BERWICK BANK WIND FARM
OFFSHORE ENVIRONMENTAL IMPACT ASSESSMENT

APPENDIX 10.3: MARINE MAMMALS ROAD MAP

EOR0766
Environmental Impact Assessment – Appendix 10.3
FINAL

BERWICK BANK WIND FARM EIA AND HRA ROAD MAP

Marine Mammals

EOR0766
Road Map –
Appendix 10.3
Final

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Document Status

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1 AIMS, SCOPE AND FORMAT OF THE ROAD MAP

1.1 Background and Aims

Phase 2 of the former Firth of Forth Zone includes Berwick Bank Wind Farm for which consents and licences (as set out below) are being sought. This Project includes both the offshore wind turbine generators (hereafter referred to as wind turbines) and associated offshore infrastructure, as well as onshore grid connection and associated infrastructure.

The Marine Mammal Road Map covers assessments in relation to the Berwick Bank Wind Farm, seaward of Mean High Water Springs (MHWS), as well as any impacts of offshore infrastructure on onshore receptors landward of MHWS (e.g. seal haul outs). This Road Map does not consider basking sharks or otters, or onshore impacts of onshore infrastructure (landward of MHWS). Consent and licence applications for the onshore and offshore components of the Project are being submitted separately. The offshore components of the Project are hereafter referred to as 'The Proposed Development'

Key components of the Proposed Development include:

- wind turbines;
- wind turbine foundations;
- inter-array cables;
- offshore substation platforms (OSPs)/Offshore convertor station platforms; and
- offshore export cables.

The Proposed Development requires the following consents, licences and permissions:

- a Section 36 consent under the Electricity Act 1989;
- marine licence(s) under the Marine and Coastal Access Act (MCAA) 2009;
- a marine licence under the Marine (Scotland) Act 2010 for the part of the offshore export cables which is within 12 Nautical Miles (NM) of the coast; and
- planning permission under the Town and Country Planning (Scotland) Act 1997 for all infrastructure located landward of Mean Low Water Springs (MLWS) and seaward of MHWS.

The aim of this Marine Mammal Road Map is to support agreement with key stakeholders on the information provided by Berwick Bank Wind Farm Limited (BBWFL), a wholly owned subsidiary of SSE Renewables Limited (hereafter referred to as the Applicant) in relation to marine mammals and underwater noise (associated with potential impact on marine mammals) offshore Environmental Impact Assessment (EIA) and the Report to Inform the Appropriate Assessment (RIAA), as part of the Section 36 Consent Application and Marine Licence Applications for the Proposed Development. This Marine Mammal Road Map documents discussions and agreements between the Applicant and the key stakeholders listed in section 2.

This Marine Mammal Road Map seeks to ensure that the information supplied in the consent Applications listed above is compliant with the requirements of the following regulations, hereafter referred to as the EIA Regulations:

- Section 36 consent application: The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017;
- marine licence application: The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Marine Works (Environmental Impact Assessment) Regulations 2007; and
- a planning application: The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017.

As well as the following regulations, hereafter referred to as the Habitats Regulations:

- the Conservation (Natural Habitats &c.) Regulations 1994 (as amended);

- the Conservation of Habitats and Species Regulations 2017 (as amended)[1]; and
- the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended)[1] (which apply to marine licences and Section 36 applications within the Scottish Offshore region.

As part of engagement in the Marine Mammal Road Map process, it was envisaged that the Applicant and key stakeholders would:

- provide information in a timely manner;
- be transparent and consistent in provision of advice;
- provide effective involvement in the stakeholder engagement process;
- aim to adhere to the programme of meetings set out in this Road Map (see section 3); and
- seek to identify any issues or additional data requirements as early as possible.

The Applicant sought to provide this Road Map as an accurate record of meetings held, discussions undertaken and points of agreement relating to the offshore EIA and Habitats Regulations Appraisal (HRA) marine mammal assessments.

1.2 Scope

The Marine Mammal Road Map was used as a tool to facilitate early and on-going engagement with key stakeholders, throughout the pre-application phase of the Proposed Development up to the point of Application submission. This included consultation on the developing baseline characterisation, approaches to data analysis, underwater noise modelling, assessment of significance, and development of the final application documentation. This Marine Mammal Road Map was a 'live' document which was used to reach and record points of agreement, for example on scoping impacts out of the offshore EIA and RIAA, and agreeing the level of assessment that were presented for impacts scoped in to the offshore EIA and RIAA, so that the focus in the assessment documents in support of the Application are on likely significant effects as defined by the EIA Regulations, and Likely Significant Effects (LSE) as defined by European case law associated with the Habitat Directive.

The Marine Mammal Road Map sought to agree the following as a minimum, however additional points of agreement/discussion were required, and these were discussed with key stakeholders and documented within this Road Map:

- receptors expected to occur within the zone of influence (ZoI) of the Proposed Development;
- key impacts that require to be assessed relevant to both draft offshore EIA and RIAA (including Unexploded ordnance (UXO), and those that can be scoped out from further assessment);
- study area and data sources to be used to inform the baseline characterisation, including additional evidence requirements;
- approach to analyses of site-specific data and results of interim data report;
- density values for key species;
- project design envelope and maximum design scenarios;
- underwater noise modelling methodology including approach to assessment of effects and population modelling;
- approach to cumulative and in-combination assessments;
- sensitivity of the relevant receptors and evidence available on potential impacts;
- approach to the offshore EIA, including the determination of significance of effects;
- potential measures which could be applied to remove significant effects and agreement on specific mitigation to reduce risk of effect (to be included in a Marine Mammal Mitigation Plan (MMMP)); and

[1] By the Conservation of Habitats and Species Amendment (EU Exit) Regulations 2019

- outputs of the offshore EIA and assessments to inform HRA.

For all the above, the Marine Mammal Road Map sought to record key areas of agreement and outstanding points of discussion.

Marine mammal survey scopes have been presented and agreement sought prior to this Road Map process with the consultees listed under section 2, and consideration of survey scopes is therefore not included further in this Road Map as no modifications were raised.

1.3 Format

Figure 1.1 outlines the key stages of the EIA and HRA processes, and how the Marine Mammal Road Map proposed to facilitate engagement during key stages and steps. The first stage of the Marine Mammal Road Map process was to agree the aims, scope and format of the Road Map, and the proposed timetable for engagement as set-out in this document.

The remainder of the Marine Mammal Road Map is set out as follows:

- section 2: identifies the key statutory stakeholders to the Marine Mammal Road Map;
- section 3: outlines the proposed marine mammal offshore EIA and HRA programmes for the Proposed Development. It includes the programme of meetings and provides a record of meetings that have taken place in relation to the marine mammal offshore EIA and HRA assessments;
- section 4: provides a summary of discussions, areas of agreement and areas of outstanding agreements in relation to the marine mammal offshore EIA and HRA assessments. The aim was to have as few issues as possible outstanding at the point of Application submission; and
- section 5: summarises the position (agreement/areas of outstanding points of discussion) at the point of Application submission.

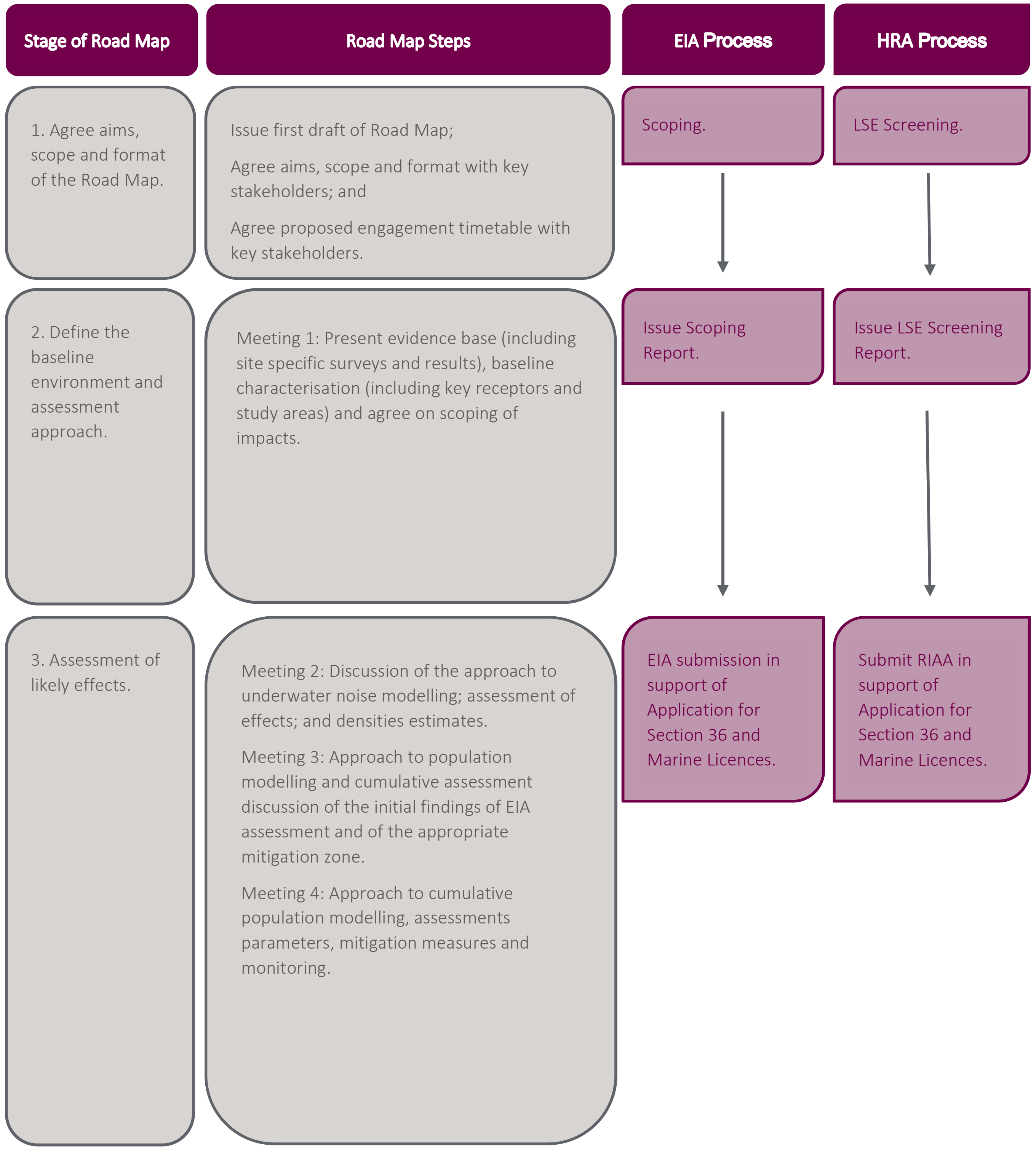

Figure 1.1: Key Stages of the Proposed Development

2 KEY STAKEHOLDERS

It was proposed that the aims of the Marine Mammal Road Map would be achieved through engagement with the following key statutory stakeholders:

- Marine Scotland Licencing and Operations Team (MS-LOT);
- Marine Scotland Science (MSS); and
- NatureScot.

The aforementioned key stakeholders attended all the meeting held.

Table 2.1 sets out the remit, role in the offshore EIA/HRA processes and the key contact for each of the stakeholders listed above.

Consultation with Natural England with regard to the Southern North Sea Special Area of Conservation (SAC) and its consideration within the Offshore EIA Report with regard to transboundary impacts, and also the RIAA was undertaken through the offshore EIA Scoping and offshore LSE screening stages.

