

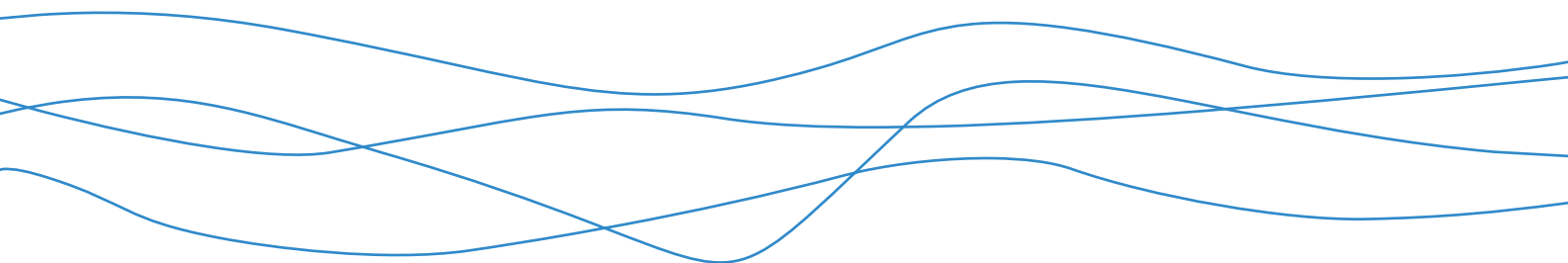


**THISTLE WIND**  
PARTNERS

# **Ayre Offshore Wind Farm Offshore EIA Report**

Volume 2, Chapter 9: Fish and Shellfish

TWP-AYR-RPS-OFE-RPT-00058 | November 2025



## Contents

|          |                                                                                              |            |
|----------|----------------------------------------------------------------------------------------------|------------|
| <b>9</b> | <b>Fish and Shellfish Ecology .....</b>                                                      | <b>1</b>   |
| 9.1      | Introduction .....                                                                           | 1          |
| 9.2      | Fish and Shellfish Ecology Study Area .....                                                  | 1          |
| 9.3      | Legislative and Policy Context.....                                                          | 3          |
| 9.4      | Consultation .....                                                                           | 11         |
| 9.5      | Data Sources .....                                                                           | 37         |
| 9.6      | Baseline Environment.....                                                                    | 41         |
| 9.7      | Key Parameters for Assessment.....                                                           | 64         |
| 9.8      | Methodology for Assessment of Effects.....                                                   | 87         |
| 9.9      | Embedded Mitigation.....                                                                     | 92         |
| 9.10     | Assessment of Significance .....                                                             | 97         |
| 9.11     | Inter-Related Effects .....                                                                  | 193        |
| 9.12     | Cumulative Effects Assessment .....                                                          | 198        |
| 9.13     | Proposed Monitoring.....                                                                     | 283        |
| 9.14     | Transboundary Effects .....                                                                  | 283        |
| 9.15     | Summary of Impacts, Mitigation, Likely Significant Environmental Effects and Monitoring..... | 283        |
|          | <b>References .....</b>                                                                      | <b>294</b> |

## List of Tables

|                                                                                                                                                                                                               |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Table 9.1: Summary of Legislation and Acts Relevant to Fish and Shellfish Ecology .....                                                                                                                       | 4   |
| Table 9.2: Summary of Scotland's National Marine Plan relevant to Fish and Shellfish Ecology (Scottish Government, 2015).....                                                                                 | 7   |
| Table 9.3: Summary of the PMFs in Scotland's Seas relevant to Fish and Shellfish Ecology (NatureScot, 2020).....                                                                                              | 9   |
| Table 9.4: Summary of the SMP for Offshore Wind Energy relevant to Fish and Shellfish Ecology (Scottish Government, 2020).....                                                                                | 9   |
| Table 9.5: Summary of the UK Marine Policy Statement relevant to Fish and Shellfish Ecology (UK Government, 2011) .....                                                                                       | 10  |
| Table 9.6: Summary of the National Planning Policy Framework 4 (Scottish Government, 2023a).....                                                                                                              | 11  |
| Table 9.7: Summary of Key Consultation Issues Raised during Consultation Activities undertaken for the Proposed Development relevant to Fish and Shellfish Ecology .....                                      | 12  |
| Table 9.8: Summary of Key Data Sources .....                                                                                                                                                                  | 37  |
| Table 9.9: Summary of Site-Specific Survey Data .....                                                                                                                                                         | 41  |
| Table 9.10: Species with Spawning and/or Nursery Grounds within the Fish and Shellfish Ecology Study Area (adapted from Coull <i>et al.</i> (1998) and Ellis <i>et al.</i> (2012), N/A = Not Applicable)..... | 46  |
| Table 9.11: Spawning Periods for Species with Spawning and/or Nursery Grounds within the Fish and Shellfish Ecology Study Area (Adapted from Coull <i>et al.</i> (1998) and Ellis <i>et al.</i> (2012)) ..... | 47  |
| Table 9.12: Designated Sites and Relevant Qualifying Features for the Fish and Shellfish Ecology Study Area.....                                                                                              | 53  |
| Table 9.13: Criteria used to define the IEFs for Fish and Shellfish Ecology .....                                                                                                                             | 56  |
| Table 9.14: IEFs Within the Fish and Shellfish Ecology Study Area.....                                                                                                                                        | 57  |
| Table 9.15: Maximum Design Scenario Considered for Each Potential Impact as Part of the Assessment of Likely Significant Environmental Effects on Fish and Shellfish Ecology .....                            | 66  |
| Table 9.16: Impacts Scoped Out of the Assessment for Fish and Shellfish Ecology (Tick Confirms the Impacts is Scoped Out) .....                                                                               | 86  |
| Table 9.17: Descriptions of Categories Related to EIA Impacts.....                                                                                                                                            | 88  |
| Table 9.18: Definition of Terms relating to Magnitude of Impact .....                                                                                                                                         | 89  |
| Table 9.19: Definition of Terms Relating to the Sensitivity of the Receptor.....                                                                                                                              | 90  |
| Table 9.20: Matrix Used for the Assessment of the Likely Significance of the Effect.....                                                                                                                      | 91  |
| Table 9.21: Definition of Likely Significance.....                                                                                                                                                            | 91  |
| Table 9.22: Embedded Mitigation Adopted as Part of the Proposed Development of Relevance to Fish and Shellfish Ecology.....                                                                                   | 93  |
| Table 9.23: Criteria for the Onset of Injury and Disturbance to Fish from Impulsive Piling (Popper <i>et al.</i> , 2014) .....                                                                                | 137 |
| Table 9.24: Criteria for the Onset of Behavioural Effects in Fish (Popper <i>et al.</i> , 2014) .....                                                                                                         | 138 |
| Table 9.25: Potential Injury and Disturbance Ranges for Single Floating Wind Turbine Anchor Pile Installation, based on the Cumulative SEL Metric for Moving Fish .....                                       | 140 |
| Table 9.26: Potential Injury and Disturbance Ranges for Single Floating Wind Turbine Anchor Pile Installation, based on the Cumulative SEL Metric for Static Fish .....                                       | 141 |
| Table 9.27: Potential Injury Ranges for Single Floating Wind Turbine Anchor Pile Installation, based on the SPL <sub>pk</sub> Metric .....                                                                    | 141 |
| Table 9.28: Potential Injury and Disturbance Ranges for Single Fixed Jacket Pile Installation, based on the Cumulative SEL Metric for Moving Fish .....                                                       | 142 |
| Table 9.29: Potential Injury and Disturbance Ranges for Single Fixed Jacket Pile Installation, based on the Cumulative SEL Metric for Static Fish .....                                                       | 143 |
| Table 9.30: Potential Injury Ranges for Single Fixed Jacket Pile Installation, based on the SPL <sub>pk</sub> Metric.....                                                                                     | 143 |
| Table 9.31: Potential Injury and Disturbance Ranges for the Realistic Scenario (Single Floating Wind Turbine Anchor Piling), based on the Cumulative SEL Metric for Moving Fish .....                         | 144 |
| Table 9.32: Potential Injury and Disturbance Ranges for the Realistic Scenario (Single Floating Wind Turbine Anchor Piling), based on the Cumulative SEL Metric for Static Fish.....                          | 145 |

