It is assumed for the purpose of assessment that basking shark will be affected by both SBP and UHR.

4.2.1 Sub-Bottom Profiling

Experiments to determine the propagation and noise level characteristics for a SBP system similar to the device proposed for use in the Cenos windfarm and cable route geophysical surveys found that the emitted signal was highly directional (Pace *et al.*, 2021). As such, for VHF cetaceans the SLs decreased <100dB re 1μPa within 500m in the direction of the survey line, and within 150m of the survey off-axis direction (Pace *et al.*, 2021). It is therefore inappropriate to utilise classic noise dissipation models such as cylindrical spread utilised for UHR (see Section 4.2.2).

The proposed SBP survey will produce intermittent sound pulses, at more intense noise levels than that emitted from other marine anthropogenic activities in the area, such as vessel engine noise. Such surveys are most relevant to HF and VHF cetaceans; harbour porpoises, white-beaked dolphins and bottlenose dolphins. These species are potentially more sensitive to the frequency range and SLs of emitted SBP pulses, and the maximum SL expected in this context could induce TTS and PTS if animals were within close proximity to the point source (Table 4.3, Section 4.1.3).

In shallow waters, where sound propagation is limited, other studies indicated that TTS could be induced in a porpoise at 350m by exposing it to 100 airgun pulse with a weighted SEL of

164dB re µPa^{2}s (Lucke *et al.*, 2009). In a reassessment of the same study, Lucke *et al.* (2020) found that the VHF-weighted TTS onset was reduced to 138dB re 1µPa^{2}s. It is important to note however, that in each study and in the figures estimated for this risk assessment, estimates were based under a conservative assumption that the porpoise would remain stationary. As highlighted by Hermannsen *et al.* (2015), porpoises perceiving such noise sources would likely move away and therefore leave the range of potential threshold shift. Considering this aspect, as well as the threshold shift distances identified in other studies, the risk of TTS/PTS is more likely within 350m (Hermannsen *et al.*, 2015; Lucke *et al.*, 2009; Pace *et al.*, 2021).

The high-frequency hearing of white-beaked dolphins are the most sensitive of any dolphin species and equally sensitive to the hearing of harbour porpoises (Nachtigall *et al.,* 2008). Indeed, their broadband high frequency (BBHF) vocalisations contain a second energy peak >200kHz (Southall *et al.*, 2019). Little is known about potential auditory threshold shifts in white-beaked dolphins, other than expected within the generalised hearing threshold category in which the species is placed (HF cetaceans; Southall *et al.,* 2019). Using the potential threshold category for VHF species as a proxy, individuals would have to be within 350m of the noise emitting survey equipment to incur TTS or PTS. Due to the risk of threshold shift during survey operations, mitigation is required to ensure white-beaked dolphins are not within range before surveys.

The bottlenose dolphin has received the most extensive study in terms of noise exposure response. Hearing level shifts in bottlenose dolphins have not been observed in animals exposed to seismic airguns at source levels from 196 to 210dB re 1 µPa SPL_{peak} and unweighted 193 to 195dB re 1µPa^{2}s SEL_{cum} (Finneran *et al.*, 2015), The SBP SL in this context may be considerably higher (~250dB re 1µPa maximum SL), yet if the VHF category is used as a proxy (as for white-beaked dolphins) individuals would have to be within 350m of the source to incur either PTS or TTS. As with white-beaked dolphins, mitigation is required to ensure animals are not within threshold shift range before and during the surveys. However, it is unlikely any animals would remain in close proximity to the survey equipment once surveys were initiated.

The likelihood of LF cetaceans such as the minke whale perceiving and reacting to such signals is lower as the frequencies are outside of their accepted hearing threshold (Table 4.3). However, while SBP pulses are unlikely to mask minke whale communication or induce behavioural change, it is worth noting that auditory damage can still occur outside of hearing frequency thresholds (Erbe, 2002). Indeed, a comparison of the likely source levels from SBP with the impulsive unweighted SPL_{peak} levels determined by Southall *et al.* (2019), identified that TTS levels for minke whales (as LF cetaceans) were exceeded by 2dB re 1µPa if the signal was produced at 215dB re 1µPa @ 1m with a 300J pulse energy. PTS levels were not exceeded. With a potential risk of TTS, it is recommended mitigation efforts include the potential for minke whale presence.

SBP source noise levels are above those that could cause mortality in basking shark, however the directionality of the technique is such that these high levels are localised as discussed above. Hence, mitigation to ensure that basking shark are not within the immediate vicinity will be appropriate to prevent injury.

The risks of acoustic Injury to marine mammals and basking shark in the Cenos windfarm and cable route area from SBP are summarised in Table 4.5 in Section 4.4: Summary of Risks.

4.2.2 2D Ultra High-Resolution Seismic Survey

Noise dissipates with distance from source, hence the distance of an animal from the source will determine whether TTS or PTS levels are exceeded. The cylindrical spreading (CS) law is deemed to be a conservative estimation tool for UHR. Hence, the following equations can be used:

$$SPL(R2) = SPL(R1) - 10 \operatorname{Log}(R2/R1)$$

where SPL(R1) is the sound pressure level at distance R1 from source, and SPL(R2) is the sound pressure level at distance R2 from source.

Table 4.5 provides the distance from source peak noise levels are predicted to reduce below relevant TTS and PTS for each species assuming a UHR source level of 230dB re 1μPa @ 1m.

Table 4.5: Hearing thresholds, detectable noise sources and the potential threshold shift and distances for each species. Threshold shifts for unweighted SPL_{peak} shown using the worst-case SL output from the proposed activities.

Species	Distance from Source (m) to <PTS	Distance from Source (m) to <TTS
Minke whale (LF)	12.6	50
Bottlenose dolphin (HF)	0	4
Harbour porpoise (VHF)	630	2511
Basking shark	12.6	50

Few studies have examined the impact of UHR on marine mammals, however it is assumed that the identified species hearing thresholds would apply until further data is available (Tougaard, 2021). The expected survey pulse SLs at 230dB re 1μPa exceed the levels which could cause both PTS and TTS for minke whales and harbour porpoise, and TTS for bottlenose dolphin (Table 4.5).

As LF cetaceans, minke whales could experience PTS 12.6 m from the UHR noise source, and TTS at a distance of 50m. While it is unlikely a minke whale would occur within 12m of an active survey vessel as they are typically fairly boat shy (Risch *et al.*, 2019), it is possible a whale could be within 50m. Similar PTS and TTS distances apply to basking sharks. As such, mitigation is required to ensure animals are not within TTS-incurring distances to the operable survey equipment.

For porpoises, the distances to potential PTS and TTS are far greater (630 and up to 2,511m, respectively). Kastelein *et al.* (2017) indicated that TTS onset thresholds of 188dB re 1μPa^{2}s SEL_{cum} persisted for harbour porpoise, when exposed to 10 consecutive shots fired from seismic airguns at a range of up to 1.3km in a water depth ~15m (Hermannsen *et al.*, 2015). The peak frequency range of such pulses was between 5 and 90Hz, within the lower range of the UHR characteristics expected in the proposed surveys. The water depths at the proposed survey areas are ~100m and hence the TTS effects are likely to be experienced by porpoise beyond 1.3km due to cylindrical noise spread.

The risks of acoustic injury to marine mammals and basking shark in the Cenos windfarm area from UHR are summarised in Table 4.6 in Section 4.4: Summary of Risks.

4.3 Risk of Acoustic Disturbance

Disturbance effects, as defined under the European Habitats Directive, will occur if animals incur sustained or chronic disruptions to behaviour that are likely to impair an individual's ability to survive, breed, reproduce, or raise young. In addition, disturbance effects include those that are likely to result in an individual being displaced (i.e., startle effects) from an area for a longer period than would occur during normal behaviour (Scottish Government, 2020).