Table 2.1: Remit, Role and Contact for Key Stakeholders Associated with the Marine Mammal Offshore EIA and HRA Road Map

Stakeholder	Remit	Role in Offshore EIA/HRA process	Contact
MS-LOT	Authority responsible for issue of Marine Licences for licensable activities in Scottish Waters	Regulatory Authority under the EIA regulations, and Competent Authority under the HRA regulations.	Emma Lees/Kerrie Bell/Gayle Holland
MSS	Supporting Scottish Government in managing marine and coastal environments to meet the long-term needs of both nature and people.	Statutory Advisor to MS-LOT	Kate Brooks/Caroline Carter
NatureScot	Lead advisory body to Scottish Government on nature, wildlife management and landscape management across Scotland	Nature Conservation advisor to Regulator and Competent Authority (HRA process) Scottish Government (Marine Scotland).	Erica Knott/Karen Taylor/Caitlin Cunningham

3 PROGRAMME

3.1 Marine Mammal Offshore EIA and HRA Programme for the Proposed Development

Table 3.1 below sets out the programme for key stages of the pre-application process in relation to the Berwick Bank Wind Farm.

Table 3.1: EIA and HRA Project Programme for Proposed Development

Detail	2020					2021												2022										
	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Submission of the 2020 Berwick Bank Wind Farm EIA Scoping Report	■																											
Submission of the Berwick Bank Wind Farm EIA Scoping Report															■													
Submission of the 2020 Berwick Bank Wind Farm LSE Screening Report			■																									
Submission of the Berwick Bank Wind Farm LSE Screening Report															■													
Submission of the Berwick Bank Wind Farm Consent Application																												■

3.2 Programme of Marine Mammal Road Map Meetings

Table 3.2 sets out the programme for stakeholder meetings in relation to key aspects of marine mammal technical assessments. These were scheduled to take place at key points of the pre-application phase and were in line with the key deliverables set out in Table 3.1 and the Marine Mammal Road Map process. The meetings listed in Table 3.2 are also listed within Figure 1.1. All meetings were held via conference calls unless otherwise specified. This was due to Covid-19 pandemic restrictions throughout the pre-Application phase.

The Applicant has presented an overview of the consenting and Road Map process and the points of discussion that have taken place as part of this Marine Mammal Road Map. In addition, as requested by MMS-LOT an Audit Document for Post-Scoping Discussions has also been provided in volume 3, appendix 5.1, summarising key points of advice received subsequent to receipt of the Berwick Bank Scoping Opinion in February 2022 and LSE screening advice, and how these have been addressed in the Application documents.

Table 3.2: Programme for Stakeholder Engagement: Marine Mammals

Detail	2020					2021												2022										
	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Stage 1: Agree aims, scope and format of the Road Map	■	■	■	■	■	■	■	■	■	■	■	■	■															
Stage 2: Define the baseline environment and assessment approach.	■	■	■	■	■	■	■	■	■	■	■	■	■	■														
Meeting 1: Present evidence base (including site specific surveys and results), baseline characterisation (including key receptors and study areas) and agree on scoping of impacts.													■															
Stage 3: Assessment of likely effects									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Meeting 2: Discussion of the approach to underwater noise modelling; assessment of effects; and densities estimates.															■													
Meeting 3:Approach to population modelling and cumulative assessment discussion of the initial findings of EIA assessment and of the appropriate mitigation zone.																		■										
Meeting 4: Approach to cumulative population modelling, assessments parameters, mitigation measures and monitoring.																								■				

3.3 Record of Marine Mammal Meetings

Table 3.3 records the meetings that have taken place, the attendees and the key discussion points in relation to the marine mammal offshore EIA and HRA assessments. This table was updated after each meeting and a tracker representing this table as circulated to all attendees as a record of the meeting and the key points of discussion. Table 3.3 does not record full minutes, however a meeting minute reference is provided for each meeting in this table and meeting minutes have been circulated following each meeting.

Table 3.3: Record of Marine Mammal and Underwater Noise Meetings Undertaken as part of the Marine Mammal Road Map

Meeting Reference	Stage of Offshore EIA Process	Date	Attendees	Key Discussion Points	Meeting Minutes Document Reference
00-MM	Pre-scoping	30 June 2020	The Applicant NatureScot MS-LOT MSS RPS	• project and programme update. • proposed approach to data analysis of site specific survey data and submission of interim data report for marine mammals. • proposed approach to scoping and Likely Significant Effect (LSE) screening for marine mammals. • approach to Stakeholder Engagement (Road Maps).	06302020 (SG2 & SG3 Pre-Scoping Meeting: Marine Mammals, Fish and Shellfish and Benthic Ecology)
01-MM	Pre-scoping	24 August 2021	The Applicant NatureScot MS-LOT MSS RPS	• overview of the Proposed Development. • study area and data sources used to inform the baseline characterisation. • approach to data analyses/results of interim data report. • receptors within the ZoI of the Proposed Development. • key issues to assess in the offshore EIA and RIAA. • approach to scoping of impacts.	LF000010&11-DEV-MOM-077
02-MM	Post-scoping	20 October 2021	The Applicant NatureScot MSS MS-LOT RPS Seiche	• marine mammal density estimates. • overview of underwater noise modelling approach. • overview of marine mammal underwater noise assessment of effects.	LF000010&11-DEV-MOM-081
03-MM	Post-scoping	18 January 2022	The Applicant NatureScot MSS MS-LOT RPS Seiche	• underwater noise energy conversion factors. • injury ranges for marine mammals and mitigation zone. • potential disturbance contours. • cumulative effects assessment (CEA). • population modelling (iPCoD).	LF000010&11-DEV-MOM-088
04-MM	Post-scoping	27 July 2022	The Applicant NatureScot MSS MS-LOT RPS	• potential injury ranges. • maximum design scenario. • mitigation. • approach to assessments. • CEA.	LF000010&11-DEV-MOM-104

4 RECORD OF DISCUSSIONS

This section of the Marine Mammal Road Map documents discussions and areas of agreement or outstanding discussion points following each meeting as set out in section 3. Further detail on key aspects of discussion are provided in meeting minutes which are not appended to this Road Map.

The following subsections record associated discussion:

- receptors expected to occur within the ZoI of the Proposed Development – section 4.1;
- key impacts that require to be assessed relevant to both draft offshore EIA and RIAA (including UXO, and those that can be scoped out from further assessment) – section 4.1;
- study area and data sources to be used to inform the baseline characterisation, including additional evidence requirements – section 4.1;
- approach to analyses of site-specific data and results of interim data report – section 4.2;
- density values for key species – section 4.2;
- Proposed Development design envelope and maximum design scenarios – section 4.3;
- underwater noise modelling methodology; approach to noise impact assessment; population modelling – section 4.3;
- approach to the CEA – section 4.3;
- sensitivity of the relevant receptors and evidence available on potential impacts – section 4.3;
- approach to offshore EIA, including the determination of significance of effects – section 4.3;
- potential measures which could be applied to remove significant effects and agreement on specific mitigation to reduce risk of effect (to be included in a MMMP) – section 4.3; and
- initial outputs of the offshore EIA and RIAA supporting the HRA assessment – section 4.3.

4.1 Receptors, Key Impacts and Data Sources

This section aims to document and agree key areas of agreement and outstanding discussion points associated with the marine mammal baseline for the Proposed Development EIA and HRA. These include the following:

- receptors expected to occur within the ZoI of the Proposed Development;
- key impacts that require to be assessed relevant to both draft offshore EIA and RIAA (including UXO, and those that can be scoped out from further assessment); and
- study area and data sources to be used to inform the baseline characterisation, including additional evidence requirements.

Table 4.1 summarises the points of discussion, areas of agreement and outstanding discussion points in relation to the marine mammal baseline for the Proposed Development.

Table 4.1: Summary of Discussion and Agreed Position on Marine Mammal Baseline Data for the Offshore EIA and HRA

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
Study areas	List of study areas: • Proposed Development marine mammal study area: – encompass Proposed development array area and export cable corridor and a 16 km buffer; and – covered by site specific surveys. • Regional marine mammal study area: – northern North Sea extended to European coastline; – inform the CEA and HRA; – reference populations are based on relevant MUs (regional baselines report); and – baseline species accounts discussed on basis of smaller regional areas (i.e. bottlenose dolphin *Tursiops truncatus* in east coast MU, seals species in East Scotland and North-east England MUs and connectivity with SACs based on telemetry data and harbour porpoise *Phocoena phocoena*, minke whale *Balaenoptera acutorostrata* and white-beaked dolphin *Lagenorhynchus albirostris* in SCANS-III Block R/JCP Firth of Forth and connectivity with SACs/Marine Protected Areas (MPAs)). The North Sea MU (harbour porpoise) is too large to assess cumulative impacts, and aligning with the larger MUs (such as the Celtic and Irish Seas) for minke whale and white-beaked dolphin.	Suggested to keep in mind that the Berwick Bank Wind Farm HRA Screening Response advised that the Southern North Sea SAC should be considered. Advised not to use SCANS Block R as a study area as it does not have any relevance in terms of populations for the Proposed Development. Suggested to use the regional study areas defined in the SCANS III. Requested to present the SCANS III Block alongside the MUs in the assessment as an element of regional context, noting the caveat that this is not an ecological relevant area.	Suggested that 2020 Berwick Bank Wind Farm Scoping Report regional marine mammal study area was too broad and requested that the impact pathways are considered prior to consideration of CEA. Highlighted concerns around including the Dogger Bank SAC within the assessment as there are different approaches to management. Proposed that there is a requirement to restrict the regional study areas for the CEA and also the HRA. Suggested to use SCANS-III block R as regional baseline.	The approach suggested by the Applicant was agreed with consideration of MUs as reference populations against which to assess impacts and the use of SCANS III Block R as harbour porpoise vulnerable subpopulation.
Baseline characterisation	The list of data to characterise the baseline are: • scientific literature (see section 4.1.1.1.1); • historic site specific surveys (see section 4.1.1.1.2); and • site specific surveys: – HiDef aerial surveys over Proposed Development plus buffer (4,980 km^2, 39 transects) for 24 months; and – Seal haul-out telemetry data (SMRU) up to 2020 to provide August moult census, grey seal *Halichoerus grypus* pup counts and satellite tracking data.	Stated that the Joint Nature Conservation Committee (JNCC) Report 544 (Heilanen and Skov, 2015) should be updated. Added that the abundance estimates for bottlenose dolphin used is based on data from 2007 and that this has been updated via a weighted mean. Highlighted a preference for the most recent data to be used and	Stated that habitat preference maps from Carter *et al.* (2020) reflect the most up to date predictions. Recommended that Carter *et al.* (2020) is used to predict absolute numbers using current scalars. This work has built on previous work (Russell *et al.,* 2017) but with notable differences. The general conclusion of Russell and Carter (2020) is that the more	The approach suggested by the Applicant was agreed with the use of the latest information on the five year weighted mean abundance estimates for bottlenose dolphin and data from SCOS report 2021 for the assessment (2022 data not available at