|                                                                                                                                                                                                                                                                                                                                     |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Table 9.33: Potential Injury Ranges for the Realistic Scenario (Single Floating Wind Turbine Anchor Piling), based on the SPL <sub>pk</sub> Metric .....                                                                                                                                                                            | 146 |
| Table 9.34: Potential Injury and Disturbance Ranges for Concurrent Floating Wind Turbine Anchor Pile Installation, with a separation of 1.9 km, based on the Cumulative SEL Metric for Moving Fish .....                                                                                                                            | 147 |
| Table 9.35: Potential Injury and Disturbance Ranges for Concurrent Floating Wind Turbine Anchor Pile Installation, with a separation of 1.9 km, based on the Cumulative SEL Metric for Static Fish .....                                                                                                                            | 147 |
| Table 9.36: Potential Injury and Disturbance Ranges for Concurrent Fixed Jacket Pile Installation, with a separation of 1.9 km, based on the Cumulative SEL Metric for Moving Fish .....                                                                                                                                            | 148 |
| Table 9.37: Potential Injury and Disturbance Ranges for Concurrent Fixed Jacket Pile Installation, with a separation of 1.9 km, based on the Cumulative SEL Metric for Static Fish .....                                                                                                                                            | 148 |
| Table 9.38: Potential Injury and Disturbance Ranges for Concurrent Piling of the Realistic Scenario, with a separation of 1.9 km, based on the Cumulative SEL Metric for Moving Fish .....                                                                                                                                          | 149 |
| Table 9.39: Potential Injury and Disturbance Ranges for Concurrent Piling of the Realistic Scenario, with a separation of 1.9 km, based on the Cumulative SEL Metric for Static Fish .....                                                                                                                                          | 149 |
| Table 9.40: Criteria for the Onset of Injury to Fish due from Explosives (Popper <i>et al.</i> , 2014) .....                                                                                                                                                                                                                        | 160 |
| Table 9.41: Details of High and Low Order UXO Disposal Assumptions and their Relevant Charge Sizes used in the Subsea Noise Modelling .....                                                                                                                                                                                         | 161 |
| Table 9.42: Potential Impact Ranges for Low Order and Low Yield UXO Clearance Activities based on the SPL <sub>pk</sub> Metric .....                                                                                                                                                                                                | 162 |
| Table 9.43: Potential Impact Ranges for High Order UXO Clearance Activities based on the SPL <sub>pk</sub> Metric .....                                                                                                                                                                                                             | 162 |
| Table 9.44: Criteria for the Onset of Injury to Fish due to Non-Impulsive Sources (Popper <i>et al.</i> , 2014) .....                                                                                                                                                                                                               | 163 |
| Table 9.45: Estimated Recoverable Injury and TTS Ranges for Site Investigation activities for Groups 3 and 4 Fish .....                                                                                                                                                                                                             | 164 |
| Table 9.46: Estimated Recoverable Injury and TTS Ranges for Other Construction Activities for Group 3 and 4 Fish .....                                                                                                                                                                                                              | 164 |
| Table 9.47: Summary of Likely Significant Inter-Related Effects for Fish and Shellfish Ecology from Individual Effects Occurring Across the Construction, O&M and Decommissioning Phase of the Proposed Development (Project Lifetime Effects) and from Multiple Effects Interacting Across all Phases (Receptor-led Effects) ..... | 195 |
| Table 9.48: List of Other Projects Considered within the CEA for Fish and Shellfish Ecology .....                                                                                                                                                                                                                                   | 200 |
| Table 9.49: Maximum Design Scenario Considered for Each Impact as part of the Assessment of Likely Significant Cumulative Effects on Fish and Shellfish Ecology .....                                                                                                                                                               | 206 |
| Table 9.50: Cumulative Footprint of Temporary Habitat Loss and/or Disturbance for the Tier 2 Projects overlapping with the Construction Phase of the Proposed Development .....                                                                                                                                                     | 215 |
| Table 9.51: Cumulative Footprint of Temporary Habitat Loss and/or Disturbance for the Tier 2 Projects overlapping with the O&M Phase of the Proposed Development .....                                                                                                                                                              | 220 |
| Table 9.52: Cumulative Footprint of Temporary Habitat Loss and/or Disturbance for the Tier 2 Projects overlapping with the Decommissioning Phase of the Proposed Development .....                                                                                                                                                  | 224 |
| Table 9.53: Cumulative Footprint of Long Term Habitat Loss and/or Disturbance for the Tier 2 Projects Overlapping with the Construction, O&M, and Decommissioning Phases of the Proposed Development .....                                                                                                                          | 235 |
| Table 9.54: Cumulative Footprint of Introduction of Artificial Structures and Subsequent Colonisation for the Tier 2 Projects Overlapping with the Construction and O&M Phase of the Proposed Development .....                                                                                                                     | 242 |
| Table 9.55: Cumulative Footprint of Introduction of Artificial Structures and Subsequent Colonisation for the Tier 2 Projects Overlapping with the Decommissioning Phase of the Proposed Development .....                                                                                                                          | 247 |

|                                                                                                                                                        |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Table 9.56: Cumulative Subsea Noise Modelling Results for the Tier 2 Projects Overlapping with the Construction Phase of the Proposed Development..... | 259 |
| Table 9.57: Cumulative Subsea Noise Modelling Results for the Tier 2 Projects Overlapping with the O&M Phase of the Proposed Development .....         | 265 |
| Table 9.58: Cumulative Potential Sources of EMFs for the Tier 2 Projects within the O&M Phase of the Proposed Development.....                         | 275 |
| Table 9.59: Cumulative Potential Sources of Entanglement for the Tier 2 Projects within the O&M Phase of the Proposed Development.....                 | 280 |
| Table 9.60: Proposed Monitoring and the Method of Implementation for Fish and Shellfish Ecology .....                                                  | 283 |
| Table 9.61: Summary of Assessment of Significance.....                                                                                                 | 285 |
| Table 9.62: Summary of CEA.....                                                                                                                        | 290 |

## List of Figures

|                                                                                                                                                                                    |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Figure 9.1: Fish and Shellfish Ecology Study Area .....                                                                                                                            | 2   |
| Figure 9.2: Potential Herring Spawning Sediment Classification in the Fish and Shellfish Ecology Study Area .....                                                                  | 50  |
| Figure 9.3: Potential Sandeel Spawning Habitat Classification within the Fish and Shellfish Ecology Study Area .....                                                               | 51  |
| Figure 9.4: Designated Sites with Relevant Fish and Shellfish Qualifying Features.....                                                                                             | 54  |
| Figure 9.5: Modelled Subsea Noise Contours (SPL <sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations .....                                                | 154 |
| Figure 9.6: Modelled Subsea Noise Contours (SPL <sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations and Cod Spawning Grounds .....                       | 155 |
| Figure 9.7: Modelled Subsea Noise Contours (SPL <sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations and Sandeel Spawning Grounds.....                    | 156 |
| Figure 9.8: Modelled Subsea Noise Contours (SPL <sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations and Herring Larval Density and Spawning Grounds..... | 157 |
| Figure 9.9: Modelled Subsea Noise Contours (SPL <sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations and Designated Sites for Fish and Shellfish.....     | 158 |
| Figure 9.10: Other Projects Screened into the CEA for Fish and Shellfish Ecology .....                                                                                             | 204 |