4.3.1 Sub-Bottom Profiling

The SLs of the proposed SBP surveys are between 240 – 250dB re 1µPa @ 1m and within the hearing frequency ranges for HF and VHF cetaceans. SBP has been also shown to induce behavioural changes in some of the species of interest. The use of large airgun arrays (at undetermined SLs) was found to reduce detection rates for porpoises and white-beaked dolphins, which may have been indicative of longer dives and changing dive behaviour (Stone *et al.,* 2017). Additionally, exposure to SBP pulses from a single airgun caused changes to echolocation rates and surfacing behaviour in tagged harbour porpoises (van Beest *et al.*, 2018). The airgun SL was 216dB re 1µPa_{pp} @ 1m ($_{pp}$ = received SPL peak-peak). Generally, HF and VHF cetaceans have a tendency to swim away from SBP noise sources or show avoidance up to a distance of ~1km (Moulton & Miller, 2005; Moulton & Holst, 2010; Pirotta *et al.*, 2014). Additionally, JNCC guidance for assessing the significance of noise disturbance against conservation objectives of harbour porpoise SACs identifies a 5km Effective Deterrence Range of SBP activity on harbour porpoise as HF cetaceans (JNCC, 2020). In this context, SBP use could cause disturbance for HF and VHF receptor species.

While there is a possibility for marine mammal occurrence within the Cenos windfarm and cable route survey areas during SBP surveys, the risk of physiological, behavioural or physical impacts will be reduced with the appropriate mitigation (see Section 6). The proposed surveys have the potential to induce short-term displacement over a period of up to 120 days, however, with the mitigation detailed, the likelihood that any of the species mentioned here will experience long-term, or population-level impacts is low. It is also unlikely that the surveys will impact upon an individual's ability to survive, breed, reproduce or raise young.

Basking sharks close to the noise source may change behaviour, but as this is less likely with distance, and the work is short-term it is unlikely to have a long-term or population level impact.

The risks of acoustic disturbance to marine mammals from SBP use are summarised in Table 4.4 in Section 4.4: Summary of Risks.

4.3.2 2D Ultra High-Resolution Seismic Surveys

UHR SL is expected to be between 200 and 230dB re 1µPa @ 1m, and within the expected hearing frequency range of LF and VHF marine mammals.

Thompson *et al.* (2013) found that short-term responses of harbour porpoises moving away from the sound source did not lead to long-term population scale displacement. Passive Acoustic Monitoring (PAM) during the same seismic survey revealed that individuals reduced their echolocation rates by 15%, while the probability of detecting vocalisations when porpoises were present increased with distance from the source vessel. This suggested that the probability of porpoise vocalisation was dependent upon received noise intensity (Pirotta *et al*., 2014). PAM during 3D seismic surveys found that porpoise echolocation activity reduced as the SEL increased to 155dB re 1µPa^{2}s. It was also estimated that porpoise density was reduced in an 8 – 12km circle around the moving seismic vessel (Sarnocińska *et al*., 2020). Modelling conducted by Gallagher *et al*. (2021) also revealed that population level impacts from exposure to seismic surveys would be most severe between August and October due to the species high energetic demands and sensitivity.

There is little research investigating the potential impacts of UHR on minke whales. One study investigating the impacts of exposure to naval sonar sources with similar acoustic characteristics (1.3 – 2kHz upsweep signals to a maximum SL of 214dB re 1µPa @ 1m) 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).

UHR surveys will only be conducted within the Cenos windfarm survey area. As these surveys will not be conducted on the proposed cable survey routes, coastally occurring minke whales and those within the Southern Trench MPA will not be exposed to this sound source. Similarly basking sharks are more likely to be found closer to the coast and hence less likely to be disturbed. In addition, due to the ultrasonic hearing threshold characteristics of white-beaked dolphins, it is unlikely that UHR conducted within the Cenos windfarm area will give rise to impacts on individuals or populations. For bottlenose dolphins, UHR is not expected to caused PTS, while TTS would only occur within four metres of the UHR noise source. It is unlikely animals will occur within such close proximity to operational survey vessels. For the remaining marine mammal receptors, the potential for long-term impacts on an individual's ability to survive, breed, reproduce or raise young or impacts to populations will be reduced with the implementation of appropriate mitigation measures (see Section 6).

4.4 TTS Summary of Risks

Table 4.6 provides a summary of the risks of acoustic injury and disturbance to marine mammals likely to be present in the Cenos windfarm and cable routes area, from geophysical surveys.

Where the assumed range for risks of acoustic injury and disturbance have been calculated, the density of individuals likely to be affected can be assumed. This is calculated by using the following equation:

$$\boldsymbol{D} \times \boldsymbol{A} = \boldsymbol{N}$$

Whereby *D* is the density of animals per km^2; *A* is the affected area (i.e., hearing threshold or disturbance range in km); and *N* is the number of animals affected in the specified area, *A*. This value has been shown in Table 4.4 for each species likely to be present in the Cenos windfarm and proposed cable route areas during the surveys. For each scenario, the worst-case in terms of hearing threshold and estimated disturbance ranges are presented.

It is important to note, however, that density estimates do not provide accurate representations on the actual number of individuals likely to be affected if animals enter the range of risk, and as such, group size estimates should be taken note of, see Appendix 2, Table A.1.

UHR will only be carried out in the windfarm survey area, it is on the border between the two SCANS-III survey blocks, hence the density of mammals within the survey area will be somewhere between the two numbers given in Table 4.6. Harbour porpoise have the highest densities occurring in the windfarm area, and as VHF mammals are the most sensitive to increased noise levels, as such they are most likely to be impacted. The UHR has been calculated to cause TTS to mammals up to 2.5km away and have the potential to cause disturbance to between 150-271 harbour porpoise.

Table 4.6: Summary of the risks of acoustic injury and disturbance to marine mammals within SCANS-III survey blocks relevant to the proposed windfarm and cable route surveys.

Species	Survey Methodology	Block	Density in Block	PTS Range (m)/ Number Affected	TTS Range (m) / Number affected	Disturbance Range (km)/ Number Affected
Harbour Porpoise	SBP	Q	0.333	Within 350[1] 0.128	Within 350 [1] 0.128	~1[2] / 5[6] 1.046/ 26.16
		R	0.599	Within 350[1] 0.231	Within 350[1] 0.231	~1[2]/ 5[6] 1.882/ 47.06
	UHR	Q	0.333	630 0.415	2511 6.600	12[4] 150
		R	0.599	630 0.747	2511 11.869	12[4] 271
Bottlenose dolphin*	SBP	R	0.03	Within 350[1] 0.012	Within 350[1] 0.012	1[2] 0.094
	UHR	R	0.03	0 ~0	4 ~0	0.5[5] 0.236
White-beaked dolphin	SBP	R	0.243	Within 350[1] 0.094	Within 350[1] 0.094	1 [2] 0.763
Minke whale	UHR	Q	0.007	12.6 ~0	50 ~0	0.5[5] 0.0055
		R	0.039	12.6 ~0	50 ~0	0.5[5] 0.031

[1]Lucke *et al.*, 2009. [2]Pirotta *et al.*, 2014. [3]Hermannsen *et al.*, 2015. [4] Using worst-case scenario from Sarnocińska *et al.*, 2020. [5]Stone, 2003. [6]JNCC, 2020.

Basking shark density is expected to be low especially in the windfarm area, PTS and TTS effects cannot be ruled out without mitigation and hence the mitigation identified in Section 6 should be applied to basking sharks.

5 Consideration of Alternative Techniques

5.1 Do Nothing

Surveys are required to inform the design and consenting (including EIA production) of the Cenos windfarm and associated cable routing. Without the surveys there is a potential that infrastructure would be inappropriately sited and potentially over designed, giving rise to increased adverse impacts during construction, operation and decommissioning phases.

5.2 SBP Coverage

SBP surveys, is the only way to obtain the required resolution of surface ground conditions in the Cenos windfarm and cable route areas. The data is required to allow cable routing and burial risk assessments to be completed, along with windfarm layout design. Without the data gathered using SBP there would need to be an extremely detailed geotechnical investigation undertaken. This would include taking a very high number of core samples within the survey boundary, which would result in extended survey durations with potential repeated disruptions to marine mammals through vessel movements. The windfarm is located within the East of Gannet and Montrose Fields MPA, which is designated for offshore deep sea muds habitat and ocean quahog, as such excessive physical disturbance of the seabed would not be acceptable. Furthermore, the duration of surveys and cost of undertaking extensive geotechnical surveys would impact the project delivery timeline and not be financially viable. Therefore, the project would not be able to proceed without the implementation of SBP.