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
		replaces Inter Agency Marine Mammal Working Group (IAMMWG) (2015). Suggested that Carter *et al.* (2020) document (seals at-sea report) is less appropriate for assessment of effects as it uses relative abundances rather than absolute abundances and suggested that the Russell *et al.* (2017) is more relevant. Added that this should be updated via Special Committee on Seals (SCOS) in spring 2022 with a potential for SMRU to update earlier.	recent habitat preference project is the best available. Advised to use both breeding and non-breeding populations and to use the JNCC maximum population estimates for the breeding populations and at-sea maps for the non-breeding populations. Advised that for the HRA, the most appropriate consideration to assess impact is to consider the pup production estimates since grey seal SACs are designated on the basis of the numbers of pups born during the breeding season. Satisfied with the suggestion to use maximum population estimates from the JNCC Standard Data Forms since SCOS (2020) does not provide grey seal pup production estimates for individual SACs.	the time of the Application). The JNCC Report 544 was not updated by the time of the Application and hence updated version not used. Coastal densities are based on additional assessment using recent literature (Arso Civil *et al.*, 2019, Arso Civil *et al.*, 2021) and offshore densities are based on SCANS III (Hammond *et al.*, 2021)
Marine mammal SACs, MPAs and Site of Community Importance (SCIs) for the assessment of effects	List of SACs for marine mammals in the vicinity of the Proposed Development: • Moray Firth (bottlenose dolphin); • Isle of May (grey seal); • Dornoch Firth and Morrich More (harbour seal *Phoca vitulina*); • Southern North Sea (harbour porpoise); • Doggersbank (harbour porpoise); • Klaverbank (harbour porpoise); • Berwickshire and North Northumberland Coast (grey seal); and • Firth of Tay and Eden Estuary (harbour seal). List of MPAs for marine mammals in the vicinity of the Proposed Development:	No specific point raised.	Stated that the purpose of seal SAC designations are different in Scotland as they are based more so on breeding. If the Proposed Development is not within the foraging range of the SAC, would not expect this SAC to be taken forward.	The approach suggested by the Applicant was agreed with the Southern Trench MPA screened out.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
	• Southern Trench (minke whale). List of SCIs for marine mammals in the vicinity of the Proposed Development: • Doggerbank (harbour porpoise).			
Marine mammal receptors	List of receptors expected within the zone of influence (ZoI) of the Proposed Development: • harbour porpoise (North Sea Management Unit (MU)); • minke whale (Celtic and Greater North Seas MU/Scans III Block R); • white beaked dolphin (Celtic and Greater North Seas MU/Scans III Block R); • bottlenose dolphin (Coastal East Scotland MU); • harbour seal (East Scotland MU and Northeast England MU); and • grey seal (East Scotland MU and Northeast England MU). Haul-out sites scoped out.	No specific point raised.	No specific point raised.	The approach suggested by the Applicant was agreed.
Scoping of impacts	List of scoped in impacts for the marine mammal assessments: • Construction: – injury and disturbance from piling; – disturbance to marine mammals from pre-construction surveys; – disturbance of marine mammals from vessel use and other construction activities; – injury of marine mammals due to collision with construction vessels; and – effects on marine mammals due to changes in prey availability. • Operation and maintenance: – disturbance of marine mammals from vessel use; – injury of marine mammals due to collision with operation and maintenance vessels; – effects on marine mammals due to changes in prey availability. • Decommissioning:	Highlighted that there is still limited data on deflagration and the Applicant should ensure to consider the maximum design scenario for potential methods of UXO clearance. Suggested that deflagration is quieter not silent and suggested this should not be scoped out completely from an assessment.	Requested that the Proposed Development export cable corridor is not missed particularly in the construction phase.	The approach suggested by the Applicant was agreed with the impacts of low order techniques (e.g. deflagration) scoped in to the assessment and the impacts from Proposed Development export cable corridor captured within the construction phase.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
	– disturbance to marine mammals from vessel use and other decommissioning activities; – disturbance of marine mammals from vessel use; and – effects on marine mammals due to changes in prey availability. List of scoped out impacts for the marine mammal assessments: • Construction: – accidental pollution; – increased suspended sediment concentrations and associated sediment deposition; – disturbance to seals on land (hauled out) from construction and pre-construction activities; and – injury and disturbance from underwater noise generated during clearance of UXO. • Operation and maintenance: – electromagnetic fields (EMFs) (from surface lain or buried cables); and – disturbance to marine mammals from operational noise. • Decommissioning: – accidental pollution during the decommissioning phase; and – increased suspended sediment concentrations and associated sediment deposition.			

4.1.1 Additional Details on Key Discussions

4.1.1.1 Baseline characterisation:

4.1.1.1.1 Scientific literature:

- Bottlenose dolphin PhotoID surveys and SAC site condition monitoring (May-September 2009 to present) (Quick *et al.*, 2014; Cheney *et al.*, 2013; Arso Civil *et al.*, 2019; Cheney *et al.*, 2018);

- Bottlenose dolphins for coastal east Scotland (Arso Civil *et al.,* 2021; Arso Civil *et al.,* 2014; Palmer *et al.*, 2019);
- East Coast Marine Mammal Acoustic Study (ECOMMAS) Passive Acoustic Monitoring (PAM) data (2013 to present) (Brookes, 2017);
- Marine Ecosystems Research Program cetacean density surfaces (1980 to 2018) (Waggitt *et al.,*2020);
- Seal haul-out counts (up to 2019) (Data provided by SMRU);
- Seal telemetry (1990 to 2018) (Data provided by SMRU);
- Small Cetaceans in European Atlantic Waters (SCANS) III (July 2016) (Hammond *et al.,* 2017);
- SCANS II (July 2005) (Hammond *et al.*, 2006);
- SCAN-III Block R (Hammond *et al.,* 2021);
- Seal at-sea usage (telemetry: 114 grey seals and 239 harbour seals, count: 2015-2020) (Carter *et al.*, 2020);
- Forth and Tay Offshore Wind Developers Group cetacean survey data analysis report (2009 to 2011) (Mackenzie *et al.*, 2012; King and Sparling, 2012);
- JNCC Report 544: Harbour Porpoise Density (1994 to 2011) (Heinänen and Skov, 2015);
- Analysis of The Crown Estate aerial survey data for marine mammals for the Forth and Tay Offshore Wind Developers Group (1994 to 2011) (Grellier and Lacey, 2011);
- Joint Cetacean Protocol Phase III (1994 to 2010) (Paxton *et al.*, 2016);
- Cetacean Baseline Characterisation for the Firth of Tay: Bottlenose dolphins (PhotoID: 2009 and 2010, PAM: 2006 to 2009) (Quick and Cheney,2011); and
- Regional Baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters (2020 report on MUs for marine mammals) (Hague *et al.*, 2020).

4.1.1.1.2 Historic specific surveys:

- The Crown Estate aerial surveys (Grellier and Lacey, 2011) providing inshore and offshore waters (including Firth of Forth and Tay) surveyed between May and August 2009 and November 2009 and March 2010;
- Seagreen Firth of Forth Round 3 (Sparling, 2012) providing visual boat based surveys carried out between May 2010 and November 2011.The survey area comprised the Firth of Forth Round 3 Zone (approximately 2,850 km^2); and
- Seagreen Phase 1 (boat-based surveys May to August 2017).

4.1.2 Summary Statement of Final Position

The lists of receptors, impacts and relevant sites to be scoped in and out of the offshore EIA assessment as well as the baseline characterisation data sources followed the suggestions from the Applicant in Table 4.1 with the inclusion of the following advice from the stakeholders agreed by the Applicant:

- consideration of MUs as reference populations against which to assess impacts and the use of SCANS III Block R as harbour porpoise vulnerable subpopulation;
- use of the latest information on the five year weighted mean abundance estimates for bottlenose dolphin and data from SCOS report 2021 for the assessment;
- Southern Trench MPA screened out; and
- the impacts of low order techniques scoped in the assessment.

4.2 Data Analyses of Site-Specific Data and Density Estimates

This section aims to document and agree key elements of the marine mammal data analysis for the Proposed Development offshore EIA and HRA. These include the following:

- approach to analyses of site-specific data and results of interim data report; and
- density values for key species.

Table 4.2 summarises the points of discussion, areas of agreement and areas of outstanding non-alignment in relation to the marine mammal data analysis for the Proposed Development.

Table 4.2: Summary of Discussion and Agreed Position on Marine Mammal Surveys and Data Analysis

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
Data analysis	List of data analyses for marine mammal assessments: • summary statistics for each of the key species or species groups; • survey effort per month of survey vs target coverage (minimum 10%); • raw count data per species per month; • counts per unit effort (encounter rate); • relative densities estimated using a non-parametric bootstrap approach with replacement; • spatial density maps for key species occurring within the survey area (current analyses); and • use of telemetry dive data to correct for availability bias. However, there are some data limitations: • snap-shot data; • missed surveys and missed transects; • availability and perception bias; and • species identification. Also some availability bias: • harbour porpoise: – tagging study in Baltic/North Sea (Teilman *et al.,* 2013); and – v-tag study Danish North Sea (van Beest *et al.,* 2018). • minke whale: – visual tracking study Iceland (McGarry *et al.,* 2017). • white-beaked dolphin: – bio-logging study of free-ranging dolphins in Iceland (Rasmussen *et al.,* 2013). • grey seal: – tracking study in Farne islands (Thompson *et al.*, 1991); and – telemetry data from SMRU – North Sea (Hornsea Three offshore wind farm (GoBe, 2018). The results of aerial surveys reported: • harbour porpoise: – encountered in every month of year. • minke whale: – sighted in low numbers during summer months only (May to August).	Suggested to see absolute abundances for availability bias. Suggested that the assessment is caveated since the tagging data is likely the best option for understanding dive profiles. Stated that there is currently no method to account for availability bias and perception bias. Suggested that both availability bias and perception bias are considered.	No specific point raised.	The approach suggested by the Applicant was agreed with no perception bias since the cameras can be angled to reduce glare and availability bias accounted for absolute and relative densities. No studies regarding minke whale availability bias available.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
	• white-beaked dolphin: – sighted in low numbers during summer months only (June to September). • bottlenose dolphin: – not identified during aerial surveys although a number of 'dolphin species'. – grey seal: – encountered in every month of year. • seal species: – number of sightings not identified to species level. • harbour seal: – none identified to species level but some may be in category 'seal species'.			
Aerial surveys results	The results from the aerial surveys showed: • harbour porpoise: – higher densities in the spring and summer months, lower in late autumn and winter; – mean relative density – 0.10 animals per km^2 (lower 95% CL: 0.026; upper 95% CL: 0.198; CV = 1.91); – density corrected for availability bias - 0.24 animals per km^2 (lower 95% CL: 0.063; upper 95% CL: 0.472); and – average group size between 1 – 3 individuals but in April 2020 large group of 49 individuals. • grey seal: – higher densities in the spring and summer months, lower in late autumn and winter; – mean relative density – 0.10 animals per km^2 (lower 95% CL: 0.026; upper 95% CL: 0.198; CV = 1.91); – density corrected for availability bias - 0.17 animals per km^2 (lower 95% CL: 0.063; upper 95% CL: 0.472); and – group size usually just one individual, largest seen was 5 individuals. • minke whale: – mean relative density – 0.004 animals per km^2; and – density corrected for availability bias - 0.009 animals per km^2 • white-beaked dolphin: – mean relative density – 0.004 animals per km^2; and	Suggested to steer away from aerial survey data for seals densities for the assessment since issues around identification between sexes and between seal species. Suggested to use "at sea" maps for the assessment and present the site-specific survey data for context. Suggested to acquire data for bottlenose dolphin from ECOMMAS. Stated that previously, populations were spread across areas which were considered as foraging areas. Suggested a general discussion on data collection/data to be used. As it stood, snapshot data	No specific point raised.	Approached presented by the Applicant was agreed including the suggestions to analyse ECOMMAS data and to use the "at-sea" maps for the assessment.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
	– density corrected for availability bias - 0.022 animals per km^2.	would be used and do not consider long-term data.		
SMRU data harbour seal	The results from SMRU data for harbour seal showed: • telemetry data: – 25 out of the 46 harbour seals tagged in the East Scotland MU were recorded in the Proposed Development marine mammal study area; and – tracks concentrated in the north-west of the Proposed Development marine mammal study area with comparatively lower numbers of tracks within eastern portion of the Proposed Development array area or export cable corridor. • august haul-out counts (1996-1997, 2000-2006, 2007-2013, 2015-2018): – East Scotland MU: 764, 667, 241, 342; and – North-east England MU: 54, 62, 83, 79.	No specific point raised.	No specific point raised.	The results presented by the Applicant were agreed.
SMRU data grey seal	The results from SMRU data for grey seal showed: • Telemetry data: – 59 adult grey seals recorded within the Proposed Development marine mammal study area (38 were tagged in the East Scotland MU, 18 in the North-east England MU and 3 in the North Coast and Orkney MU; – These 59 adult grey seals demonstrated some connectivity with several United Kingdom (UK) grey seal SACs such as the Berwickshire and North Northumberland Coast SAC (73%),the Isle of May SAC (41%), the Faray and Holm of Faray SAC (3%), the Humber Estuary SAC (2%), the North Rona SAC (2%) and the Monach Islands SAC (2%). • August haul-out counts (1996-1997, 2000-2006, 2007-2013, 2015-2018): – East Scotland MU: 2328, 1898, 1982, 3762; and – North East England MU: N/A, 1100,2354, 6502.	No specific point raised.	No specific point raised.	The results presented by the Applicant were agreed.
Densities estimates	Relative densities estimates (mean abundance/model based density, estimate per km^2/densities based density, estimate per km^2): • harbour porpoise: – winter: 195.409/0.039/0.039; – spring: 1745.688/0.351/0.307; – summer: 375.140/0.076/0.084; and – autumn: 203.629/0.041/0.045.	Suggested to use 5-year weighted average provided by Marine Scotland for bottlenose dolphin which is 224.	No specific point raised.	The density estimates suggested by the Applicant were agreed with a change from relative to absolute density and the population of bottlenose dolphins