## Glossary

| Defined Term                                   | Definition                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0-group fish</b>                            | Fisheries statistics term which refers to fish within their first year of life.                                                                                                                                                                                                                                                                                                               |
| <b>Allision/Contact</b>                        | Allision in shipping and navigation refers to the impact of a moving vessel with a stationary object, such as a Wind Turbine. It is distinct from a collision, which involves two moving vessels.                                                                                                                                                                                             |
| <b>Annex II</b>                                | Species of community interest whose conservation requires the designation of Special Areas of Conservation (SACs) under the Habitats Directive (Council Directive 92/43/EEC).                                                                                                                                                                                                                 |
| <b>Applicant (the)</b>                         | Ayre Offshore Wind Farm Limited (AOWFL).                                                                                                                                                                                                                                                                                                                                                      |
| <b>Appropriate Assessment (AA)</b>             | An assessment to determine the implications of a plan or project for a European site in view of that site's conservation objectives. An Appropriate Assessment forms part of the Habitats Regulations Appraisal (HRA) and is required when a plan or project (either alone or in combination with other plans or projects) is likely to have a significant adverse effect on a European site. |
| <b>Array Area</b>                              | The Array Area is the area in which the Offshore Generation Assets will be located.                                                                                                                                                                                                                                                                                                           |
| <b>Ayre Offshore Wind Farm Limited (AOWFL)</b> | A Special Purpose Vehicle (SPV) (legal entity) for the purpose of developing the Project. AOWFL are the Applicant for the Offshore Application.                                                                                                                                                                                                                                               |
| <b>Benthic</b>                                 | Living on or in the seabed.                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Cetacean</b>                                | Marine mammals that are entirely aquatic. These include whales, dolphins, and porpoises.                                                                                                                                                                                                                                                                                                      |
| <b>Collision</b>                               | The effect by which a bird, or bat, may be impacted by direct collision. Birds passing through an OWF are at risk of colliding with the Wind Turbines (moving and stationary parts).                                                                                                                                                                                                          |
| <b>Commercial fishing</b>                      | Any form of fishing activity legally undertaken where the catch is sold for taxable profit.                                                                                                                                                                                                                                                                                                   |
| <b>Cumulative effects</b>                      | The effects of the Proposed Development assessed together with effects from the Onshore Infrastructure forming the Project as well as one or more different projects on the same receptor/resource.                                                                                                                                                                                           |
| <b>Demersal fish</b>                           | Fish which live and feed on or near the seabed.                                                                                                                                                                                                                                                                                                                                               |
| <b>Diadromous fish</b>                         | Fish which move between freshwater and seawater as part of their life cycle.                                                                                                                                                                                                                                                                                                                  |
| <b>Digital Aerial Surveys (DAS)</b>            | A method for undertaking baseline ornithological and marine mammal data collection surveys. Usually undertaken over a period of 24 months.                                                                                                                                                                                                                                                    |
| <b>Dynamic cable</b>                           | A section of suspended cable between the floating infrastructure and the seabed.                                                                                                                                                                                                                                                                                                              |

| Defined Term                                                         | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Effect</b>                                                        | Term used to express the consequence of an impact i.e. the result of change or changes on specific environmental resources or receptors. The significance of an effect is determined by correlating the magnitude of the impact with the importance, or sensitivity of the receptor or resource in accordance with defined significance criteria.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Embedded mitigation</b>                                           | Measures that are adopted as part of the Proposed Development and therefore assessed within the EIA. The proposed approach for the EIA for the Proposed Development is that Embedded Mitigation includes both primary mitigation and tertiary mitigation. These are defined by the ISEP as follows:<br>Primary: Modifications to the location or design of the development made during the pre-application phase that are an inherent part of the project, and do not require additional action to be taken.<br>Tertiary: Actions that would occur with or without input from the EIA feeding into the design process. These include actions that will be undertaken to meet other existing legislative requirements, or actions that are considered to be standard practices used to manage commonly occurring environmental effects. |
| <b>Environmental Impact Assessment (EIA)</b>                         | Assessment of the potential likely significant effects of the Proposed Development on the physical, biological, and human environment during construction, Operations and Maintenance (O&M) and decommissioning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Environmental Impact Assessment Regulations (EIA Regulations)</b> | Terminology used in the Offshore EIA Report to refer to three sets of regulations:<br><ul style="list-style-type: none"> <li>• The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017;</li> <li>• The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017; and</li> <li>• The Marine Works (Environmental Impact Assessment) Regulations 2007.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>European Sites</b>                                                | This term recognises Special Protection Areas (SPAs) and SACs which protect species and habitats shared across Europe and were originally designated under European legislation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Export Cable Corridor</b>                                         | The area seaward of Mean High Water Springs (MHWS), which connects the Array Area with the Landfall area within which the Offshore Export Cables will be installed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Habitats Regulations</b>                                          | A term that refers to the collective legislation that translates the Habitats Directive into specific legal obligations in Scotland, namely: the Conservation (Natural Habitats, &c.) Regulations 1994; the Conservation of Habitats and Species Regulations 2017; and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (in each case as amended).                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Habitats Regulations Appraisal (HRA)</b>                          | An assessment carried out under the Habitats Regulations to determine if a plan or project could adversely affect the integrity of a European site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |



| Defined Term                                                              | Definition                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>High Voltage Alternating Current (HVAC)</b>                            | A system of power transmission and distribution that utilises alternating current at voltages typically exceeding 1000 volts, as defined by the International Electrotechnical Commission (2015). HVAC systems are designed to efficiently deliver electricity over long distances with minimal losses, leveraging transformers to modify voltage levels.                            |
| <b>Impact</b>                                                             | A change caused by an action that occurs during a project's lifetime.                                                                                                                                                                                                                                                                                                                |
| <b>Important Ecological Feature (IEF)</b>                                 | Habitats, species and ecosystems (including ecosystem function and processes) that may be affected by the Proposed Development, with reference to a geographical context in which they are considered important.                                                                                                                                                                     |
| <b>Impulsive sound</b>                                                    | Sound which is broadband, very brief with a high rise time and high peak level compared to the energy averaged sound level.                                                                                                                                                                                                                                                          |
| <b>Infauna</b>                                                            | Organisms living within the seabed sediment.                                                                                                                                                                                                                                                                                                                                         |
| <b>Inter-Array Cables (IAC)</b>                                           | Cables which link the Wind Turbines to each other and with the Offshore Substation Platforms (OSPs).                                                                                                                                                                                                                                                                                 |
| <b>Inter-related effects</b>                                              | The potential effects of multiple impacts from the construction, O&M and decommissioning of the Project, affecting one receptor.                                                                                                                                                                                                                                                     |
| <b>Interconnector Cables</b>                                              | Cables which will connect individual OSPs to each other to provide redundancy against cable failure elsewhere.                                                                                                                                                                                                                                                                       |
| <b>Intertidal area</b>                                                    | The area between MHWS and Mean Low Water Springs (MLWS).                                                                                                                                                                                                                                                                                                                             |
| <b>Invasive Non-Native Species (INNS)</b>                                 | Non-native plants or animals that successfully establish themselves in aquatic and fringing habitats and damage natural flora and fauna.                                                                                                                                                                                                                                             |
| <b>Landfall</b>                                                           | The area in which the Offshore Export Cables make landfall and is also the transitional area between the Offshore Transmission Assets and the Onshore Transmission Assets. Located in the intertidal area (see definition above) at Sinclair's Bay.                                                                                                                                  |
| <b>Marine Directorate (MD)</b>                                            | The Marine Directorate of the Scottish Government, formerly known as Marine Scotland. The planning and licensing authority for Scotland's seas and custodian of Scotland's National Marine Plan (NMP). The Marine Directorate - Licensing and Operations Team (MD-LOT) are specifically responsible for managing Section 36 Consent and Marine Licence Applications seaward of MHWS. |
| <b>Marine Directorate – Science, Evidence, Data and Digital (MD-SEDD)</b> | The scientific division of the MD, which provides expert scientific, economic and technical advice and services on issues relating to marine fisheries, aquaculture, marine renewable energy, and the aquatic environment and its flora and fauna.                                                                                                                                   |