5.3 UHR Coverage

UHR provides an understanding of the sediment grain sizes and thickness of sediment layers, to build up a picture of the seabed sediment layers and the internal structures to depths of 50m. This is required to inform design and placement of infrastructure of wind turbine anchoring systems and the offshore electrical hub elements of the project, as these include elements such as anchors and piles which may penetrate deeply into the seabed. Cables are normally installed within the first couple of meters of the seabed and hence do not require data on the seabed at depths to be understood. As such it is proposed that the UHR is only utilised in the windfarm survey area and not on the cable route survey areas. The alternative to UHR data would be to undertake extensive geotechnical investigations with boreholes to significant depths. As discussed in Section 5.2 this would not be acceptable for multiple reasons.

5.4 Alternative Survey Locations

The suggested survey locations for both UHR and SBP provide optimal coverage of the sediment and seabed in order to inform the design of the windfarm and associated cabling an electrical hub platform. The information gathered will be utilised to inform the:

- Environmental Impact Assessment;
- Turbine and mooring layout;
- Mooring and sub-structure design; and
- Cable routing and cable burial risk assessment for inter-array and export cables.

Alternative survey locations adjacent or near to the proposed locations would not provide the specific geophysical detail needed for the project and would potentially lead to installation and project longevity risks and potentially higher impacts on benthic habitats. Therefore, alternative survey locations are not a feasible option.

6 Mitigation Plan

As described in Sections 4.2 and 4.3, geophysical surveys have the potential to cause acoustic injury and acoustic disturbance to marine mammal species and basking shark within the area. Mitigation measures will be implemented in order to minimise the risk of injury and disturbance to marine mammals.

Mitigation measures outlined are based on the JNCC's statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from geophysical surveys (JNCC, 2017). In order to minimise potential impacts to marine mammals, the survey vessels will adhere to the provisions of The Scottish Marine Wildlife Watching Code (SMWWC).

Both visual and PAM will be required to allow for surveying during various weather conditions and hours of both daylight and darkness. Visual observations will be preferred over PAM where possible, as animals may be less acoustically detectable if they have been disturbed and it can be utilised for basking sharks, which do not vocalise. PAM will be used when conditions do not lend themselves well to visual observation. Clear communication channels between the Marine Mammal Observer (MMO)/PAM operator and, the Survey Party Chief and relevant crew, must be established prior to the commencement of any operations.

6.1 Visual Monitoring

Marine mammal observations during daylight, good visibility and sea states less than 4, will be conducted visually by an MMO based on the acoustic survey vessel. The MMO's vantage point will be located at a high position on the vessel and will afford the MMO a clear view of the horizon, mitigation zone and ahead of the vessel. The vantage point will also be in a safe location away from machinery, ropes, high power transmitters etc. The vantage point will also provide some protection from the prevailing conditions. The MMO will be equipped with 7x50 magnification binoculars. Visual monitoring is carried out to ensure that there are no marine mammals or basking sharks within 500m (the mitigation zone), prior to works commencing. This significantly reduces the potential of injury (TTS or PTS) occurring.

6.2 Passive Acoustic Monitoring (PAM)

PAM operations will be undertaken during hours of darkness and poor visibility conditions and can also be used in conjunction with visual monitoring. PAM will be carried out from the source vessel with the operator positioned in the most appropriate location to allow them to monitor the PAM equipment for acoustic detections and to allow them to maintain contact with the crew (and MMO if required) for mitigation purposes and to ensure the PAM equipment is deployed correctly. Similar to visual monitoring, PAM is carried out to ensure that there are no marine mammals within 500m (the mitigation zone), prior to works commencing. This significantly reduces the potential of injury occurring.

6.3 Soft Start

Observations and acoustic monitoring will include monitoring the mitigation zone for the full duration of the pre-shooting search and soft start procedure. The soft start procedure will involve slowly ramping up to full power over a period of a minimum of 20 minutes. A soft start should not exceed 40 minutes. During a soft start, power will be built up gradually, in uniform stages from a low energy start up (e.g. increasing the number of airguns starting with the smallest in the array or, increasing pressure). A soft start will be implemented every time the airguns are scheduled to be used. Exceptions to this will be the use of mini airguns (single gun volume equal to or less than 10 cubic inches) and when testing a single airgun.

Soft start produces lower sound levels than full power operations, this allows animals to move away from the noise source while at its lower levels, thereby further reducing the risk of injury.

6.4 Marine Mammal Observer (MMO) and Passive Acoustic Monitoring (PAM) Experience

Marine mammal observations will be carried out by an experienced MMO with a minimum of 20 weeks' experience of implementing JNCC guidelines in UK waters over the previous ten years, and preferably within the last five. The MMO will be experienced in identifying UK marine mammal species visually and acoustically and, will be familiar with their behaviour.

6.5 Mitigation Protocols

6.5.1 Visual Monitoring Protocols

Visual monitoring will be used during daylight hours where weather conditions allow. The MMO protocol is outlined below:

1. The Survey Party Chief will inform the MMO of the intention to commence acoustic survey operations, at least 1 hour prior to arrival at the Start of Line (SoL) position.
2. The MMO will commence a continuous pre-shooting search using binoculars, at least 30 min before the intended arrival at the SoL.
3. If marine mammals are observed, the MMO will advise the Survey Party Chief, so that measures can be taken to minimise the impacts of any potential delays on the survey operations.
4. When the vessel is arriving at the SoL and the 30 min pre-watch is complete, the Survey Party Chief will ask the MMO whether acoustic survey operations can commence.
    - If no marine mammals have been observed within the 500m mitigation zone, the MMO will give permission to commence a soft start. The MMO will continue to monitor the mitigation zone during the soft start.
    - If marine mammals have been observed inside the 500m mitigation zone, the MMO will delay acoustic survey operations until at least 20 min after the last sighting within the mitigation zone.
5. Once the acoustic survey operations have commenced whilst the airguns are firing either during the soft start procedure or at full power, there will be no requirement to stop if a marine mammal enters the mitigation zone.
6. If line changes are expected to take longer than 40 minutes:
    - Firing is to be terminated at the end of the survey line (or during geophone repositioning);
    - A pre-shooting search is to be undertaken during the schedule line change (or geophone repositioning);

- The soft start is to be delayed if marine mammals are seen within the mitigation zone during the pre-shooting search; and
- A full 20 minute soft start is to be undertaken before the start of the next line.

7. If line changes are expected to take less than 40 minutes:
    - Airgun firing can continue during the line change if power is reduced to 180 cubic inches (or as close as practically feasible) at standard pressure. Airgun volumes of less than 180 cubic inches can continue to fire at their operational volume and pressure; and
    - The Shot Point Interval (SPI) is increased to provide a longer duration between shots, with the SPI not to exceed 5 minutes; and
    - The power is increased and the SPI is decreased in uniform stages during the final 10 minutes of the line change (or geophone repositioning), prior to data collection recommencing.
8. In the event that an unplanned or unexpected break in survey operations occurs, the Survey Party Chief will inform the MMO who will begin to monitor the mitigation zone as quickly as possible following the break.
    - If the break is less than 10 minutes in duration, and airguns can be restarted and data acquisition resumed in less than 10 minutes, there is no requirement for a soft start and firing can commence at the same power level or less provided no marine mammals have been detected in the mitigation zone during the breakdown period. If a marine mammal is detected in the mitigation zone during the breakdown period, the MMO will delay the recommencement of the acoustic survey operations until at least 20 minutes after the last sighting within the mitigation zone.
    - If the break exceeds 10 minutes, a full start-up procedure will be required (see steps 1-4). If an MMO has been monitoring during the breakdown period, this time can contribute to the pre-shooting search.
9. If the visibility falls to below 500m around the survey vessel, or the sea state increases to greater than 3, then the Acoustic Monitoring Protocol will be used.