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
	• grey seal: – winter: 146.269/0.029/0.029; – spring: 250.428/0.050/0.048; – summer: 225.856/0.045/0.041; and – autumn: 237.820/0.048/0.045. Densities estimates for bottlenose dolphin (Quick *et al*., 2014; Arso Civil *et al.,* 2021; Arso Civil *et al.,* 2014; Palmer *et al.,* 2019; ECOMMAS, 2017) split into five coastal segments: St Abbs, St Andrews, Arbroath, Stonehaven and Cruden Bay: • the area of Tay estuary and adjacent waters is used by more than a half of the total estimated population every summer (in 2019 approximately 53.5%); • East Coast of Scotland population - 213 individuals (95% CI = 186 to 244); • number of animals expected to be present between Peterhead and Farne Islands: 115 individuals; • bottlenose dolphins are most likely to be encountered within 5 km from the shore; and • bottlenose dolphins are most likely to be encountered in waters between 2 m and 20 m deep.			for Coastal East Scotland (224 animals) used data presented in Arso Civil *et al.* (2021).

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position
Marine mammal densities	Marine mammal densities from site-specific aerial surveys and SCANS-III (Hammond *et al*., 2021): • harbour porpoise: 0.299 – 0.826 (site-specific surveys) in the North Sea MU with a population of 346,601 (IAMMWG, 2021) and 38,646 from SCANS-III (Hammond *et al.,* 2021); • bottlenose dolphin: 0.197 – 0.294 (inshore, Arso Civil *et al.,*2019), 0.0298 (offshore Hammond *et al.,* 2021) in the Coastal East Scotland MU with a population of 224 (Arso Civil *et al.,*2021) and 1,924 (Hammond *et al.,* 2021); • white-beaked dolphin: 0.243 (Hammond *et al.,* 2021) in Celtic and Greater North Sea MU with a population of 43,951 (IAMMWG, 2021) and 15,694 (Hammond *et al.,* 2021); • minke whale: 0.0387 (Hammond *et al.,* 2021) in Celtic and Greater North Sea MU with a population of 20,118 (IAMMWG, 2021) and 2,498 (Hammond *et al.,* 2021); • grey seal: 0.276 – 1.2 (site specific surveys, Carter *et al.,* 2020) in East Scotland and North-east England Mus with a population of 42,600 (Sinclair, 2022; SCOS, 2020); and • harbour seal: 0.0001 – 0.002 (Carter *et al.*, 2020) in East Scotland and North-east England MUs with a population of 586 (Sinclair, 2022; SCOS, 2020). Grey seal site-specific density estimates are highly precautionary as these also include “seal species” (seals that could not be identified to species level) on the assumption that most seals within the site were likely to be grey seal (as this was the most commonly occurring seal species across the aerial survey area).	Requested more rationale to be provided for not assuming harbour seals as grey seals which is supported by the telemetry data.	Suggested to support this data with Carter *et al.* (2020) maps over SCOS data or SMRU absolute density maps. Site specific data is used for grey seal disturbance however the density maps would be more appropriate. White-beaked dolphin and minke whale numbers had been updated for the MU data (IAMMWG 2021). Stated that density should be based on telemetry data and various other data sources (including telemetry data, haul-out data and habitat preference data). SMRU use best data available and that the sample should be all existing data from SMRU.	The densities estimated for marine mammal species suggested by the Applicant were agreed with the use of Carter *et al.* (2020) data to estimate numbers affected. Both non-site and site-specific data are presented in the assessment along with a better rationale for distinguishing seal species. IAMMWG (2021) data is used as reference population for harbour porpoise, white-beaked dolphin and minke whale.

4.2.1 Summary Statement of Final Position

The data analysis approach for the assessment of effects and the interim results followed the suggestions and data presented by the Applicant as agreed with the stakeholders as in Table 4.2 with regards to the following agreed points:

- the perception bias is not an issue since the cameras can be angled to reduce glare;
- the availability bias is accounted for absolute and relative densities;

- the use of absolute density instead of relative densities;
- the use of 224 animals for population of bottlenose dolphins for Coastal East Scotland;
- the use of Carter *et al.* (2020) data to estimate numbers affected; and
- to present both non-site and site specific data in the assessment along with a better rationale for distinguishing seal species.

4.3 Approach to EIA and HRA

This section aims to document and agree key topics associated with the maximum realistic design scenarios assessed in relation to the marine mammal assessments for Proposed Development EIA and HRA. These include the following:

- project design envelope and maximum design scenarios;
- underwater noise modelling methodology;
- approach to underwater noise impact assessment;
- population modelling;
- approach to cumulative effects assessment;
- sensitivity of the relevant receptors and evidence available on potential effects;
- approach to offshore EIA, including the determination of significance of impacts;
- potential measures which could be applied to remove significant effects and agreement on specific mitigation to reduce risk of effect (to be included in a MMMP); and
- initial outputs of the offshore EIA and HRA assessment.

Table 4.3 summarises the points of discussion, areas of agreement and areas of outstanding agreements in relation to the approach to the offshore EIA for the Proposed Development.

Table 4.3: Summary of Discussion and Agreed Position on Marine Mammal Approach to Offshore EIA and HRA

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
Underwater noise assessment	Sources included in the assessment are: • pre-construction phase: – geophysical site investigation activities including Multi-Beam Echo-Sounder (MBES); Sidescan Sonar (SSS), Single Beam Echosounder (SBES), Sub-Bottom Profilers (SBP) and UHRS.; – geotechnical site investigation activities including Core Penetration Tests (CPTs) and vibrocores.; – use of geophysical/geotechnical survey vessels; and – clearance of UXOs using low-order (deflagration). • construction phase: – impact and drill piled jacket foundations for wind turbines; – impact and drill piled jacket foundations for OSPs/Offshore convertor station platforms; – vessels used for a range of construction activities including e.g. boulder clearance, sand wave clearance, drilling and trenching; – range of construction vessels including installation vessels, cargo barges, support vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels and resupply vessels; • operation and maintenance phase: – operational noise from wind turbines; – routine geophysical surveys; and – Operational and maintenance vessels, including crew transfer vessels, jack up vessel, support vessels, cable repair vessel, service operations vessels, cable survey vessel and excavator/backhoe dredger. • decommissioning phase – vessels for a range of decommissioning activities, assumed as per vessel activity described for construction phase. and some of the main considerations include:	Stated that Centre for Environment Fisheries and Aquaculture Science (Cefas) Energy Flux Model was previously the only one requiring conversion factor to undertake the modelling. Stated that for seals, the rate looks high for a sustained speed over that range.	Agreed with swim speeds proposed.	The approach suggested by the Applicant was agreed. Both models (Cefas and Weston) should provide the same outputs if the same input data are used.

[2] As of October 2022.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
	• the bathymetry to be relatively flat and typically 60 m; and • the seafloor prominently consists of a sandy bottom with sandstone layers underneath. The proposed model is Weston Energy Flux Model used in other offshore wind farms in the UK including Scotland and previously accepted by MSS. It is calibrated against other noise models and peer reviewed. The conservatism in the assessment is shown with: • the use of precautionary Southall *et al.*(2019) criteria; • the use of impulsive thresholds at larger ranges – at some distance the initially impulsive sound will elongate due to dispersion and multiple reflections to become non-impulsive. Currently no quantitative method of determining this point; • thresholds assume no recovery between pulses and also use of 24-hour assessment period is precautionary. • piling scenario based on maximum design scenario parameters – unlikely to be required for all piles (maximum pile hammer energy, maximum number of strikes and piling duration and assessment of maximum design scenario for consecutive piling)' • robust pile source levels based on peer review literature; • calibrated and peer reviewed underwater noise modelling; and • conservative assumptions for swim speed. Steps for the underwater noise modelling are described in section 4.3.1.1. The swim speeds assumed for exposure modelling are found in section 4.3.1.2.			
Pilling source modelling methodology	A broadband source-level sound exposure level (SEL) value is evaluated for a given operation scenario from De Jong and Ainslie (2008): • SEL = $120+10log_{10}((\beta E C_0 \rho)/4\pi)$. β is the energy transmitted from the pile into the water column, E is the hammer energy employed in J, C_0 is the speed of sound in the water column, and ρ is the density of the water. The peak sound pressure level is calculated via the empirical fitting between pile driving SEL and sound peak level (SPL) data, given in Lippert *et al.* (2015).	Mentioned that Moray Firth used conversion factors of 1%, 4% and 10%. The 1% conversion factor used for Seagreen 1 was due to consultation not being undertaken on the conversion factors. Disagreed with 0.5% conversion factor being the	Suggested that the 0.5% conversion factor is too low and not precautionary enough. Stated that Robinson *et al.* (2007) was based on measurements obtained from much shallower waters than for the Proposed Development (8 m - 10 m) and only used hammer energy up to 800 kJ, that Dahl *et al.* (2015) is a	Ranges conversion factors were modelled. Five different conversion factors were explored (1% constant, 4% reducing to 0.5%, 10% reducing to 1%, 4% constant and 10% constant) with results presented in a sensitivity assessment volume 3, appendix 10.1. The sensitivity analysis was