| Defined Term                                                                                    | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Marine Licence</b>                                                                           | A Marine Licence permits the undertaking of different activities in the marine environment, including construction, the deposition or removal of substances or objects, and dredging. The Marine (Scotland) Act 2010 requires Marine Licences to be obtained for licensable activities taking place within Scottish Territorial Waters (MHWS to 12 nm). The Marine and Coastal Access Act (MCAA) 2009 requires a Marine Licence to be obtained for licensable marine activities within the Scottish offshore region (12 nm – 200 nm). |
| <b>Marine Protected Areas (MPAs)</b>                                                            | MPAs are designated under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act (MCAA) 2009. The MPA network protects nationally and internationally important marine wildlife, habitats, geology, and underwater landforms. Scotland's MPAs are significantly important for European, North-East Atlantic, and global MPA networks.                                                                                                                                                                                   |
| <b>Maximum Design Scenario (MDS)</b>                                                            | The scenario within the design envelope likely to result in the greatest impact on a particular topic receptor, and therefore the one that should be assessed for that topic receptor.                                                                                                                                                                                                                                                                                                                                                |
| <b>Mean High Water Springs (MHWS)</b>                                                           | The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Mean Low Water Springs (MLWS)</b>                                                            | The average tidal height throughout the year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest.                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Mitigation</b>                                                                               | Measures to avoid, prevent, reduce or control effects on the environment. See also definitions for Embedded Mitigation and Additional Mitigation.                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Non-impulsive (or continuous) sound</b>                                                      | Sound which is either continuous or intermittent but without the characteristics described above for impulsive sound.                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Offshore Application</b>                                                                     | Term used to refer to the applications associated with the Proposed Development. The Applicant will apply for: <ul style="list-style-type: none"> <li>• A Section 36 Consent under the Electricity Act 1989; and</li> <li>• Marine Licence(s) under Marine Scotland Act 2010 and Marine and Coastal Access Act 2009.</li> </ul>                                                                                                                                                                                                       |
| <b>Offshore Environmental Impact Assessment (EIA) Report (hereafter, 'Offshore EIA Report')</b> | Document prepared to report the findings of the EIA for the Proposed Development and produced in accordance with the EIA Regulations. An Offshore EIA will be submitted to support the Offshore Application for the Proposed Development.                                                                                                                                                                                                                                                                                             |
| <b>Offshore Export Cable</b>                                                                    | Subsea cables used to transmit electricity generated offshore by the Wind Turbines from the OSPs to shore. The Transition Joint Bay (TJB) is the location where the Offshore Export Cable terminates, and the onshore cabling begins.                                                                                                                                                                                                                                                                                                 |
| <b>Offshore Generation Assets</b>                                                               | The infrastructure of the Proposed Development required to generate electricity comprising of the Wind Turbines, Wind Turbine foundations and associated infrastructure e.g. IACs.                                                                                                                                                                                                                                                                                                                                                    |
| <b>Offshore Infrastructure</b>                                                                  | All of the Onshore Infrastructure associated with the Project that is located landward of MLWS.                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Defined Term                                  | Definition                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Offshore Scoping Report</b>                | The Report that presents the findings of the EIA scoping process undertaken for the Proposed Development with the purpose of obtaining a Scoping Opinion. The Report defines what is intended to be assessed and reported as part of the EIA.                                                                                                                                                                  |
| <b>Offshore Substation Platform(s) (OSPs)</b> | OSPs comprise the support structure, topside and electrical components used for collecting and/or converting electricity generated by the Wind Turbines for transmission by the Offshore Export Cables.                                                                                                                                                                                                        |
| <b>Offshore Transmission Assets</b>           | The infrastructure of the Proposed Development required to transmit the generated electricity comprising of the OSPs, Offshore Export Cables and associated infrastructure up to MHWS.                                                                                                                                                                                                                         |
| <b>Operation and Maintenance (O&amp;M)</b>    | The phase of the Proposed Development following completion of construction. This phase of development includes routine inspections, repairs and replacement of infrastructure and equipment (including interconnector and IACs), scour protection replenishment or replacement, major component replacement, painting and/or other coating works, removal of marine growth, and replacement of access ladders. |
| <b>Oslo-Paris [Convention] (OSPAR)</b>        | A Convention for the Protection of the Marine Environment of the North-East Atlantic.                                                                                                                                                                                                                                                                                                                          |
| <b>Particle motion</b>                        | Component of the pressure wave comprising the movement of particles within the water or sediment relative to an equilibrium point.                                                                                                                                                                                                                                                                             |
| <b>Pelagic fish</b>                           | Fish which live within the water column, not on or near the seabed or at the coasts.                                                                                                                                                                                                                                                                                                                           |
| <b>Physical processes</b>                     | The collective term for the following: hydrodynamics (water levels and currents); winds and waves; stratification and frontal systems; geology and seabed sediments (including sediment transport); seabed geomorphology; and coastal geomorphology.                                                                                                                                                           |
| <b>Piling</b>                                 | The action of installing piles: installation can use various methodologies, the most common of which are impact piling (in which the piles are struck by a “hammer”) and drilling (during which a hole is drilled into the seafloor, the drilling tool is removed, and the pile is slotted into that hole).                                                                                                    |
| <b>Plan Option Area (POA)</b>                 | A location identified in the SMP as a preferred area for commercial scale offshore wind development.                                                                                                                                                                                                                                                                                                           |
| <b>Project (the)</b>                          | An overarching term for the Ayre Offshore Wind Farm comprising the offshore and onshore infrastructure required to generate and transmit electricity from the Array Area to the onshore Grid Connection Point. The Project includes the Offshore Generation Assets, the Offshore Transmission Assets and the Onshore Infrastructure.                                                                           |
| <b>Project Design Envelope (PDE)</b>          | A description of the range of possible elements that make up the design options for the Proposed Development under consideration when the exact engineering parameters are not yet known.                                                                                                                                                                                                                      |

| Defined Term                                          | Definition                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Proposed Development</b>                           | Term used to define the Offshore Infrastructure associated with the Project seaward of MHWS for which consent is being sought. Further details of the parameters are included in Volume 1, Chapter 3: Project Description.                                                                                                                                                                   |
| <b>Qualifying Features</b>                            | The features for which a European site has been officially designated to protect.                                                                                                                                                                                                                                                                                                            |
| <b>Report to Inform Appropriate Assessment (RIAA)</b> | The RIAA provides detailed information to support the process of Appropriate Assessment (undertaken by the competent authority) as part of the HRA, which evaluates the potential impacts of a project or plan on European sites.                                                                                                                                                            |
| <b>Scoping Opinion</b>                                | A document produced by MD-LOT which is issued in response to submission and review of the scoping report. The scoping opinion is supported with feedback and advice from consultees, which details what is expected to be included in the Offshore EIA Report and what can be scoped out of the EIA process.                                                                                 |
| <b>Scoping Workshop</b>                               | A series of sessions preceding the finalisation of the Offshore Scoping Report to provide an opportunity for the Applicant to consult on the draft scope and for stakeholders to request additional information on key issues.                                                                                                                                                               |
| <b>Scottish Ministers (the)</b>                       | The decision makers with regard to Marine Licence(s) and Section 36 Consent applications in Scottish Offshore Waters and Scottish Marine Area.                                                                                                                                                                                                                                               |
| <b>Scour protection</b>                               | Protective materials installed to avoid sediment being eroded away from the base of the foundations and/or buried subsea cable due to the flow of water.                                                                                                                                                                                                                                     |
| <b>Significance</b>                                   | Effect factor that is determined by the magnitude of impact along with the sensitivity of the receptor.                                                                                                                                                                                                                                                                                      |
| <b>Site Boundary</b>                                  | The boundary within which all elements of the Proposed Development will be located. The Site Boundary comprises the Array Area and Export Cable Corridor which ends at MHWS.                                                                                                                                                                                                                 |
| <b>Special Areas of Conservation (SACs)</b>           | SACs are areas designated for the conservation of certain plant and animal species listed in the Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.                                                                                                                                                                                                    |
| <b>Spring Tidal Excursion</b>                         | The distance suspended sediment is transported prior to being carried back on the returning tide.                                                                                                                                                                                                                                                                                            |
| <b>Statutory Nature Conservation Body (SNCB)</b>      | A statutory adviser to the UK and Scottish Governments on Scottish, UK and international nature conservation.                                                                                                                                                                                                                                                                                |
| <b>Study area</b>                                     | For each environmental topic, the baseline environment will be characterised, and the potential environmental impacts will be described within a topic-specific study area. Specific study areas are defined for each topic and are based on the maximum spatial extent across which potential impacts of the Project may be experienced by the relevant receptors (i.e. Zone of Influence). |
| <b>Subsea noise</b>                                   | Noise which propagates underwater.                                                                                                                                                                                                                                                                                                                                                           |

| Defined Term                       | Definition                                                                                                                                |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Subtidal</b>                    | Areas of the coastal marine environment that lie below the level of MLWS and are continuously submerged by seawater.                      |
| <b>Thistle Wind Partners (TWP)</b> | The Joint Venture (JV) of DEME Group, Qair, and Aspiravi as the energy companies that have partnered to develop the Proposed Development. |
| <b>Tidal Ellipse</b>               | The illustration of the variance of tidal currents in horizontal space.                                                                   |
| <b>Wind Turbines</b>               | Structures comprising of a tubular tower, rotor blades, and a nacelle which houses the Wind Turbine generator.                            |