6.5.2 Acoustic Monitoring Protocol

PAM may be used in conjunction with visual monitoring but will only be used as an alternative to visual monitoring where visual observations are insufficient due to reduced visibility or increased sea sates as per Section 6.1.1 - 9. If PAM is not available, surveys must be delayed until conditions are suitable for visual observations.

The following protocol will be implemented for commencing acoustic survey operations using PAM:

The PAM protocol is outlined below:

1. The Survey Party Chief will inform the PAM operator of the intention to commence acoustic survey operations, at least 1 hour prior to arrival at the SoL position.

2. The PAM operator will commence a continuous pre-shooting search using passive PAM equipment at least 30min before the intended arrival at the SoL.
3. If marine mammals are detected, the PAM operator will advise the Survey Party Chief, so that measures can be taken to minimise the impacts of any potential delays on the survey operations.
4. When the vessel is arriving at the SoL and the 30min pre-watch is complete, the Survey Party Chief will ask the PAM operator whether acoustic survey operations can commence.
    - If no marine mammals have been detected within the 500m mitigation zone, the PAM operator will give permission to commence a soft start prior. The PAM operator will continue to monitor the mitigation zone during the soft start.
    - If marine mammals have been detected inside the 500m mitigation zone, the PAM operator will delay acoustic survey operations until at least 20min after the last detection within the mitigation zone.
5. Once the acoustic survey operations have commenced whilst the airguns are firing either during the soft start procedure or at full power, there will be no requirement to stop if a marine mammal enters the mitigation zone.
6. If line changes are expected to take longer than 40 minutes:
    - Firing is to be terminated at the end of the survey line (or during geophone repositioning);
    - A pre-shooting search is to be undertaken during the schedule line change (or geophone repositioning);
    - The soft start is to be delayed if marine mammals are detected within the mitigation zone during the pre-shooting search; and
    - A full 20-minute soft start is to be undertaken before the start of the next line.
7. If line changes are expected to take less than 40 minutes:
    - Airgun firing can continue during the line change if power is reduced to 180 cubic inches (or as close as practically feasible) at standard pressure. Airgun volumes of less than 180 cubic inches can continue to fire at their operational volume and pressure; and
    - The SPI is increased to provide a longer duration between shots, with the SPI not to exceed 5 minutes; and
    - The power is increased, and the SPI is decreased in uniform stages during the final 10 minutes of the line change (or geophone repositioning), prior to data collection recommencing.
8. In the event that an unplanned or unexpected break in survey operations occurs, the Survey Party Chief will inform the PAM operator who will begin to monitor the mitigation zone as quickly as possible following the break.

- If the break is less than 10 in duration, and airguns can be restarted and data acquisition resumed in less than 10 minutes, there is no requirement for a soft start and firing can commence at the same power level or less provided no marine mammals have been detected in the mitigation zone during the breakdown period. If a marine mammal is detected in the mitigation zone during the breakdown period, the PAM operator will delay the recommencement of the acoustic survey operations until at least 20min after the last detection within the mitigation zone.
- If the break exceeds 10 minutes, a full start-up procedure will be required (see steps 1-4). If a PAM operator has been monitoring during the breakdown period, this time can contribute to the pre-shooting search.

7 Variation to EPS Licence

A request is made to vary EPS License EPS/BS-00010419, granted for geophysical surveys in relation to the Cenos Floating Offshore Windfarm project. The reason for the variation request is two-fold:

- following amendment to Route B outlined in Section 1.3.2.2: Updated Cable Survey Area, necessary to avoid potential ecological features; and
- to clarify the area to which inshore EPS License EPS/BS-00010419 applies, as noted in a letter to MD-LOT 8th August 2023.

With regards to the EPS Licence area it is proposed that survey activity within 10nm of the 12nm limit (i.e. out to 22nm) be included, as illustrated in Drawing FLO-CEN-GIS-MAP020-Cenos Survey Area-Rev001. This allows sufficient precaution with respect to the anticipated range of disturbance effect for the SBP survey activity taking place within cable Route B, which is expected to be in the region of 1km (0.54nm) (see Section 4.3.1: Risk of Acoustic Disturbance, Sub-Bottom Profiling). It is also in accordance with JNCC guidance on Effective Deterrence Range for Harbour porpoise of 5km (2.70nm) in relation to SBP activity (JNCC, 2020), as included within advice from NatureScot (B Campbell MD-LOT, personal communication via email, 13th June 2023).

The coordinates of the revised cable survey area are provided in Appendix 3. Proposed coordinates for the EPS Licence area are provided in Appendix 4.

8 Conclusions

The use of SBP and UHR survey techniques have the potential to cause injury and disturbance to marine mammals and basking sharks. With regard to the Cenos Floating Offshore Windfarm and associated cable surveys, harbour porpoise are most at risk due to their sensitivity to noise and high densities in the area. Mitigation has therefore been proposed which will ensure that they are not within the 500m mitigation zone prior to soft start. Soft start will then be employed to allow mammals to move away from the source, such that by the time full power is reached mammals will be outwith the range they could experience PTS and TTS levels of noise. As such, there is no risk of acoustic injury to marine mammals from the planned geophysical survey activities.

Unfortunately, disturbance to marine megafauna cannot be fully avoided. This document therefore supports the application for an EPS Licence to Disturb Cetaceans for geophysical surveys, under The Conservation (Natural Habitats, &c.) Regulations 1994. Specifically, this is in relation to survey work associated with the western end of cable Route B, which could give rise to disturbance of marine mammals in the inshore area.

Following advice from NatureScot, no license to disturb EPS in the offshore region under The Conservation of Offshore Marine Habitats and Species Regulations 2017 or to disturb basking shark under the Wildlife and Countryside Act 1981 (as amended) is required (B Campbell MD-LOT, personal communication via email, 13th June 2023).

Alternative techniques have been considered which has led to the optimisation of the survey protocol. As such, use of UHR will only take place in the windfarm area.

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10 Glossary

Acronym	Definition
BBHF	Broadband High Frequency
CNS	Central North Sea
CS	Cylindrical Spreading
dB	decibels
EPS	European Protected Species
GNS	Greater North Sea
HF	High Frequency
HWDT	Hebridean Whale and Dolphin Trust
Hz	Hertz
IUCN	International Union for the Conservation of Nature
J	Joules
JNCC	Joint Nature Conservation Committee
kHz	kilohertz
km	kilometres
km^2	square kilometres
LF	Low Frequency
m	metres
MBES	Multibeam Echosounder
min	minute
MMO	Marine Mammal Observer
MPA	Marine Protected Area
MU	Management Unit
nm	nautical miles
PAM	Passive Acoustic Monitoring
pps	pulses per second
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
SBES	Single Beam Echosounder
SBP	Sub-bottom Profiler
SCANS-III	Small Cetaceans in European Atlantic Waters and the North Sea
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SPI	Shot Point Interval
SPL_{peak}	Sound Pressure Level Peak
SL	Source Level
SMWWC	Scottish Marine Wildlife Watching Code
SoL	Start of Line
SSS	Side Scan Sonar
TTS	Temporary Threshold Shift
UHR	2-Dimensional Ultra High-resolution Seismic
UK	United Kingdom
VHF	Very High Frequency
μPa	micropascal
$\mu Pa^2 s$	micropascal per second
μPa_{pp}	micropascal received SPL peak-peak