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
	Proposed to use energy conversion factor (β) of 0.5% (Seagreen 1 used a conversion factor of 0.5% and provided a comparison with 1% in an appendix). Both full-scale observational (Robinson *et al.,* 2007; Dahl and Reinhall, 2013) and detailed (Zampolli *et al.,* 2013) numerical studies suggest that 0.5% of hammer energy radiates as sound into the water column. One study (Thompson *et al.,* 2020) found energy conversion factor of 10% using a submersible impact hammer on pin piles which do not penetrate above the water This was for a different method of installing piles where the pile is driven using a submersible hammer. It is therefore not considered applicable to the methods proposed for the Proposed Development. Measurements on piles using above water impact hammers show approximately linear SEL to hammer energy relationship (e.g., Lepper *et al.,* 2007; Robinson *et al.,* 2009; Bailey *et al*., 2010; Lepper *et al.,* 2012; Robinson *et al*., 2013). Thresholds from Southall *et al.* (2019) for criteria for marine mammals (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)) are described in section 4.3.1.3.	current consensus within the scientific community. The data supporting the 0.5% conversion factor is not from Scotland and in 60 m depths. Stated that where there is uncertainty, it is not unusual for ranges of conversion factors/values to be used in an assessment (e.g. same approach applied for ornithology modelling). Added that evidence regarding the 0.5% conversion factor used data collected from different environment. Whilst 10% may not be right, the conversion factor is also not constant throughout the pilling operation. Expected to see the 4% conversion factor modelled. Agreed with the position of NatureScot regarding the choice of conversion factors.	review published in Acoustics Today, and presents the conversion factor taken from the same limited number of studies and that Dahl & Reinhall (2013) is based on measurements taken from a ferry dock in shallow water depths, with the measurements only made during the final 0.3 m penetration depth. Advised that the Thompson *et al*. (2020) study is not dismissed as inapplicable In the absence of evidence, requested that all assessment are undertaken with precaution. Disagree with the use of a single conversion factor (1%) to be used since the limited literature provided to support the conversion factor is based on different shallower environments than those expected in Scottish waters. Therefore, a data gap remains. 10% conversion factor estimated for the Moray Firth along with research undertaken in the Moray East offshore wind farm illustrates too much uncertainty on the use of 1%. Agreed on the issues regarding to impulsiveness. Suggested that the interim method as proposed in Southall *et al.*	run to determine the most appropriate approach for the conversion factor used in the assessments. The recommended approach is a 4% conversion factor reducing to 0.5%. In some cases, the 1% ranges were larger, therefore this conversion factor was included where it represented a more precautionary approach to ensure the most robust approach taken (both conversion factors are included in the assessment). The 10% conversion factor was found to be overly precautionary but included in volume 3, appendix 10.5, as 10% reducing to 1% conversion factor. A 1% constant conversion factor (reflective of the highest energy in pilling sequence) is also presented in the assessment and in the iPCoD model.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
			(2019), to look at how it could be factored into the model to estimate where the transition may be from frequency, in order to distinguish when relevant hearing criteria transitions from impulsive to non-impulsive noise. Suggested, regarding pin piles, that a decreasing conversion factor could be modelled as piling progresses. Therefore, not using the worst case throughout the entire scenario. Rather than using a single conversion factor throughout, this could replicate the pattern of noise measured from pin piles. This is not the case if it was monopile. Suggested to have a bench-mark exercise whereby actual measured sound levels at approximately 750 m away from the available offshore wind piling data could be compared to the received levels at 750 m as predicted and compare this with the model at 750 m. This would provide more confidence in the proposed conversion factor. Reinforced that much of the cited work used as evidence is theoretical and require therefore further supporting evidence to back this up. If using a lower conversion factor than elsewhere, require evidence to back this up.	

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
			Understood the layers of conservatism and acknowledged that the ranges as predicted for cumulative PTS are large. Highlighted that there are two elements to auditory risk: the instantaneous injury risk (mitigated using pre-piling mitigation) and the cumulative risk to auditory impairment, considered under EIA and European Protected Species (EPS). Two aspects which are the instantaneous risk and also the cumulative risk. With regard to the 10% conversion factor, understood the concerns with the peer reviewed paper, but it is in the public domain and therefore need to have a clear evidence chain within the Offshore EIA Report. For Moray Firth, the model used in the assessment had under predicted what was found in the environment and therefore probably under predicted the level of risk associated with the piling scenario. Additional details in section 4.3.1.4.	
Marine mammal assessment of effects	The impacts that might affect marine mammals are: • pre-construction phase: – disturbance to marine mammals from underwater noise during pre-construction surveys including geophysical surveys, geotechnical surveys, vessel noise and number of vessels); and	No specific point raised.	Stated that Scottish Government has signed an agreement stating that low order techniques should be used for UXO clearance. Shared preference to use low	The approach to the assessment of effects suggested by the Applicant is agreed with the assessment undertaken on a species-by-species basis and with

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
	– injury/disturbance to marine mammals from underwater noise due to clearance of UXOs with up to 70 UXOs, low order detonations with donor charges and up to 2 detonations per day (daylight only). • construction phase: – injury/disturbance to marine mammals from underwater noise due to pile-driving – jacket and OSP/Offshore convertor station platform foundations; – max adverse spatial (up to 4,000 kJ); and – max adverse temporal (up to 10 hours). – disturbance to marine mammals from underwater noise due to vessel activity – range of vessel types; and – maximum number of vessel trips. • operation and maintenance phase: – disturbance to marine mammals from underwater noise during operation and maintenance vessel activity including routine geophysical surveys, vessel associated with all operation and maintenance activities, range of vessel types and maximum number of vessel trips. • decommissioning phase – disturbance to marine mammals from underwater noise during decommissioning vessel activity as per vessel activity described for construction phase. Pile driving (injury) considerations are a focus on PTS with TTS modelled for completeness, a dual metric approach following guidance from Southall *et al.* (2019) and looked at peak SPL (SPL_{pk}) and cumulative SEL (SEL_{cum}). The largest of the two metrics is used to inform the mitigation zone. The ranges for SPL_{pk} were looked at over the entire piling sequence (i.e. from initiation to full hammer energy) and the point at which the largest range was reached at any time over the sequence was reported. However, it is the SEL_{cum} that results in the larger injury ranges compared to SPL_{pk} and therefore this is what has been proposed to be adopted for defining the mitigation zone. Injury ranges were predicted for different species using either the 4% reducing to 0.5% conversion factor or the 1% constant		order techniques for UXO clearance whenever possible. Requested evidence of efficacy for any technique used to provide to the regulators. Applicant needs to provide all of the details mentioned and that should be sufficient on the basis high order is not the preferred technique. This nominal number would be needed for the marine licence. The required focus is on how the mitigation works (e.g. scare charges being louder than the UXO discharge, or the donor charge). Agreed with how the assessment is completed. Advised that instantaneous PTS (SPL_{pk}) and accumulated PTS (SEL_{cum}) should be undertaken and presented separately to avoid confusion. Advised that the dual metric approach should be conducted in line with Southall *et al.* (2019). This should be performed for two purposes: once for the instantaneous PTS assessment, and once for the accumulated PTS assessment, rather than all combined. This has been the usual approach for all other offshore wind farm consent applications thus far. In Scotland, consideration is given that the pre-piling mitigation should be related to one strike at the max hammer energy risk. This is consistent	both SPL_{pk} and SEL_{cum} modelled for PTS for each of the marine mammal hearing groups and both are presented in the assessment following the dual metric approach as recommended by Southall *et al.* (2019). Supplementary details about impact ranges based on maximum hammer energy and maximum conversion factors will also be presented for instantaneous PTS in volume 3, appendix 10.1, annex B of the Offshore EIA Report as well as volume 3, appendix 10.5 of the Offshore EIA Report (for information only). While the Applicant is leaving the options open for UXO clearance, low order is the preferred option to use low order techniques, however, scenario of high order detonation in terms of impact and mitigation has also been assessed due to small risk of potential for unintended consequence of low order clearance to result in high order detonation of UXO.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
	conversion factor depending on which of the two dual acoustic metrics (SPL_{pk} or SEL_{cum}) resulted in the largest predicted ranges, as the 4% reducing conversion factor did not represent the most conservative output in all instances. An unweighted peak SPL was used for the hammer initiation. The Marine Mammal Mitigation Protocol (MMMP) provides mitigation zones based on largest injury range predicted across all species and pre-start monitoring with marine mammal observer and passive acoustic monitoring (PAM). The residual effects will be mitigated to reduce risks further through the use of Acoustic Deterrent Device (ADD) (modelled assuming 30 minutes of ADD activation). Initiation and soft start measures are designed in measured and not mitigation. Dose response is considered. The behavioural effects of noise are also considered following Southall *et al.* (2021). UXO (injury) considerations are: • all low order detonation, SPL_{pk}; • maximum range effect; • number of individuals affected (based on density values); • total number of UXO clearance events; Marine mammal observer, PAM and ADD are included in the MMMP. The number of UXOs will be revised pre-construction following UXO survey. Currently, the Applicant has based the assessment on the Seagreen 1 findings proportionally to the area of the Proposed Development. The number will likely be reduced as majority of the UXOs will be avoided. High order detonations are considered for 10% of all UXO clearance events and thus an UXO disposal marine licence may be required. Underwater noise modelling included a maximum charge size for low order detonation and a maximum UXO size for high order detonation, because, although low order is the preferred method, there is a small risk that it could result in high order detonation (e.g. accidental or if too unstable to attempt the low order		with the logic of the JNCC piling mitigation protocol for marine mammal observer/PAM mitigation, which aimed to ensure there were no animals present before piling commenced. This logic has now been applied to the use of acoustic deterrence pre-piling. In reality, the first strike, is at soft start levels rather than at maximum hammer energy; however, maximum hammer energy is used as the worst case. Experience elsewhere has shown the soft start was the loudest noise levels through the piling sequence. Welcomed the third party review of the technical note, still advised that it is highly uncertain which conversion factor is more appropriate based on currently available evidence. Thus, using max hammer energy (and maximum conversion factor) is precautionary, but is (or has been so far) mitigable. Key point is that it is the instantaneous risk being assessed and therefore a reducing conversion factor is not appropriate as there is only one strike being considered, rather than the entire piling sequence. Suggested that for the accumulated scenario (SEL_{cum}), it may be more appropriate to	Evidence of efficacy will be provided post-consent.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
	approach due to safety reasons). The Applicant assumed that the maximum UXO size that could be found within the Proposed Development array area/export cable corridor is up to 300 kg. 300 kg maximum charge was based on Seagreen UXO study as well as data from maximum UXO size found during clearance across projects located in the outer Firth of Forth (Seagreen and Neart na Gaoithe). Underwater noise modelling for UXO clearance has been undertaken using the methodology described in Soloway and Dahl (2014). Details regarding the injury ranges and animals with the potential to experience PTS due to UXO clearance is found in section 4.3.1.5. Vessel activity and other construction noise (injury/disturbance) considerations are SEL_{cum} (Southall *et al.*, 2019) for injury, National Marine Fisheries Service (NMFS) (2005) threshold and Southall *et al.*(2021) for disturbance, maximum range of effect for each vessel/activity type, number of individuals affected (based on the density values) and number of vessels on site at any one time (marine mammal observer and PAM where injury potential in the Vessel Code of Conduct). Geophysical surveys (injury/disturbance) considerations are SEL_{cum} or SPL_{pk} depending on source type (Southall *et al.,* 2019) for injury, NMFS (2005) threshold and Southall *et al.* (2021) for disturbance, maximum range of effect for each activity type, number of individuals affected (based on density values) and number of surveys at any one time (marine mammal observer, PAM and ADD in the MMMP). Maximum design scenario used are described in section 4.3.1.6. Precaution included within the assessment: • impulsive to non-impulsive sound; and • precautionary swim speeds.		use a decreasing conversion factor based on the pin piled Moray Firth experience (and supported by the Offshore Renewables Joint Industry Programme (ORJIP) ReCon project paper in draft). Requested to undertake the assessments on a species-by-species basis.	