## Acronyms

| Acronym        | Definition                                                                      |
|----------------|---------------------------------------------------------------------------------|
| <b>2D</b>      | Two Dimensional                                                                 |
| <b>AC/DC</b>   | Alternating Current/Direct Current                                              |
| <b>ADD</b>     | Acoustic Deterrent Device                                                       |
| <b>ASA</b>     | Acoustical Society of America                                                   |
| <b>AtoN</b>    | Aid to Navigation                                                               |
| <b>AUV</b>     | Autonomous Underwater Vehicle                                                   |
| <b>BEIS</b>    | Department for Business Energy and Industrial Strategy                          |
| <b>BOEM</b>    | Bureau of Ocean Energy Management                                               |
| <b>CaP</b>     | Cable Plan                                                                      |
| <b>CBA</b>     | Cable Burial Assessment                                                         |
| <b>CBRA</b>    | Cable Burial Risk Assessment                                                    |
| <b>CEA</b>     | Cumulative Effects Assessment                                                   |
| <b>CEFAS</b>   | Centre for Environment, Fisheries, and Aquaculture Science                      |
| <b>CIEEM</b>   | Chartered Institute for Ecology and Environmental Management                    |
| <b>CITES</b>   | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| <b>CMACS</b>   | Centre for Marine and Coastal Sciences                                          |
| <b>CMS</b>     | Construction Method Statement                                                   |
| <b>CoCP</b>    | Code of Construction Practice                                                   |
| <b>COLREGs</b> | 1972 Collision Regulations                                                      |
| <b>CSIP</b>    | Cable Specification and Installation Plan                                       |
| <b>CTV</b>     | Crew Transfer Vessels                                                           |
| <b>DAS</b>     | Digital Aerial Surveys                                                          |
| <b>DDC</b>     | Drop Down Camera                                                                |
| <b>DSLIP</b>   | Development Specification and Layout Plan                                       |
| <b>DSFB</b>    | District Salmon Fishery Board                                                   |
| <b>EcIA</b>    | Ecological Impact Assessment                                                    |
| <b>eDNA</b>    | Environmental Deoxyribonucleic Acid                                             |
| <b>EEA</b>     | European Economic Area                                                          |
| <b>EIA</b>     | Environmental Impact Assessment                                                 |
| <b>EMF</b>     | Electromagnetic Field                                                           |
| <b>EMODNet</b> | European Marine Observation and Data Network                                    |
| <b>EMP</b>     | Environmental Management Plan                                                   |
| <b>EPS</b>     | European Protected Species                                                      |
| <b>FeAST</b>   | Feature Activity Sensitivity Tool                                               |

| <b>Acronym</b> | <b>Definition</b>                                                                        |
|----------------|------------------------------------------------------------------------------------------|
| <b>FMS</b>     | Fisheries Management Scotland                                                            |
| <b>GES</b>     | Good Environmental Status                                                                |
| <b>HDD</b>     | Horizontal Directional Drilling                                                          |
| <b>HSE</b>     | Health and Safety Executive                                                              |
| <b>HVAC</b>    | High Voltage Alternating Current                                                         |
| <b>HVDC</b>    | High Voltage Direct Current                                                              |
| <b>IAC</b>     | Inter Array Cable                                                                        |
| <b>IALA</b>    | International Association of Marine Aids to Navigation and Lighthouse Authorities        |
| <b>IBTS</b>    | International Bottom Trawl Survey                                                        |
| <b>ICES</b>    | International Council for the Exploration of the Seas                                    |
| <b>IEF</b>     | Important Ecological Feature                                                             |
| <b>IHLS</b>    | International Herring Larvae Survey                                                      |
| <b>IMO</b>     | International Maritime Organisation                                                      |
| <b>INNS</b>    | Invasive Non-Native Species                                                              |
| <b>ITOPF</b>   | International Tanker Owners Pollution Federation Limited                                 |
| <b>IUCN</b>    | International Union for the Conservation of Nature                                       |
| <b>JNCC</b>    | Joint Nature Conservation Committee                                                      |
| <b>LMP</b>     | Lighting and Marking Plan                                                                |
| <b>MarESA</b>  | Marine Evidence Based Sensitivity Assessment                                             |
| <b>MarLIN</b>  | Marine Life Information Network                                                          |
| <b>MARPOL</b>  | ‘Marine Pollution’ - International Convention for the Prevention of pollution from Ships |
| <b>MBA</b>     | Marine Biological Association                                                            |
| <b>MBES</b>    | Multibeam Echosounder                                                                    |
| <b>MCA</b>     | Maritime and Coastguard Agency                                                           |
| <b>MCAA</b>    | Marine and Coastal Access Act                                                            |
| <b>MCZ</b>     | Marine Conservation Zone                                                                 |
| <b>MDS</b>     | Maximum Design Scenario                                                                  |
| <b>MD-LOT</b>  | Marine Directorate-Licensing Operations Team                                             |
| <b>MD-SEDD</b> | Marine Directorate – Science, Evidence, Data and Digital                                 |
| <b>MFE</b>     | Mass Flow Excavation                                                                     |
| <b>MGN</b>     | Marine Guidance Note                                                                     |
| <b>MHWS</b>    | Mean High Water Springs                                                                  |
| <b>MLWS</b>    | Mean Low Water Springs                                                                   |
| <b>MMO</b>     | Marine Management Organisation                                                           |
| <b>MMO</b>     | Marine Mammal Observer                                                                   |
| <b>MPA</b>     | Marine Protected Area                                                                    |

| <b>Acronym</b> | <b>Definition</b>                                                       |
|----------------|-------------------------------------------------------------------------|
| <b>MPCP</b>    | Marine Pollution Contingency Plan                                       |
| <b>MSS</b>     | Marine Scotland Science                                                 |
| <b>N/A</b>     | Not Applicable                                                          |
| <b>NBN</b>     | National Biodiversity Network                                           |
| <b>N/E</b>     | Not Exceeded                                                            |
| <b>NEQ</b>     | Net Explosive Quantity                                                  |
| <b>NLB</b>     | Northern Lighthouse Board                                               |
| <b>NSP</b>     | Navigation Safety Plan                                                  |
| <b>NSTA</b>    | North Sea Transition Authority                                          |
| <b>OEHHA</b>   | Office of Environmental Health Hazard Assessment                        |
| <b>OMP</b>     | O&M Programme                                                           |
| <b>OSP</b>     | Offshore Substation Platform                                            |
| <b>OSPAR</b>   | Oslo Paris [Convention]                                                 |
| <b>OWF</b>     | Offshore Wind Farm                                                      |
| <b>O&amp;M</b> | Operation and Maintenance                                               |
| <b>PDE</b>     | Project Design Envelope                                                 |
| <b>PEMP</b>    | Project Environmental Monitoring Programme                              |
| <b>PMF</b>     | Priority Marine Feature                                                 |
| <b>POA</b>     | Plan Option Area                                                        |
| <b>PSA</b>     | Particle Size Analysis                                                  |
| <b>RAMS</b>    | Risk Assessment Method Statements                                       |
| <b>RIAA</b>    | Report to Inform Appropriate Assessment                                 |
| <b>rms</b>     | Root Mean Square                                                        |
| <b>SAC</b>     | Special Area of Conservation                                            |
| <b>SBL</b>     | Scottish Biodiversity List                                              |
| <b>SBP</b>     | Sub-bottom Profiler                                                     |
| <b>ScotMER</b> | Scottish Marine Energy Research                                         |
| <b>SC</b>      | Subsea Collector                                                        |
| <b>SEER</b>    | United States Offshore Wind Synthesis of Environmental Effects Research |
| <b>SEL</b>     | Sound Exposure Level                                                    |
| <b>SFF</b>     | Scottish Fishing Federation                                             |
| <b>SF6</b>     | Sulphur Hexafluoride                                                    |
| <b>SMP</b>     | Sectoral Marine Plan                                                    |
| <b>SNCBs</b>   | Statutory Nature Conservation Bodies                                    |
| <b>SOLAS</b>   | International Convention for the Safety of Life at Sea                  |
| <b>SPI</b>     | Species of Principal Importance                                         |