Appendix 1: Original Survey Coordinates

ID	Location (e.g. Quay 1 Dredge Area, Example Harbour)	Latitude											Longitude										
	Windfarm	5	7	°	1	6	.	5	0	5	'N		0	0	1	°	2	4	.	3	5	7	'E
		5	7	°	0	9	.	6	2	8	'N		0	0	1	°	3	7	.	9	0	1	'E
		5	7	°	0	4	.	7	2	2	'N		0	0	1	°	3	7	.	7	9	3	'E
		5	7	°	0	2	.	6	8	9	'N		0	0	1	°	3	6	.	9	1	7	'E
		5	7	°	0	0	.	5	9	5	'N		0	0	1	°	2	4	.	2	8	2	'E
		5	7	°	0	0	.	7	3	5	'N		0	0	1	°	1	7	.	3	4	1	'E
		5	7	°	0	2	.	9	3	7	'N		0	0	1	°	1	4	.	9	6	7	'E
		5	7	°	0	8	.	6	7	8	'N		0	0	1	°	1	4	.	9	6	3	'E
		5	7	°	1	5	.	1	0	7	'N		0	0	1	°	2	0	.	4	0	0	'E
	Route A	5	7	°	2	0	.	3	9	7	'N		0	0	1	°	0	4	.	7	0	0	'E
		5	7	°	2	8	.	5	6	3	'N		0	0	0	°	5	6	.	4	8	2	'E
		5	7	°	3	2	.	2	1	8	'N		0	0	0	°	5	1	.	4	9	5	'E
		5	7	°	3	8	.	8	9	2	'N		0	0	0	°	3	7	.	0	2	3	'E
		5	7	°	4	0	.	6	0	0	'N		0	0	0	°	3	0	.	8	3	0	'E
		5	7	°	4	1	.	6	7	9	'N		0	0	0	°	1	4	.	0	5	3	'E
		5	7	°	4	3	.	4	0	8	'N		0	0	0	°	0	5	.	0	4	9	'E
		5	7	°	4	3	.	6	3	7	'N		0	0	0	°	0	4	.	1	5	9	'E
		5	7	°	4	4	.	0	7	3	'N		0	0	0	°	0	3	.	1	4	3	'E
		5	7	°	4	9	.	5	4	0	'N		0	0	0	°	0	6	.	7	1	0	'W
		5	7	°	5	6	.	0	2	3	'N		0	0	0	°	1	6	.	5	1	1	'W
		5	7	°	5	6	.	3	9	7	'N		0	0	0	°	1	6	.	9	8	6	'W
		5	7	°	5	9	.	3	2	5	'N		0	0	0	°	0	8	.	5	0	0	'W
		5	7	°	5	3	.	0	5	5	'N		0	0	0	°	0	0	.	9	5	4	'E
		5	7	°	4	8	.	2	5	7	'N		0	0	0	°	0	9	.	6	0	2	'E
		5	7	°	4	6	.	9	4	6	'N		0	0	0	°	1	6	.	3	3	0	'E
		5	7	°	4	5	.	8	9	2	'N		0	0	0	°	3	2	.	9	3	3	'E
		5	7	°	4	5	.	7	9	8	'N		0	0	0	°	3	3	.	7	7	4	'E
		5	7	°	4	5	.	6	1	3	'N		0	0	0	°	3	4	.	6	3	3	'E
		5	7	°	4	3	.	5	3	6	'N		0	0	0	°	4	2	.	1	5	9	'E
		5	7	°	4	3	.	1	8	8	'N		0	0	0	°	4	3	.	1	2	4	'E
		5	7	°	3	6	.	0	2	1	'N		0	0	0	°	5	8	.	6	3	7	'E
		5	7	°	3	5	.	6	5	2	'N		0	0	0	°	5	9	.	2	4	4	'E
		5	7	°	3	1	.	4	2	2	'N		0	0	1	°	0	4	.	9	7	9	'E
		5	7	°	2	1	.	5	5	6	'N		0	0	1	°	1	4	.	8	7	3	'E
		5	7	°	1	6	.	4	6	0	'N		0	0	1	°	1	8	.	9	9	8	'E

ID	Location (e.g. Quay 1 Dredge Area, Example Harbour)	Latitude		Longitude
		57°15.107'N		001°20.400'E
		57°13.284'N		001°18.848'E
		57°15.423'N		001°16.672'E
		57°19.087'N		001°08.265'E
	Route B	57°23.486'N		001°01.599'E
		57°20.368'N		001°10.091'E
		57°16.460'N		001°18.998'E
		57°15.107'N		001°20.400'E
		57°13.284'N		001°18.848'E
		57°15.423'N		001°16.672'E
		57°19.087'N		001°08.265'E
		57°24.332'N		000°53.934'E
		57°21.783'N		000°45.289'E
		57°20.131'N		000°39.005'E
		57°20.062'N		000°38.535'E
		57°20.069'N		000°38.145'E
		57°21.391'N		000°30.219'E
		57°21.537'N		000°29.717'E
		57°27.125'N		000°20.954'E
		57°27.412'N		000°20.709'E
		57°28.353'N		000°20.437'E
		57°28.521'N		000°19.383'E
		57°28.867'N		000°18.907'E
		57°28.970'N		000°16.556'E
		57°29.025'N		000°16.211'E
		57°29.060'N		000°14.325'E
		57°30.095'N		000°11.009'W
		57°30.385'N		000°48.512'W
		57°30.790'N		000°56.396'W
		57°31.520'N		001°05.332'W
		57°32.796'N		001°06.275'W
		57°34.514'N		001°24.856'W
		57°35.687'N		001°25.542'W
		57°36.067'N		001°23.927'W
		57°34.292'N		001°04.771'W
		57°34.151'N		001°04.246'W
		57°33.912'N		001°03.862'W
		57°32.750'N		001°03.036'W
		57°32.001'N		000°48.417'W

ID	Location (e.g. Quay 1 Dredge Area, Example Harbour)	Latitude		Longitude
		57°31.710'N		000°10.871'W
		57°30.761'N		000°02.880'E
		57°30.620'N		000°16.772'E
		57°29.757'N		000°22.203'E
		57°29.575'N		000°22.796'E
		57°29.413'N		000°23.046'E
		57°29.170'N		000°23.236'E
		57°27.947'N		000°23.586'E
		57°22.865'N		000°31.523'E
		57°21.734'N		000°38.264'E
		57°23.229'N		000°43.949'E
		57°25.991'N		000°53.313'E
		57°26.075'N		000°53.776'E
		57°26.074'N		000°54.264'E
		57°25.963'N		000°54.811'E
	Route B.1	57°28.180'N		000°47.124'W
		57°30.511'N		000°50.195'W
		57°31.758'N		000°46.930'W
		57°29.425'N		000°43.860'W

Appendix 2: Marine Mammal Abundance Density

Table A.1: Abundance and density (animals per km^2) from the SCANS-III aerial surveys (Hammond *et al.*, 2017), where – indicates no sightings of the species were made during the surveys.

Species	Block Q			Block R		
		Abundance	Density	Mean Group Size	Abundance	Density
Harbour Porpoise	1.31	16,569	0.333	1.38	38,646	0.599
Bottlenose Dolphin	6.3*	-	-	5.25	1924	0.030
White-Beaked Dolphin	3.43	-	-	3.7	15,694	0.243
Minke Whale	1	348	0.007	1.18	2,498	0.039
Risso's Dolphin		-	-		-	-
White-Sided Dolphin		-	-		644	0.010
Common Dolphin		-	-	-	-	-
Striped Dolphin		-	-	-	-	-
Pilot Whale		-	-	-	-	-
Beaked Whale		-	-	-	-	-