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
Mitigation zone and mitigation measures	Greatest ranges predicted for injury based on 4% reducing to 0.5% conversion factor based on minke whale as it was associated with the highest injury ranges: • concurrent piling @ 4,000 kJ: 2,319 m (based on SEL_{cum} for minke whale); and • single piling @ 4,000 kJ: 1,023 m (based on SEL_{cum} for minke whale). Approach is very conservative, as adjacent piling at two locations is very unlikely to occur. Additional details in section 4.3.1.7 For each species disturbance, concurrent scenario would lead to the greatest effect. Scenarios with greatest area of effect or greatest potential overlap with sensitive habitats considered (e.g. overlaps with the coastal areas used by bottlenose dolphin east coast population). Within the Proposed Development, the dose-response curve is used from the steepest dose response for a precautionary assessment. With the use of 30 minutes of ADD, all marine mammal species (except minke whale) predicted to flee based on maximum injury ranges predicted using SPLpk with 1% conversion factor. For minke whale, without ADD, potentially one minke whale within injury zone during pilling and none with 30 min ADD based on maximum injury ranges predicted using SELcum with 4% reducing to 0.5% conversion factor (with injury range, swim speed and swim distance included). Modelled over 24 hours. 30 min of ADD was selected in an effort to minimise the ADD deployment to avoid adding extra noise. The 30 min ADD is incorporated into the modelling. UXO mitigation has used a flow-chart from Seagreen to inform mitigation procedures.	Stated that evidence indicates that animals move out of the area (and so do not suffer effects over the duration of piling). Therefore, injury ranges should account for the risk of instantaneous injury and use SPL_{pk} as a precaution. The mitigation zone is usually based on the worst outcome, which is maximum hammer SPL_{pk}. Advised to push for precaution (i.e. maximum hammer energy and maximum conversion factor from initiation). Together with the use of a 1% conversion factor, approach is likely to underestimate impact ranges. Supported comments on need for efficacy of the low order method and confirmed there will be monitoring requirements in this regard. Advised caution on overreliance on Seagreen's consented approach, which happened during a learning period. The Applicant cannot apply, necessarily, the same approach or findings, although the framework is useful. MSS and NatureScot suggested that the conversion factor can be modelled on a reducing scale in line with pin pile penetration depth. This pattern is also corroborated in	Requested to see mitigation covering more than 1 km mitigation zone for UXO clearance and confirmed support for the use of ADD. However, questioned the use of scare charges since the efficacy of scare charges found that greatest noises were coming from the scare charges and these were greater than the UXO discharge itself (Robinson et al., 2022b). In addition, there is a lack of evidence showing that they enhance protection for marine mammal purposes. The use of low noise alternatives (to high order detonation) should make scare charges redundant. Therefore, advised that scare charges should not be employed for marine mammal mitigation. However, mitigation should be designed to protect in the event of a high order detonation. Recommended to not completely remove scare charges for depths that currently restrict the use of noise abatement methods, but that they are used at charge sizes suitable for fish mortality mitigation For the mitigation ranges, requested instantaneous PTS impact ranges using the highest hammer energy for 1%, 4% and 10% constant conversion factors and accumulated PTS using a	Given the current uncertainties about the number and size of UXO present at the Proposed Development, a fully detailed assessment of UXOs will be undertaken once more information is available (e.g. numbers, size, locations of UXOs). Therefore, mitigation will be developed post-consent based on this assessment. In the situation that scare charges are not considered to be suitable, they will not be employed. At a later stage, when details about UXO sizes and specific clearance techniques to be used become available, it will be possible to provide detailed assessment and tailor the mitigation to specific UXO sizes and species to reduce the risk of injury. Therefore, prior to the commencement of UXO clearance works, a more detailed assessment will be produced as a part of the EPS licence supporting information for the UXO clearance works. Appropriate mitigation measures, based on all the information presented in the Offshore EIA Report, will be agreed with stakeholders as a

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
	Based on JNCC guidelines, a mitigation zone of 1 km radius from the detonation location will be established. Duration of ADD and soft start charges have been incorporated in the modelling. Additional mitigation proposed to reduce the potential for injury. Mitigation tailored to UXO size and high order detonation scenario. Mitigation developed is based on the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives. The Applicant proposes to operate ADD for a pre-determined length of time (time adjusted depending on the UXO size) to deter marine mammals prior to any detonation. For some UXO size there may be a need to reduce the risk of PTS over larger ranges that can be achieved using an ADD alone. Therefore, following an ADD activation period a 'soft start' will be undertaken, using a sequence of small explosive charges.	ORJIP ReCon project draft results which used pin pile measurements out with Scottish waters.	decreasing conversion factor, including 4% decreasing to 0.5% and 10% reducing to 1%. Suggested to include appropriate justification indicating which conversion factor is believed to be more realistic, which can be considered alongside the worst case conversion factor used in the assessment. Supported modelling SEL_{cum} over the entire pilling sequence using the decreasing conversion factor (i.e. 4% reducing to 0.5%) to estimate the level of risk and help understand predicted disturbance effects and population level effects for each species. Suggested that Noise Abatement Systems (NAS) could potentially be considered at this stage. Requested that predictions on instantaneous PTS impact ranges should be made using the highest conversion factor and the highest hammer energy. Advised that the Seagreen UXO noise monitoring reports should be reviewed, and updated UXO mitigation should be proposed that builds on lessons learnt to date. The monitoring at Seagreen found that the noise levels were louder than anticipated, using the Soloway and Dahl (2014) model. Although this is the	part of a UXO specific MMMP post-consent particularly with regards to emerging scientific evidence regarding the efficacy currently used techniques. The Applicant has committed to the use of low order clearance of UXOs although the marine mammal chapter (volume 2, chapter 10) will also provide an assessment for high order as a worst case. The assessment considers the use of ADD and scare charges as mitigation in the event that high order detonation could occur (in the event that low order leads to accidental high order) as a widely accepted and applied approach in the UK. Other techniques (all will be considered) will be reviewed and a determination made as to which method will provide the best service. The Applicant presented mitigation zone based on SPL_{pk} and highest conversion factor 10% constant. However, mitigation will be based on the more

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
			commonly used method to date, advised consideration is also given to other modelling methods, for example the Weston model, and the Aron, Cole and Weston model as cited by Robinson *et al.* (2022a). Advised that scare charges should not be employed for marine mammal mitigation. Scare charges can introduce significant noise into the environment (Robinson *et al.*, 2022b), but there is a lack of evidence showing that they enhance protection of marine mammal. The use of low noise alternatives (to high order detonation) should make scare charges redundant. However, mitigation should be designed to protect in the event of a high order detonation. Recommended not to have the complete removal of scare charges, for depths that currently restrict the use of noise abatement methods, but that they are used at charge sizes suitable for fish mortality mitigation. Emerging evidence on the use of the HYDRA-jet methodology suggests that clearance using this methodology may have resulted in partial detonations. Whilst low noise alternatives to high order clearance are preferred, agreed that the risk assessment should consider a	precautionary approach presented in the assessment. Results for the 10% reducing conversion factor was not considered to be representative. Further details about injury ranges for all conversion factors are provided in volume 3, appendix 10.5. ADD will be used as part of the mitigation protocol (30 min for pilling mitigation). Outstanding point of discussion on presentation of a residual (post-mitigation) number of potentially animals injured by clearance of high order UXO. As there will be a final mitigation plan developed post-submission, number of animals are not quantified at this point. No residual numbers are therefore provided in the assessment. At a later stage, when details about UXO sizes and specific clearance techniques to be used become available, it will be possible to provide detailed assessment and tailor the mitigation to specific UXO sizes and species to reduce the risk

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
			high order detonation in terms of impact and mitigation. Agreed that the use of the impulsive PTS threshold over extended distance is likely to be over precautionary given the likely change in impulse characteristics with propagation. Suggested a potential mechanism to accommodate this transition from impulsive to non-impulsive was to consider the higher frequency content as Southall *et al.* (2021) as an interim measure. Advise that full explanations are provided for how nominal numbers are determined, otherwise they are just arbitrary. Advised that to estimate the number of animals which might be subject to PTS, it would start with the actual number as predicted. This number can then be reduced for each suggested over-precaution, in order to logically predict a reduced number affected.	of injury. Therefore, prior to the commencement of UXO clearance works, a more detailed assessment will be produced as a part of the EPS licence supporting information for the UXO clearance works.
Population modelling: iPCoD	Overview of the model: • compares impacted with un-impacted population; • simulations to predicted population trajectory over time (1,000 simulations); • probability risk of a 1%, 2% and 5% decline in population; and • demographic parameters included in the model: survival rates and fertility.	Raised concerns on including harbour seal due to harbour seal population going down to extinction over time regardless of disturbance. Stated that it can have a bearing on the populations at the end of the model if there is	Agreed with harbour seal concerns and suggested to not include it. Suggested including minke whale. Stated that the up to date number for bottlenose dolphin is 224 instead of 189.	The approach suggested by the Applicant was agreed along with the inclusion of harbour seal and minke whale against their respective MUs and SCANs block as vulnerable subpopulations. A proportion of the North

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
	Limited understanding of how auditory disturbance can impact the survival and fitness of individuals. Aims to investigate how physiological changes can impact fitness and survival of populations. See section 4.3.1.8 for demographic parameters recommended for iPCoD (Sinclair *et al.,* 2020) and details on relevant populations and disturbance parameters. Focal species: • harbour porpoise; • bottlenose dolphin; and • grey seal. No demographic parameters available for white-beaked dolphin. Scenarios modelled: • concurrent piling (4,000 kJ); • OSP/Offshore convertor station platform single piling (3,000 kJ); • months in which piling occurs: 16 months plus 12 months over construction period; • total piling days: 286 days (wind turbine concurrent) plus 85 (OSP/Offshore convertor station platform single) (372 days total); • cumulative scenario (as above plus cumulative projects); and • MU populations. Pilling schedule is based on maximum duration that pilling could occur and number of piles which could be installed in one day. The model does not request details of concurrent piling but can input proportions of the day which would result in disturbance. For the model, assumed piling occurs within each 24 hours period. The Applicant looked at different scenarios and adopted the maximum scenario (i.e. concurrent scenario at turbines with 4000 kJ hammer energy) in the model. There will be a maximum of two piling events at any one time. IPCoD model and data was peer reviewed by SMRU.	a difference in the piling schedule for on/off days. Stated that harbour seals have been in decline on the east coast of Scotland for several years and numbers of animals using the Firth of Tay and Eden Estuary SAC have decreased considerably. Advised that iPCoD modelling should be undertaken for this species to better understand potential population-level impacts since this population is of conservation concern. The East Scotland Management Unit population should be used as the reference population, and demographic parameters should be taken from Sinclair *et al.* (2020). Recommended that the iPCoD modelling for harbour porpoise and minke whale use two approaches for the vulnerable population parameter: • 100% of the management unit population, and • a sub-population based on the SCANS III estimate of abundance. This can be used to derive a % of the management unit population. Using both of these numbers will provide a range of outputs, which can be used to assess the population-level impacts.	Queried whether 100% is the most appropriate value for the vulnerable population for every species or why the vulnerable population has been flagged as 100%. Advised using a proportion as well as 100% (e.g. in proportion to the SCANS III abundance) to give a range from regional to MU scale. Agreed that it may be worth for species such as harbour porpoise. Satisfied with the approach taken for iPCoD modelling for the Proposed Development alone. However, the input parameters for iPCoD will be affected by the choice of conversion factors. Unable to comment on the initial results from the iPCoD modelling at this stage.	Sea MU for harbour porpoise is considered to be affected as a vulnerable population (e.g. 50%) and the relevant population size for bottlenose dolphin applied is 224. A range of conversion factors (1% constant, 4% reducing to 0.5% and 10% reducing to 1%) was modelled and all scenarios are presented in the volume 2, chapter 10.