| <b>Acronym</b>          | <b>Definition</b>                                       |
|-------------------------|---------------------------------------------------------|
| <b>SPL</b>              | Sound Pressure Level                                    |
| <b>SPL<sub>pk</sub></b> | Peak Sound Pressure Level                               |
| <b>SSC</b>              | Suspended Sediment Concentration                        |
| <b>SSE</b>              | Scottish South and Southern Electricity Networks        |
| <b>SSENT</b>            | Scottish and Southern Electricity Networks Transmission |
| <b>SSS</b>              | Side-scan Sonar                                         |
| <b>TLP</b>              | Tension Leg Platform                                    |
| <b>TWP</b>              | Thistle Wind Partners                                   |
| <b>UHRs</b>             | Ultra High-Resolution Seismic                           |
| <b>UK</b>               | United Kingdom                                          |
| <b>USA</b>              | United States of America                                |
| <b>USV</b>              | Uncrewed Surface Vehicle                                |
| <b>UXO</b>              | Unexploded Ordnance                                     |
| <b>VHF</b>              | Very High Frequency                                     |
| <b>VMP</b>              | Vessel Management Plan                                  |
| <b>WSDOT</b>            | Washington State Department of Transport                |
| <b>WW2</b>              | World War Two                                           |
| <b>ZoI</b>              | Zone of Influence                                       |

## Table of Units

| Units             | Definition                      |
|-------------------|---------------------------------|
| %                 | Percent                         |
| °C                | Degree Celsius                  |
| cm                | Centimetre                      |
| dB                | Decibel                         |
| g/l               | Grams per litre                 |
| gauss             | Gauss (magnetic induction)      |
| ha                | Hectare                         |
| Hz                | Hertz                           |
| kg/m <sup>3</sup> | Kilograms per cubic metre       |
| kg/s              | Kilograms per second            |
| kHz               | Kilohertz                       |
| kJ                | Kilojoule                       |
| km                | Kilometre                       |
| km <sup>2</sup>   | Square kilometre                |
| kV                | Kilovolt                        |
| m                 | Metre                           |
| mG                | Milligauss                      |
| mg/l              | Milligrams per litre            |
| m <sup>2</sup>    | Square Metre                    |
| m <sup>3</sup>    | Cubic metres                    |
| mT                | MilliTesla                      |
| mV/m              | Millivolt per metre             |
| MW                | Megawatt                        |
| nm                | Nautical mile                   |
| V/m               | Volts per metre                 |
| μPa               | Micropascal                     |
| μT                | MicroTesla (10 <sup>-6</sup> T) |
| μV/cm             | MicroVolt per centimetre        |
| μV/m              | MicroVolt per metre             |

## **9 Fish and Shellfish Ecology**

### **9.1 Introduction**

9.1.1 This chapter of the Offshore Environmental Impact Assessment (EIA) Report presents the assessment of the likely significant effects on fish and shellfish ecology that may potentially occur as a result of the Proposed Development during the construction, Operations and Maintenance (O&M) and decommissioning phases.

9.1.2 The assessment presented is informed by the following technical chapters and reports:

- Volume 2, Chapter 7: Physical Processes;
- Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report; and
- Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report.

### **9.2 Fish and Shellfish Ecology Study Area**

9.2.1 The study area for fish and shellfish ecology is shown in Figure 9.1 and is defined as a 100 km buffer around the Array Area and Export Cable Corridor and includes the Moray Firth. As illustrated in Figure 9.1, landmasses have been excluded from this area. However, as diadromous fish migrate between the marine environment and freshwater habitats, it should be noted that the Fish and Shellfish Ecology Study Area also includes rivers and other freshwater habitats flowing into it to account for the life histories of diadromous species. Any freshwater-resident fish species within the rivers and freshwater habitats along the coast of the Fish and Shellfish Ecology Study Area are, however, outwith the scope of this assessment.

9.2.2 The Fish and Shellfish Ecology Study Area was presented to, and agreed with, Statutory Nature Conservation Bodies (SNCBs) during Scoping (Marine Directorate – Licensing Operations Team (MD-LOT, 2024)) and has been defined to fully encompass the large spatial and temporal variability of most fish and shellfish species. The defined Fish and Shellfish Ecology Study Area is therefore large enough to consider the Zone of Influence (Zoi) of all direct and indirect impacts associated with the Proposed Development, including impacts from subsea noise, and is an adequate size to characterise the baseline. The Fish and Shellfish Ecology Study Area encompasses the area surveyed during site-specific benthic subtidal and intertidal surveys and Digital Aerial Surveys (DAS) for birds and marine mammals. Where relevant to fish and shellfish, the results of these surveys have been incorporated into the baseline characterisation (see Section 9.5 and Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report).

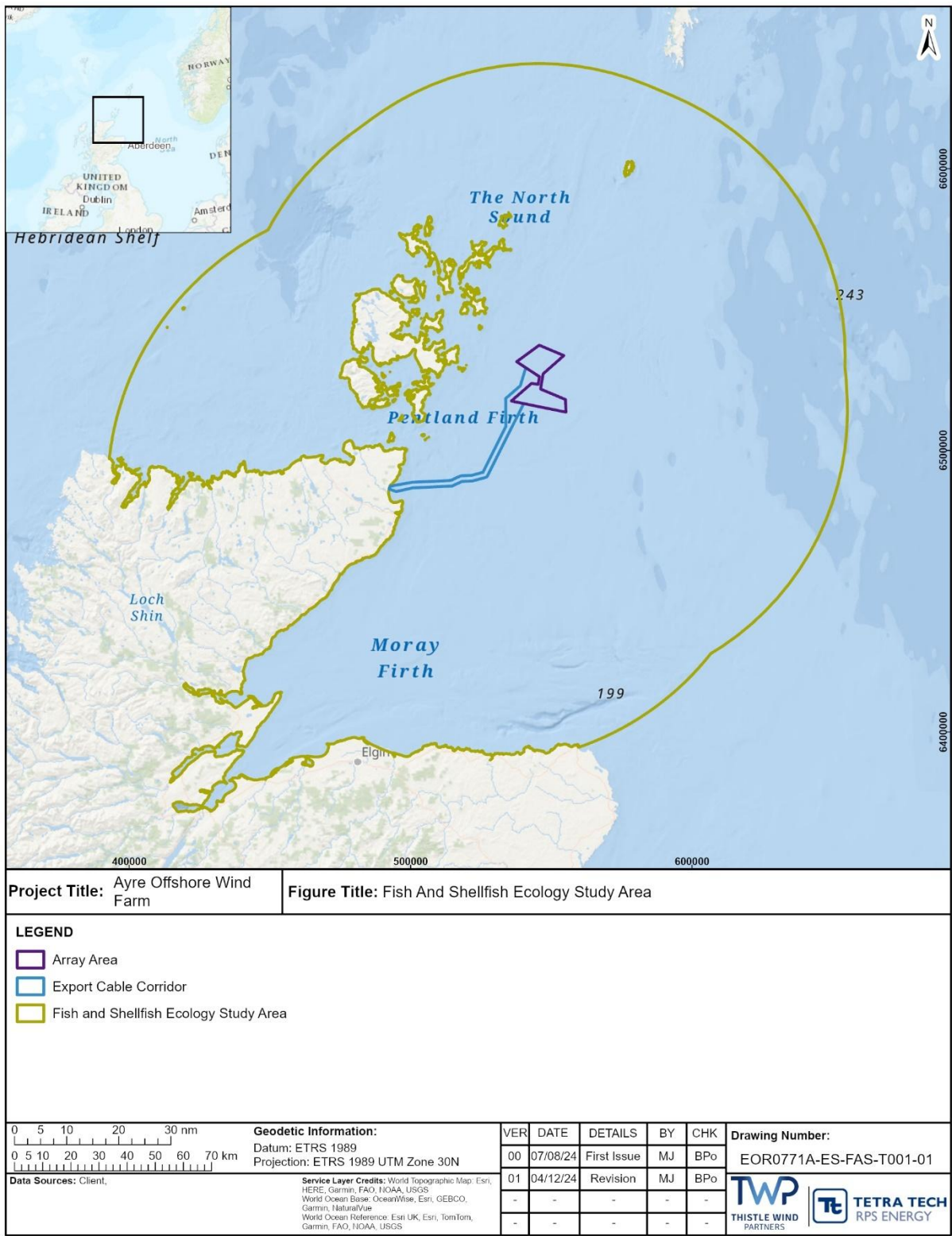


Figure 9.1: Fish and Shellfish Ecology Study Area

## **9.3 Legislative and Policy Context**

- 9.3.1 The overarching policy and legislation applicable to the Proposed Development is presented in Volume 1, Chapter 2: Policy and Legislation. Policy and legislation specific to fish and shellfish ecology is contained in the Marine and Coastal Access Act (MCAA) 2009, the Habitats Regulations, Scotland's National Marine Plan, the Sectoral Marine Plan (SMP) and the United Kingdom (UK) Marine Policy Statement. A summary of the legislative provisions and policy relevant to fish and shellfish ecology are provided in Table 9.1 to Table 9.6.