*Wilson *et al.*, 1993

Appendix 3: Revised Survey Coordinates

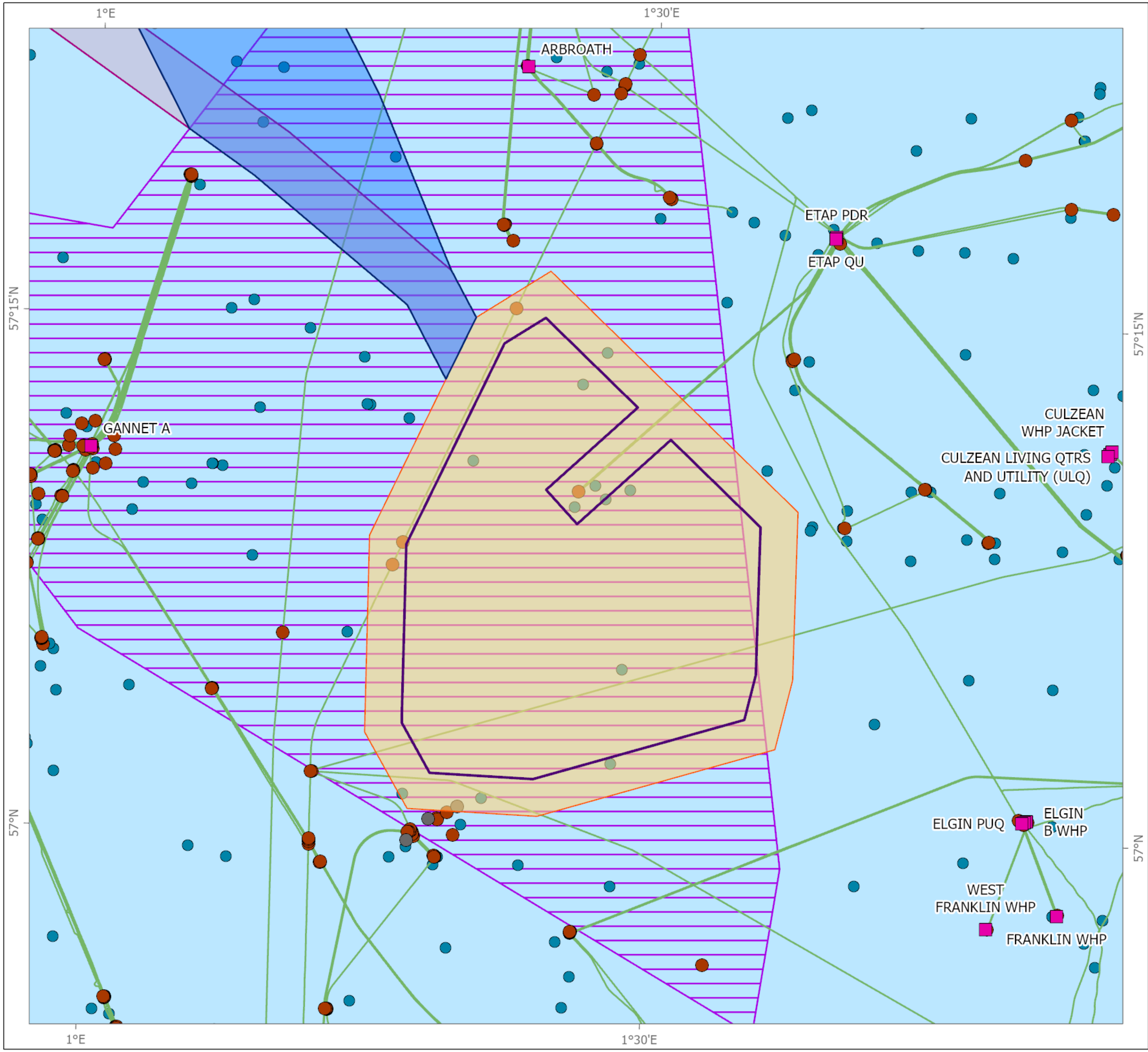
Location	Latitude	Longitude
Route B	57° 35.664' N	001° 25.641' W
	57° 40.281' N	001° 05.905' W
	57° 34.349' N	001° 05.380' W
	57° 34.291' N	001° 04.771' W
	57° 34.151' N	001° 04.246' W
	57° 33.912' N	001° 03.862' W
	57° 32.750' N	001° 03.036' W
	57° 32.001' N	000° 48.417' W
	57° 31.710' N	000° 10.871' W
	57° 30.761' N	000° 02.880' E
	57° 30.620' N	000° 16.772' E
	57° 29.756' N	000° 22.203' E
	57° 29.575' N	000° 22.796' E
	57° 29.413' N	000° 23.046' E
	57° 29.170' N	000° 23.236' E
	57° 27.947' N	000° 23.586' E
	57° 22.865' N	000° 31.523' E
	57° 21.734' N	000° 38.263' E
	57° 23.229' N	000° 43.949' E
	57° 25.990' N	000° 53.313' E
	57° 26.075' N	000° 53.776' E
	57° 26.074' N	000° 54.264' E
	57° 25.962' N	000° 54.811' E
	57° 23.486' N	001° 01.599' E
	57° 20.368' N	001° 10.091' E
	57° 16.460' N	001° 18.997' E
	57° 15.107' N	001° 20.400' E
	57° 13.284' N	001° 18.848' E
	57° 15.423' N	001° 16.672' E
	57° 19.087' N	001° 08.265' E
	57° 24.332' N	000° 53.934' E
	57° 21.783' N	000° 45.289' E
	57° 20.131' N	000° 39.005' E
	57° 20.062' N	000° 38.535' E
	57° 20.069' N	000° 38.145' E
	57° 21.391' N	000° 30.218' E
	57° 21.537' N	000° 29.717' E
	57° 23.803' N	000° 26.170' E
	57° 25.272' N	000° 18.516' E

	57° 27.023' N	000° 18.457' E
	57° 27.265' N	000° 11.904' E
	57° 28.814' N	000° 11.904' E
	57° 29.241' N	000° 10.044' E
	57° 30.095' N	000° 11.008' W
	57° 30.385' N	000° 48.512' W
	57° 30.790' N	000° 56.396' W
	57° 31.503' N	001° 05.130' W
	57° 31.321' N	001° 05.114' W
	57° 32.861' N	001° 24.118' W
Route B.1	57° 28.180' N	000° 47.124' W
	57° 30.511' N	000° 50.195' W
	57° 31.758' N	000° 46.930' W
	57° 29.425' N	000° 43.860' W

Appendix 4: Proposed EPS Licence Coordinates

Location	Coordinate Reference	Latitude											Longitude										
Western end of Route B survey area (12nm - 22nm as detailed in Section 7: Variation to EPS Licence)	A	5	7	°	3	5	.	6	6	4	'N		0	0	1	°	2	5	.	6	4	1	'W
	B	5	7	°	4	0	.	2	8	1	'N		0	0	1	°	0	5	.	9	0	5	'W
	C	5	7	°	3	1	.	3	2	1	'N		0	0	1	°	0	5	.	1	1	4	'W
	D	5	7	°	3	2	.	8	6	1	'N		0	0	1	°	2	4	.	1	1	8	'W

Note, the proposed EPS Licence area is bounded by straight lines between coordinates A, B and C (corresponding to point 1, 2 and 3 on Drawing FLO-CEN-GIS-MAP020-Cenos Survey Area-Rev001Between coordinates A and D the boundary of the proposed EPS Licence area follows the contour of the 12nm limit, as depicted in Drawing FLO-CEN-GIS-MAP020-Cenos Survey Area-Rev001 (in which coordinates A and D correspond to points 1 and 4 respectively).



LEGEND

- CENOS Windfarm development area
- CENOS Windfarm survey area

Cable corridor search areas

- Route A
- Route B
- East of Gannet and Montrose Fields ncMPA
- O&G platform
- Other O&G infrastructure
- Subsurface infrastructure / object
- Wells
- Pipelines / Umbilicals / Cables

0 15
Kilometres

Data:
NSTA, NatureScot. Contains public sector information licensed under the Open Government Licence v3.0
Esri, HERE, Garmin, USGS
Esri, HERE
Esri, Ordnance Survey, NASA, NGA, USGS
Esri UK, Esri, HERE, Garmin, Foursquare, METI/NASA, USGS

PROJECT: CENOS

TITLE: Windfarm Survey Area

REV	DATE	COMMENTS	DRAWN	CHECKED
001	27/04/2023		SK	FH

ARCGIS REF: FLO_CEN_GIS_PRJ001_CenRouteSurv_Rev001
DRAWING: FLO-CEN-GIS-MAP002-Windfarm Survey-Rev001