Topic	The Applicant Proposed Approach	MS-LOT and MSS Advice/Position	NatureScot Advice/Position	Summary of Final Position[2]
	IPCoD findings show that all populations are likely to recover following the cessation of pilling. Specifically: • harbour porpoise: The modelling (average across the area for harbour porpoise and seasonal peak) predicted no long-term decline in the population using the SCANS block as vulnerable subpopulation. • bottlenose dolphin: No long-term disturbance predicted even though reference population is small. • minke whale: Unmitigated scenario that predicted injury for one individual as well as behavioural disturbance. No decline of the population using SCANS block as vulnerable subpopulation. • grey and harbour seals: Models predicted little difference from natural variation and no long-term decline in the population.			
CEA screening	List of other developments screened in the CEA: • Methil Demo (Energy Park Fife); • Inch Cape Offshore Wind Farm; • Moray (West) (seal species scoped out); • Neart na Gaoithe; • Seagreen 1; • Seagreen 1A Project; • Seagreen 1A Export Cable Corridor; • Dogger Bank Creyke Beck A and B (bottlenose dolphins and seals species scoped out); and • Hornsea Three (bottlenose dolphins and seals species scoped out). List of other developments scoped out: • Moray (East); • Beatrice offshore wind farm; • Kincardine offshore wind farm; • Hywind Scotland; • Aberdeen Bay (European Offshore Wind Deployment Centre (EOWDC)); • Acorn Carbon capture; and	Granted that there is not much information available regarding Scotwind projects, but requested an acknowledgement of these projects in the Offshore EIA Report.	Agreed with list of cumulative projects screened in the CEA but advised to include Moray West in the list of development	The list of developments suggested by the Applicant for the CEA was agreed with Moray West scoped in and Scotwind projects included in screening but not taken forward due to lack of information.

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	• Scotwind projects.			
CEA approach	Cumulative assessment for piling considered: • projects located within the wider Firth of Forth and Tay area for harbour seal and grey seal • projects located within the CES MU for bottlenose dolphin; and • all projects located within the regional marine mammal study area for harbour porpoise and minke whale. Underwater noise from vessel use and other activities and injury due to collision with vessels are assessed in the Firth of Forth and Tay region Changes in fish and shellfish communities are assessed within the fish and shellfish study area plus a 20 km buffer (100 km buffer for underwater noise) as per volume 2, chapter 9. Developments that have a construction overlap (but no concurrent pilling) with the Proposed Development: • Cambois connection; • Seagreen 1; • Seagreen 1A Project; • Seagreen 1A Export Cable Corridor and • Inch Cape Offshore Wind Farm. Developments (more distant) that will have a construction overlap including pilling and without pilling): • Dogger Bank Teesside A/Sofia; • Hornsea Project Three; • Hornsea Project Four; • Green Volt; • Eastern Link 1; and • Eastern Link 2. The impact of pilling on all marine mammal species is considered for Seagreen 1A and Inch Cape. Dogger Bank Teesside A/Sofia, Hornsea Project Three and Hornsea Project Four are considered for harbour porpoise, white-beaked dolphin and minke whale. Green Volt is considered for harbour porpoise, bottlenose dolphin and minke whale.	No specific point raised.	Advised to include Moray West in the list of development with overlapping construction. Expected to see iPCoD used in the CEA. Advised that this is informed by the most up to date information in the public domain where possible. Satisfied with the approach proposed to distribute piling evenly over the total piling period where information on the specific piling schedule is not publicly available. Advised that for smaller MUs (e.g. bottlenose dolphin, harbour seal and grey seal), all projects within the relevant MU should be included in the CEA. However, a level of pragmatism is required for the larger MUs (e.g. minke whale and harbour porpoise). Advised that a quantitative assessment is conducted for nearby projects for which information is known, and a qualitative assessment is conducted for those projects further afield.	The approach suggested by the Applicant was agreed with the inclusion of cumulative iPCoD modelling including projects as per the CEA and Moray West was included as overlapping construction phase with the Proposed Development.

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	The iPCoD population modelling for the CEA has made the following assumptions: • all projects may be piling at same time (e.g. up to 5 offshore wind farms), conservative assumption: • estimated piling scenarios as no project-level information • assessment based on maximum design scenario for each project, hence over-precautionary: • assessment based on project design envelope in consented design for other offshore wind farms but parameters often change Without actual knowledge, the Applicant sees limited value in population modelling for the CEA and proposes not to undertake iPCoD modelling for CEA.			
Monitoring	None specified.	Stated that monitoring will be required. If there are particular areas where it is being noticed that there is a lack of evidence, then the monitoring is likely to focus there. The Applicant might be asked to contribute to strategic monitoring that aim to close data gaps or questions raised during consenting.	Expect monitoring for the UXO and pilling activities. Supported the suggestion in-field noise monitoring at 750 m from the piling location, ideally a minimum of four measurement positions at increasing distances from the piling location should be used: 750 m; 1,500 m to 3,000 m; 5,000 m to 8,000 m; and >10,000 m. This would enhance the understanding of noise characteristics from piling activities and allow more meaningful comparisons between modelled predictions and real world data. Requested noise monitoring for any UXO clearance to follow National Physical Laboratory (NPL) monitoring guidance (NPL, 2020). Additionally, noise monitoring of piling would be very useful (e.g. to further inform dose-response curves), which would build on the work carried out to date in the Moray Firth	The monitoring required by the Applicant will be discussed post-consent.

4.3.1 Additional Details on Key Discussions

4.3.1.1 Underwater noise modelling method steps:

a. The bathymetry information around the source point will be extracted from the General Bathymetric chart of the Oceans (GEBCO) database in different transects;

b. A geoacoustic model of the different sea-floor layers in the survey region will be calculated;

c. A calibrated Weston Energy model will be employed to estimate the TL matrices for different frequencies of interest (e.g. 25 Hz to 80 kHz) along the transects;

d. The source level values calculated will be combined with the TL results to achieve a frequency and range dependant received level (RL) of acoustic energy around the chosen source position;

e. The recommended marine mammal weightings will be employed and the TTS and PTS impact ranges for different marine mammal groups will be calculated using relevant metrics (from Southall *et al.*, 2019) and by employing a moving animal model;

f. For the moving animal model that employs a SEL_{cum} metric, the marine mammal is assumed to start swimming away from the piling location at a constant speed at the start of the piling and to continue moving away at the same speed throughout the piling activity;

g. Instantaneous (unweighted) peak sound pressure levels will also be calculated; and

h. Both SEL_{cum} and SPL_{pk} are presented in the Subsea Noise Technical Report (volume 3, appendix 10.1)

4.3.1.2 Assumed swim speeds for exposure modelling:

- harbour porpoise: 1.5 m/s (Otani *et al.*, 2000);
- bottlenose dolphin: 1.52 m/s (Bailey and Thompson, 2010);
- white-beaked dolphin: 1.52 m/s (Bailey and Thompson, 2010);
- minke whale: 2.3 m/s (Boisseau *et al.*, 2021); and
- seals: 1.8 m/s (Thompson, 2015).

Marine mammal swim speeds for dolphin and seal species are the same as used for Seagreen 1A Project; porpoise and minke whale updated based on more recent literature. Cumulative SEL exposure depends on swim speed, hammer strike rate/distance swam between each pulse and per pulse hearing weighted SEL at receiver location. Scenarios include consideration of slow start, soft start, ramp up and ADD – if required. That minke whale came from a study on ADD in Iceland. Otherwise, all of the speeds are literature/research based and presented and agreed during Road Map meeting based on published report by NatureScot.

4.3.1.3 Noise Threshold Levels

- low frequency cetaceans:
  - SPL_{pk} unweighted: 219 (impulsive); and
  - SEL_{cum} weighted: 183 (impulsive) and 199 (non-impulsive).
- high frequency cetaceans:
  - SPL_{pk} unweighted: 230 (impulsive); and
  - SEL_{cum} weighted: 185 (impulsive) and 198 (non-impulsive).
- Very high frequency cetaceans:
  - SPL_{pk} unweighted: 202 (impulsive); and
  - SEL_{cum} weighted: 155 (impulsive) and 173 (non-impulsive).
- Phocid carnivores in water:
  - SPL_{pk} unweighted: 218 (impulsive); and
  - SEL_{cum} weighted: 185 (impulsive) and 201 (non-impulsive).
- Other marine carnivores in water:
  - SPL_{pk} unweighted: 232 (impulsive); and
  - SEL_{cum} weighted: 203 (impulsive) and 219 (non-impulsive).

4.3.1.4 Conversion factors:

The Applicant had concerns that on 'layering of precaution' which could cause an overly conservative and unrealistic assessment. The Applicant stated that the conversion factor is based on evidence, therefore use of submersible hammer for 10% conversion factor is not applicable for the Proposed Development. In addition, the size of the pile will have an effect on the radiation efficiencies. Ideally, measurements on larger piles should be used but these are not available as this technology is not yet being used in the field (hence the need to extrapolate using a conversion factor). The Applicant has undertaken a range of underwater noise modelling and suggested that 0.5% would be a realistic conversion factor.

The use of energy conversion factor can be thought of as the way that lower energy hammer measurement data can be scaled up for larger hammer energies. For another offshore wind farm, the maximum hammer energy was assessed as 2,300 kJ however was built out with an average maximum of 1,100 kJ and an overall average of 900 kJ.

Source SEL is a theoretical construct which is useful in underwater noise modelling but it is only a theoretical construct which cannot be measured and must be calculated. Higher conversion factors from surveys are caused by higher propagation coefficients as a result of extrapolating measurement data well beyond the measurement range. Use of these higher numbers could lead to significant overprediction of the far-field sound levels. Greater emphasis should be placed on peer reviewed studies, and studies which utilise full acoustic modelling to determine the source SEL. A hammer energy conversion factor of β ≈ 1% is a precautionary value for piling based theoretical considerations. This is consistent with peer reviewed studies based on empirical measurements:

- β = 0.3% (Robinson *et al.,* 2007),
- β = 0.8% (De Jong and Ainslie, 2008) and
- β ≈ 1% (Dahl and Reinhall, 2013).

β ≈ 1% is likely to be an over-precautionary assumption that cover uncertainties and the current scientific consensus is that a more representative conversion factor is β ≈ 0.5%.