**Table 9.1: Summary of Legislation and Acts Relevant to Fish and Shellfish Ecology**

| Summary of relevant legislation or Act                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | How and where considered in the EIA Report                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>MCAA 2009</b><br/>MPAs (Scottish waters) and MCZs (English waters) existing beyond the 12 nm limit are designated under the MCAA 2009. MPAs and MCZs are areas that have been designated for the purpose of conserving marine flora and fauna, marine habitats, and features of geological or geomorphological interest (Section 117 of the MCAA 2009).</p>                                                                                                                                                                                                      | <p>All relevant MPAs in Scottish offshore waters (beyond 12 nm) are listed in Section 9.6, and further described in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report and potential effects on the relevant qualifying features of these are considered in Section 9.10. No MCZs designated for fish and shellfish features were identified in the Fish and Shellfish Ecology Study Area.</p>                                                                                                                                                                                |
| <p><b>Habitats Regulations</b><br/>Before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which is likely to have a significant effect on a European offshore marine site or a European site (either alone or in combination with other plans or projects), and is not directly connected with or necessary to the management of the site, a competent authority must make an appropriate assessment of the implications of the plan or project for that site in view of that site's conservation objectives.</p> | <p>All relevant designated sites are listed in Section 9.6, along with their proximity to the Site Boundary, and potential effects on the relevant qualifying features of these are considered in Section 9.10. In addition, Section 9.12 also considers impacts upon relevant qualifying features of these designated sites from other plans and projects cumulatively with the Proposed Development. Adverse effects on integrity of European sites with Annex II diadromous fish features have been assessed in accordance with the Habitats Regulations in the RIAA (TWP-AYR-RPS-ENV-RPT-00019).</p> |
| <p><b>The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention; 1979)</b><br/>The principal aims of the Convention are to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention).</p>                                                                                                                                                                                                                                               | <p>These acts and conventions have been used to determine IEF status for fish and shellfish ecology. Fish and shellfish species listed under these laws and conventions have been assigned as international or national importance depending on the different legislation that applies to them (see Table 9.13 and Table 9.14).</p>                                                                                                                                                                                                                                                                      |
| <p><b>The Wildlife and Countryside Act 1981 (as amended)</b><br/>The Wildlife and Countryside Act 1981 was enacted primarily to implement the Birds Directive and Bern Convention in Great Britain.</p>                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p><b>The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention 1992)</b><br/>The Convention for the Protection of the Marine Environment of the North East Atlantic was adopted in Paris, France in September 1992 and entered into force in March 1998. With the adoption of Annex V in 1998, the convention embraced a more holistic responsibility for environmental protection in the region, including its biodiversity.</p>                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| Summary of relevant legislation or Act                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | How and where considered in the EIA Report                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>The Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention 1979)</b><br/>This convention was adopted in Bonn, Germany, on 23 June 1979, and entered into force on 1 November 1983. The Bonn Convention brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.</p>                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><b>Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003</b><br/>This Act is the key governing legislation for Scotland's district salmon fishery boards, and it sets out the provisions for the constitution, composition and financing of the boards. It is also the framework for a number of other important regulatory areas, including legal methods of fishing and offences, close times, local regulatory measures, protection of juvenile and spawning salmon, passage of salmon, and general powers relating to appointment of water bailiffs and enforcement of salmon and freshwater fisheries law.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><b>The International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) 2004</b><br/>This is an international maritime treaty which requires signatory flag states to ensure that ships flagged by them comply with standards and procedures for the management and control of ships' ballast water and sediments.</p>                                                                                                                                                                                                                                         | Compliance with this convention will be undertaken by all vessels associated with the Proposed Development as an industry standard.                                                                                                                                                                                                                                                                                                                                                                                                               |
| <p><b>Marine Strategy Framework Directive (Directive 2008/56/EC) 2008</b><br/>The Marine Strategy Framework Directive is a European Directive originally aimed at achieving or maintaining Good Environmental Status (GES) in European marine regions and sub-regions</p>                                                                                                                                                                                                                                                                                                                                                            | <p>A range of GES descriptors are relevant to this chapter:</p> <ul style="list-style-type: none"> <li>• Descriptor 1: Marine biodiversity;</li> <li>• Descriptor 4: Food webs;</li> <li>• Descriptor 6: Seabed integrity;</li> <li>• Descriptor 8: Contaminants; and</li> <li>• Descriptor 11: Energy, including subsea noise.</li> </ul> <p>Under this directive, each of these descriptors has a range of goals and targets required to achieve GES. It could be assumed that if all impacts have been concluded as not significant in EIA</p> |
| <p><b>Marine Strategy Regulations 2010</b><br/>These regulations require action to be taken to achieve or maintain GES in UK seas</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |



| Summary of relevant legislation or Act                                                                             | How and where considered in the EIA Report                                                                                        |
|--------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                    | terms, then the Proposed Development would be acting in a way in which maintains GES, with regards to fish and shellfish ecology. |
| <b>The Sandeel (Prohibition of Fishing) (Scotland) Order 2024</b><br>Prohibits sandeel fishing in Scottish waters. | This act has been considered as part of the future baseline scenario in Section 9.6.                                              |

**Table 9.2: Summary of Scotland's National Marine Plan relevant to Fish and Shellfish Ecology (Scottish Government, 2015)**

| Summary of relevant policy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | How and where considered in the EIA Report                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chapter 4: General Policies</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                 |
| <b>General Policy 5 (Climate Change): Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     | The impact of climate change on the baseline environment and how this may influence the assessment of effects is considered as part of the future baseline in Section 9.6. Further assessment on climate change in general is presented in Volume 2, Chapter 22: Climatic Change.                               |
| <b>General Policy 9 (National Heritage) of the National Marine Plan requires that development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species; (b) Not result in a significant impact on the national status of Priority Marine Features (PMFs); and (c) Protect and, where appropriate, enhance the health of the marine area.</b>                                                                                                                                                                                         | Protected fish and shellfish species and PMFs are detailed in Table 9.14. Sections 9.10 and 9.12 present assessments of the significance of the effects of the Proposed Development alone and cumulatively on protected fish and shellfish ecology receptors as well as mitigation measures, where appropriate. |
| <b>General Policy 9 (National Heritage) paragraph 4.47 of the National Marine Plan: The Marine Acts place a duty on all regulators to ensure that there is no significant risk of hindering the achievement of the conservation objectives of an MPA before giving consent to an activity. Where an ongoing activity presents a significant risk of hindering the achievement of the conservation objectives of an MPA there will be a management intervention. This intervention will be practical and proportionate, utilising the most appropriate statutory mechanism to reduce the risk</b> | Sections 9.10 and 9.12 present assessments of the significance of the effects of the Proposed Development alone and cumulatively on fish and shellfish ecology receptors, including on the features of the relevant designated sites, such as MPAs.                                                             |
| <b>General Policy 10 Invasive Non-Native Species (INNS): Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.</b>                                                                                                                                                                                                                                                                                                                                        | Embedded mitigation measures are detailed in Table 9.22, and include the development of and adherence to an Environmental Management Plan (EMP). This will include actions to minimise INNS and will be submitted as part of the application.                                                                   |
| <b>General Policy 21 Cumulative impacts: Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.</b>                                                                                                                                                                                                                                                                                                                                                                                                                  | Section 9.12 assesses the significance of the effects of the Proposed Development cumulatively with other plans and projects.                                                                                                                                                                                   |
| <b>Chapter 8: Wild Salmon and Diadromous Fish</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                 |

| Summary of relevant policy                                                                                                                                                                                                                                                                                                                                                                                                                                   | How and where considered in the EIA Report                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WILD FISH 1: The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision making processes. Where evidence of impacts on salmon and other diadromous species is inconclusive, mitigation should be adopted where possible and information on impacts on diadromous species from monitoring of developments should be used to inform subsequent marine decision making.</b> | Sections 9.10 and 9.12 include assessments of the significance of the effects of the Proposed Development, alone and cumulatively, on diadromous fish species. |