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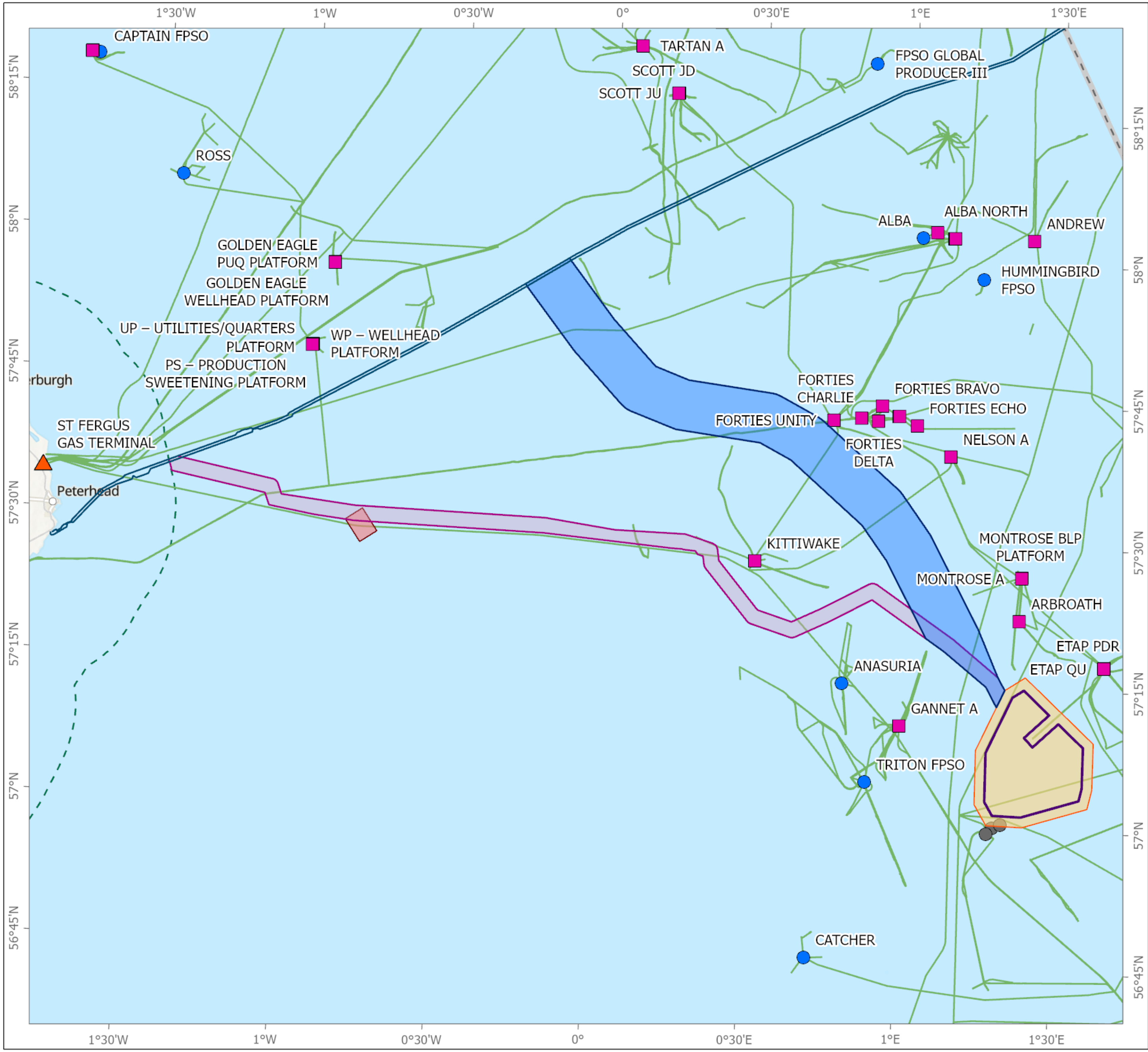
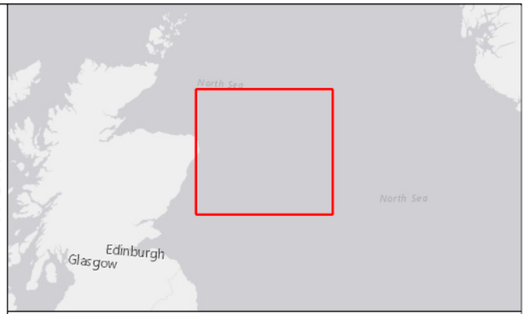
cenos





LEGEND

- CENOS Windfarm development area
- CENOS Windfarm survey area

Cable corridor search areas

- Route A
- Route B
- Route B.1
- North Connect cable corridor
- O&G platform
- FPSO
- Terminal
- Other O&G infrastructure
- Pipelines / Umbilicals / Cables
- 12 nm limit
- EEZ limit (UK)

0 60

Kilometres

Data:
NSTA, UKHO
Esri, HERE, Garmin, USGS
Esri, CGIAR, N Robinson, NCEAS, USGS
Esri, HERE
Esri UK, Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS

PROJECT: CENOS

TITLE: Survey Areas

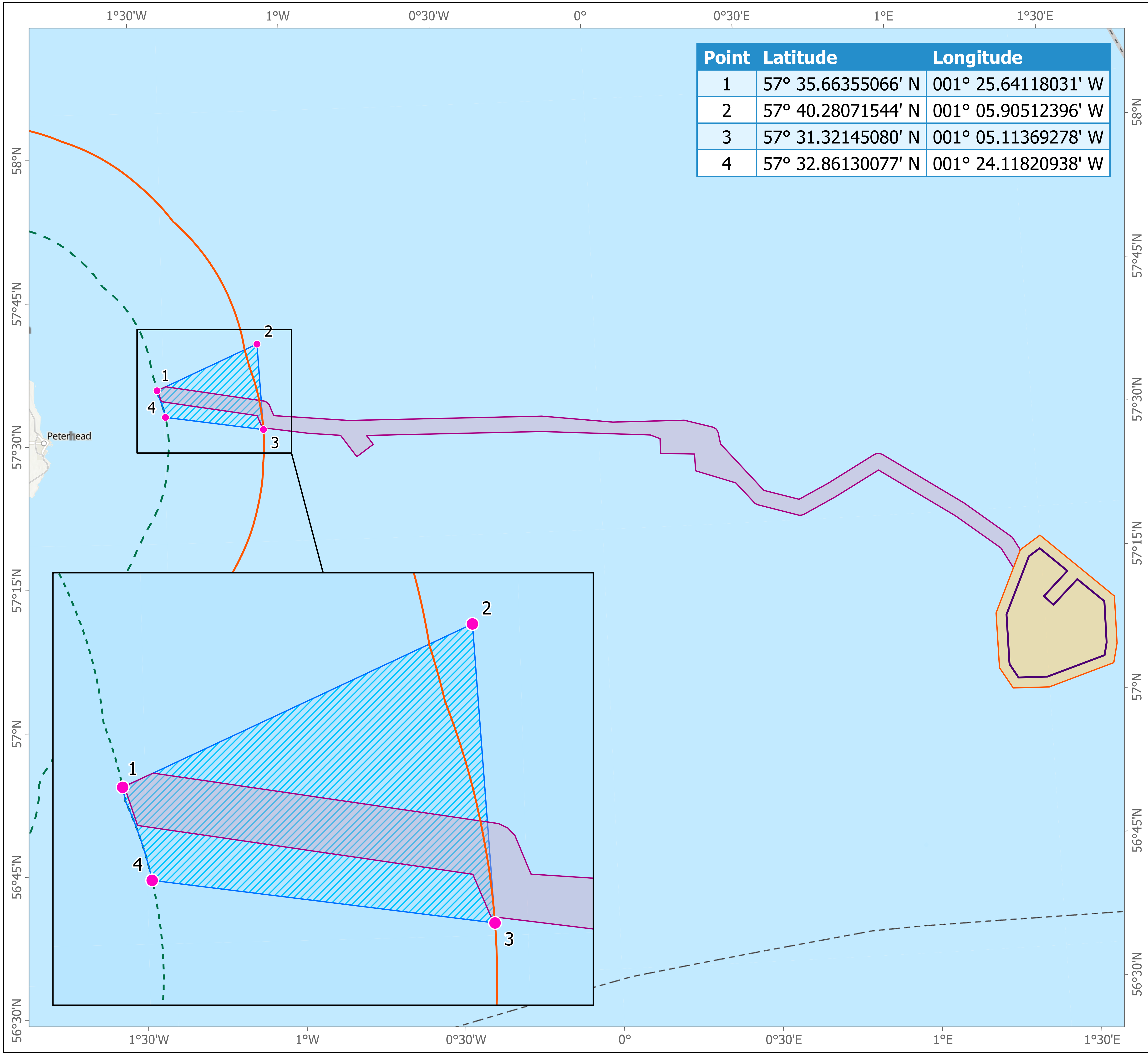
REV	DATE	COMMENTS	DRAWN	CHECKED
001	26/04/2023		SK	FH
001	28/04/2023		SK	FH