Conservatism was built into the assessment as the modelling assumed the maximum hammer energy would be reached at all locations, whereas this is unlikely to be the case. The 1% conversion factor used in the model is twice that considered the scientific consensus (0.5%). Larger piles will produce less radiated sound energy for a given hammer energy since the same force has to excite more mass elements. The soft start procedure simulated does not allow for short pauses in piling (e.g. for realignment). The modelling assessment assumed that animals swim away from the noise source at constant and conservative average speeds based on published values. This is likely to lead to overestimates of the potential range of effect where animals exceed these speeds. The use of the SEL metric assumes the same noise-induced threshold shift regardless of how the energy is distributed over time. It does not account for recovery of hearing between pulses. The model overestimates the noise exposure an animal receives since it does not account for any time that marine mammals spend at the surface and the reduced sound levels near the surface. Impulsive sounds are likely to transition into non-impulsive sounds at distance from the sound source with empirical evidence suggesting such shifts in impulsivity could occur markedly within 10 km from the source. There are other conservatisms built in throughout the assessment. The emphasis is on a precautionary approach at all stages both in the model and the assessment of effects. With other layers of precaution added in the marine mammal assessment, the overall assessment remains precautionary.

4.3.1.5 Injury ranges and animals with the potential to experience PTS due to UXO clearance

It is suggested in the EIA assessment that for UXO sizes of up to 300 kg, pre-detonation search and use of ADD will be sufficient to reduce the potential of experiencing PTS by bottlenose dolphin, white-beaked dolphin, minke whale, harbour seal and grey seal to negligible magnitude and effectively reduce the risk of injury. It has been estimated that harbour porpoises could potentially experience an auditory injury at distances that cannot be fully mitigated by application of ADD and soft start charges. It is therefore expected that small numbers of animals could be exposed to potential PTS. Given that details about UXO clearance technique to be used and charge sizes will not be available until after the consent is granted (pre-construction period, following UXO survey), it is not possible to quantify the effects of UXO detonations and therefore the residual number of animals is not presented within the assessment. At a later stage, when details about UXO sizes and specific clearance techniques to be used become available, it will be possible to provide a more detailed assessment and tailor the mitigation to specific UXO sizes and species to reduce the risk of injury. Therefore, prior to the commencement of UXO clearance works, a more detailed assessment will be produced as a part of the EPS license supporting information for the UXO clearance works. Appropriate mitigation measures will be agreed with stakeholders as a part of a UXO specific MMMP. It is therefore anticipated that following the application of mitigation measures following receipt of more detail regarding size and number of UXO, the risk of injury will be reduced to low.

4.3.1.6 Maximum design scenario

Wind turbine foundations:

- maximum hammer energy: 4,000 kJ;

- realistic maximum hammer energy: 3,000 kJ;
- number of pin piles: 1,432;
- maximum pile diameter: 5.5 m; and
- total piling phase: 14,320 hours.

OSP/Offshore convertor station platform foundations:

- maximum hammer energy: 4,000 kJ;
- realistic maximum hammer energy: 3,000 kJ;
- number of pin piles: 256;
- maximum pile diameter: 4 m;
- total piling phase: 2,048 hours

Total number of days when pilling occurs within piling phase for wind turbines and OSPs/Offshore convertor station platforms: 372 days.

4.3.1.7 Maximum injury ranges

At hammer initiation, the injury ranges are smaller. It would not be expected that an animal would experience full effects at initiation during soft start piling. The more conservative ranges are therefore based on the maximum SELs over the piling sequence. Whilst SPL_{pk} do typically provide the greatest injury range for harbour porpoise, in this case, the greater range results from the 1% conversion factor and minke whale is the greatest of all. The ranges for SPL_{pk} were based on the maximum over the entire piling sequence (i.e. from initiation to full hammer energy) and are therefore conservative in this respect. If SPL_{pk} was used at just hammer initiation, the ranges would be smaller. The assessment undertaken is precautionary as it looks at both SPL_{pk} and SEL_{cum} and takes whichever is the largest of these two. This is the dual metric approach as recommended by Southall *et al.* (2019).

4.3.1.8 IPCoD parameters:

- harbour porpoise:
  - North Sea MU;
  - relevant population: 346,601 (100% vulnerable);
  - residual disturbance: 1 day of pilling plus 0.1;
  - proportional days disturbance: 50%, 100%;
  - years: 25 years;
  - age calf/pup becomes independent: 1;
  - age at first reproduction: 5;

  - calf/pup survival: 0.8455 (0.6);
  - juvenile survival: 0.85;
  - adult survival: 0.925 (0.85-0.925);
  - fertility: 0.34 (0.958 -0.479); and
  - growth rate: 1.
- grey seal:
  - East Coast Scotland and North East England MU;
  - relevant population: 42,600 (100% vulnerable);
  - residual disturbance: 1 day of pilling plus 0.1;
  - proportional days disturbance: 50%, 100%;
  - years: 25 years;
  - age calf/pup becomes independent: 1;
  - age at first reproduction: 5;
  - calf/pup survival: 0.222;
  - juvenile survival: 0.94;
  - adult survival: 0.94
  - fertility: 0.84 and
  - growth rate: 1.01.
- bottlenose dolphin:
  - Coastal East Scotland MU;
  - relevant population: 189 (100% vulnerable);
  - residual disturbance: 1 day of pilling plus 0.1;
  - proportional days disturbance: 53.8%, 100%;
  - years: 25 years;
  - age calf/pup becomes independent: 3 (2);
  - age at first reproduction: 9;
  - calf/pup survival: 0.925 (0.9);

- juvenile survival: 0.962 (0.94);
- adult survival: 0.98 (0.9497);
- fertility: 0.24 (0.3); and
- growth rate: 1.018.

4.3.2 Summary Statement of Final Position

The approach to the assessment of effects, the CEA, noise and population modelling, as well as the parameters in the maximum design scenario and mitigation zone as presented by the Applicant in Table 4.3 were agreed by the stakeholders and maintained with regards to the following agreed points:

- five different conversion factors were explored (1% constant, 4% reducing to 0.5%, 10% reducing to 1%, 4% constant and 10% constant) with results presented in a sensitivity assessment volume 3, appendix 10.1;
- determination of the most representative and precautionary conversion factor with evidence and justification presented in a fully referenced and peer-reviewed report (volume 3, appendix 10.1);
- accumulated PTS (SEL_{cum}) over the entire piling sequence has been assessed using the decreasing conversion factor as the piling progresses;
- the assessment of injury (PTS) as a result of underwater noise during piling is based on the conversion factor resulting in the largest injury ranges for the different marine mammal hearing groups and the highest hammer energy of 4,000 kJ;
- both SPL_{pk} and SEL_{cum} have been modelled for PTS, and both are presented in the assessment that has been undertaken for each of the marine mammal hearing groups. These were modelled and presented for 1% conversion factor, 4% reducing to 0.5% and 10% reducing to 1%. Instantaneous PTS impact ranges using the highest hammer energy and following constant conversion factors 1%, 4% and 10% constant are provided for information in volume 3, appendix 10.5. However, the instantaneous injury ranges for all species are smaller than injury range for minke whale based on SEL_{cum} and 4% reducing to 0.5% conversion factor (2,319 m); and
- prior to the commencement of UXO clearance works, a more detailed assessment will be produced as a part of the EPS licence supporting information along with the choice of appropriate mitigation measures to be informed by available studies and agreed as a part of a UXO specific MMMP.

5 AREAS OF AGREEMENT AND OUTSTANDING NON-ALIGNMENT

Table 5.1 summarises the position following completion of the Marine Mammal Road Map process at the point of Application submission. This forms the basis of the EIA and HRA assessments presented within the Offshore EIA Report and RIAA for the Proposed Development.

Table 5.1: Areas of Agreement and Outstanding Non-Alignment Following Completion of the Road Map Process Marine Mammals

Area of Agreement and Outstanding Non-Alignment	Summary of Issue	Final Approach	Discussion
UXO clearance	Request for maximum design scenario for high order detonation in terms of impact and mitigation to be modelled. Scare charges should not be employed for marine mammal mitigation and therefore updated UXO mitigation required. Request to provide nominal number of animals.	• Risk of high order detonation event has been modelled. • Number of animals are not quantified until the final mitigation plan to support an EPS license post-consent is developed. No residual number are provided in the assessment.	The Applicant has prepared the Application based on the use of “scare charges” for UXO based on [previous advice/approach taken on other projects]. The Applicant is not in a position to re-model prior to Application submission (or undertake an assessment of UXO clearance without use of scare charges). The Applicant acknowledges the feedback from stakeholders, but considers the use of scare charges to be standard and effective. The Applicant and will look to further explore these points post-application or post-consent.
Conversion factors	In the 2022 Scoping Opinion, MS-LOT advised the Applicant to model a range of conversion factors (1%, 4% and 10%). The Applicant believes the conversion factors requested may not be as precautionary and robust as the approach adopted in the assessment.	• five different conversion factors were explored (1% constant, 4% reducing to 0.5%, 10% reducing to 1%, 4% constant and 10% constant); • determination of the most representative and precautionary conversion factor with evidence and justification presented; • accumulated PTS (SEL_{cum}) over the entire piling sequence has been assessed using the decreasing conversion factors as the piling progresses; and • both SPL_{pk} and SEL_{cum} have been modelled for PTS, and both are presented in the assessment that has been undertaken for each of the	Following the publication 2022 Scoping Opinion, a key topic of post-scoping discussion has been the most appropriate conversion factor to apply to the underwater noise modelling and related chapter impact assessments. At Application, all requested conversion factors within requested range have been modelled (1%, 4% and 10%) with all results provided in the Offshore EIA Report. The requested justification for the most appropriate conversion factor is also provided. A late clarification of the Scoping Advice established that instantaneous PTS impact ranges should be calculated using the highest hammer energy for 1%, 4% and 10% constant conversion factors. These were subsequently included in a technical appendix to the Marine Mammals Offshore EIA Report chapter (volume 2, chapter 10) Chapter as supplementary information. The Applicant remains confident that the approach taken forward for assessment is based on the most appropriate criteria and follows the Scoping Advice.

Area of Agreement and Outstanding Non-Alignment	Summary of Issue	Final Approach	Discussion
		marine mammal hearing groups. These were modelled and presented for 1% conversion factor, 4% reducing to 0.5% and 10% reducing to 1%. Instantaneous PTS impact ranges using the highest hammer energy and following conversion factors 1%, 4% and 10% constant are provided but the instantaneous injury ranges for all species are smaller than injury range for minke whale based on SEL_{cum} and 4% reducing to 0.5% conversion factor (2,319 m).	
Injury ranges and mitigation zone	Applicant advised that injury ranges should be based on risk of instantaneous injury and use SPL_{pk} as a precaution, with the mitigation zones based on the worst outcome, which is SPL_{pk} at max hammer	• the assessment of injury (PTS) is based on the conversion factor resulting in the largest injury ranges for the different marine mammal hearing groups and the highest hammer energy of 4,000 kJ.	The marine mammal assessment looks at both SPL_{pk} and SEL_{cum} and takes whichever is the largest of these two (dual metric approach as recommended by Southall *et al*. (2019)). The Applicant is confident that they have undertaken a more precautionary option than requested by stakeholders when considering this advice.

6 CONCLUSION

The aim of the Marine Mammal Road Map was to ensure that the final consent Application submitted provides MS-LOT and its statutory advisors with sufficient information with which to make a determination. This document has set-out the meetings, agreements and areas of outstanding discussion that have been achieved in relation to the marine mammal topic for the offshore EIA and HRA.

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