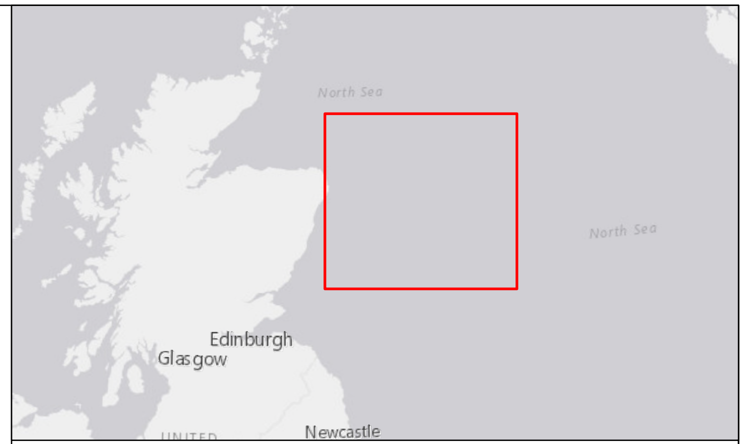
ARCGIS REF: FLO_CEN_GIS_PRJ001_CenRouteSurv_Rev001
DRAWING: FLO-CEN-GIS-MAP001-Survey Areas-Rev002

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:1,000,000	A4	WGS 1984 UTM Zone 31N

cenos

Point	Latitude	Longitude
1	57° 35.66355066' N	001° 25.64118031' W
2	57° 40.28071544' N	001° 05.90512396' W
3	57° 31.32145080' N	001° 05.11369278' W
4	57° 32.86130077' N	001° 24.11820938' W





LEGEND

- Cenos ECC survey area
- CENOS Windfarm development area
- CENOS Windfarm survey area
- EPS licence area
- EPS licence coordinates
- 22 nm line
- 12 nm limit
- Scotland adjacent waters
- EEZ limit (UK)

0 60
Kilometres

Data:
UKHO
Esri, HERE, Garmin, USGS
Esri, Intermap, NASA, NGA, USGS
Esri, HERE
Esri UK, Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS
Esri, USGS
Esri UK, Esri, HERE, Garmin, Foursquare, METI/NASA, USGS

PROJECT: CENOS

TITLE: Cenos Survey Area

REV	DATE	COMMENTS	DRAWN	CHECKED
001	24/08/2023		SK	JS

ARCGIS REF: FLO_CEN_GIS_PRJ001_CenRouteSurv_Rev001
DRAWING: FLO-CEN-GIS-MAP020-Cenos Survey Area-Rev001

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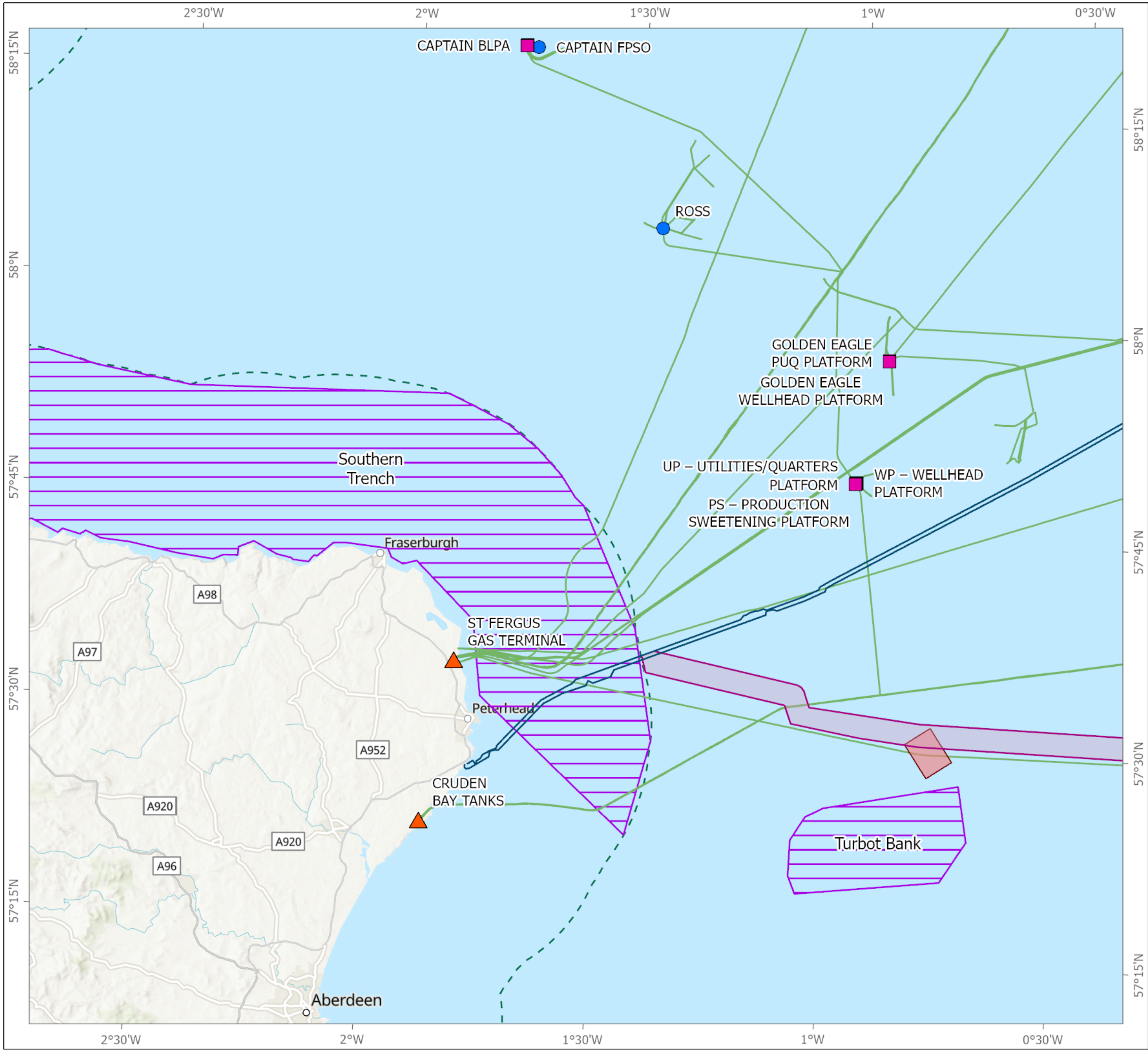

LEGEND

Cable corridor search areas

- Route B
- Route B.1
- ncMPA
- North Connect cable corridor
- O&G platform
- FPSO
- Terminal
- Pipelines / Umbilicals / Cables
- 12 nm limit

0 40

Kilometres

Data:
NSTA, NatureScot. Contains public sector information licensed under the Open Government Licence v3.0
Esri, HERE, Garmin, USGS
Esri, CGIAR, N Robinson, NCEAS, USGS
Esri, HERE
Esri UK, Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS

PROJECT: CENOS

TITLE: Cable Corridor Survey

REV	DATE	COMMENTS	DRAWN	CHECKED
001	27/04/2023		SK	FH
002	28/04/2023		SK	FH

ARCGIS REF: FLO_CEN_GIS_PRJ001_CenRouteSurv_Rev001
DRAWING: FLO-CEN-GIS-MAP003-Cable Corridor Survey-Rev002

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