**Table 9.3: Summary of the PMFs in Scotland's Seas relevant to Fish and Shellfish Ecology (NatureScot, 2020)**

| Summary of relevant policy                                                                                                                                                                                                        | How and where considered in the EIA Report                                                                                                                                                                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Fish and Shellfish Species</b>                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                          |
| <b>PMFs are habitats and species that NatureScot have considered to be conservation priorities in Scottish waters. These include 32 species of fish and shellfish, including elasmobranch species and one decapod crustacean.</b> | Relevant PMFs are identified in Table 9.14. Sections 9.10 and 9.12 include assessments of the significance of the effects of the Proposed Development, alone and cumulatively, on PMFs within the Fish and Shellfish Ecology Study Area, where an impact pathway exists. |

**Table 9.4: Summary of the SMP for Offshore Wind Energy relevant to Fish and Shellfish Ecology (Scottish Government, 2020)**

| Summary of relevant policy                                                                                                                                                                                                                                                   | How and where considered in the EIA Report                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>General Policies</b>                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>The potential adverse effects on other marine users, economic sectors and the environment resulting from further commercial scale offshore wind development should be reduced.</b>                                                                                        | The potential for adverse effects on the identified environmental (i.e. fish and shellfish) receptors are considered fully in section 9.10, with consequent effects on other environmental receptors (e.g. marine mammals and offshore ornithology) and commercial fisheries considered in Volume 2, Chapters 10, 11 and 13, respectively. The cumulative effects of the Proposed Development alongside other plans and projects are assessed in section 9.12. |
| <b>Offshore Wind and Marine Renewable Energy Policies</b>                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Regional cumulative effects include the potential for negative effects on bird populations, benthic habitats, cetaceans, navigational safety, seascape/landscape and commercial fisheries. The SMP includes measures to mitigate potential impacts at various scales.</b> | Potential cumulative effects of the Proposed Development alongside plans and projects have been assessed in section 9.12.                                                                                                                                                                                                                                                                                                                                      |

**Table 9.5: Summary of the UK Marine Policy Statement relevant to Fish and Shellfish Ecology (UK Government, 2011)**

| <b>Summary of relevant policy</b>                                                                                                                                   | <b>How and where considered in the EIA Report</b>                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Ensure a sustainable marine environment which promotes healthy, functioning marine ecosystems and protects marine habitats, species and our heritage assets.</b> | The potential for adverse effects on fish and shellfish receptors within the marine environment has been considered fully in Section 9.10. The cumulative effects of the Proposed Development alongside other plans and projects have been assessed in Section 9.12.                                                                                                                     |
| <b>The marine environment plays an important role in mitigating climate change.</b>                                                                                 | The impact of climate change on the baseline environment and how this may influence the assessment of effects is considered as part of the future baseline in Section 9.6. Further assessment on climate change in general is presented in Volume 2, Chapter 22: Climatic Change.                                                                                                        |
| <b>Biodiversity is protected, conserved and where appropriate recovered and loss has been halted.</b>                                                               | The potential for adverse effects on the biodiversity of fish and shellfish species within the marine environment has been considered fully in Section 9.10. The cumulative effects of the Proposed Development alongside other plans and projects have been assessed in Section 9.12.                                                                                                   |
| <b>Marine businesses are acting in a way which respects environmental limits and is socially responsible.</b>                                                       | This chapter considers the possibility for the Proposed Development to restrict environmental limits with regards to fish and shellfish ecology. It could be assumed that if all impacts have been concluded as not significant in EIA terms, then the Proposed Development would be acting in a way in which respects environmental limits, with regards to fish and shellfish ecology. |

**Table 9.6: Summary of the National Planning Policy Framework 4 (Scottish Government, 2023a)**

| Summary of relevant policy                                                                                                                                                                                               | How and where considered in the EIA Report                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Part 2 – National Planning Policy: Climate mitigation and adaptation</b><br>To encourage, promote and facilitate development that minimises emissions and adapts to the current and future impacts of climate change. | The impact of climate change on the baseline environment and how this may influence the assessment of effects is considered as part of the future baseline in Section 9.6. Further assessment on climate change in general is presented in Volume 2, Chapter 22: Climatic Change.      |
| <b>Part 2 – National Planning Policy: Biodiversity</b><br>To protect biodiversity, reverse biodiversity loss, deliver positive effects from development and strengthen nature networks.                                  | The potential for adverse effects on the biodiversity of fish and shellfish species within the marine environment has been considered fully in Section 9.10. The cumulative effects of the Proposed Development alongside other plans and projects have been assessed in Section 9.12. |

## 9.4 Consultation

- 9.4.1 The approach to consultation for the Proposed Development is set out in Volume 1, Chapter 5: Consultation and Engagement. A summary of the issues raised during consultation activities undertaken to date specific to fish and shellfish ecology is presented in Table 9.7, together with how these issues have been considered in the production of this assessment. Further detail is presented within Volume 1, Chapter 5: Consultation and Engagement, Volume 3, Technical Appendix 5.1: Consultation Logs, and Volume 3, Technical Appendix 5.2: Pre-Application Consultation Report.

**Table 9.7: Summary of Key Consultation Issues Raised during Consultation Activities undertaken for the Proposed Development relevant to Fish and Shellfish Ecology**

| Date       | Consultee and Type of Consultation                                  | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                      |
|------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 06/03/2024 | NatureScot, MD-LOT, and the Orkney Island Council: Scoping Workshop | A fish and shellfish expert was not present in the workshop, however NatureScot provided written, post-workshop advice. This is provided in the following rows.                                                                                                                                                                                                                                                                                                                                                                                        | See rows below.                                                                                                                                                                                                                                                                                                                                                                                                       |
| 30/04/2024 | NatureScot: Post-Scoping Workshop advice                            | <i>Basking shark Cetorhinus maximus are discussed within the subsea noise slides but have not been included in the preliminary baseline characterisation slides for fish and shellfish (slide 64 and 65). In Scoping for other OWFs we have often seen basking shark considered as megafauna within the marine mammal chapters, however, we note that the marine mammal slide pack for Ayre does not include basking shark. We would expect to see further consideration of basking shark and potential impact pathways within the Scoping Report.</i> | A detailed account on basking shark within the Fish and Shellfish Ecology Study area has been provided in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report. Basking shark has been defined as an Important Ecological Feature (IEF) of international importance and assessed throughout the assessment of the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12). |
|            |                                                                     | <i>The study area for fish and shellfish is defined within the environmental receptors slide pack (slide 61). The study area is a 100 km buffer around the offshore project, which includes the offshore Export Cable Corridor. The study area is large, including all of Orkney, North Coast and the Moray Firth. We are content that this study area will include all potential impacts for fish and shellfish receptors.</i>                                                                                                                        | This response was noted, and no changes were made to the Fish and Shellfish Ecology Study Area (see Figure 9.1).                                                                                                                                                                                                                                                                                                      |
|            |                                                                     | <i>The following data sources</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | The additional data sources provided by NatureScot have been incorporated into the baseline, presented in Volume 3, Technical                                                                                                                                                                                                                                                                                         |



| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                      |
|------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      |                                    | <i>should also be included González-Irusta and Wright (2016a), González-Irusta and Wright (2016b), and González-Irusta and Wright (2017).</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Appendix 9.1: Fish and Shellfish Ecology Technical Report.                                                                                                                                                                                                                                                                                                                                                                                                            |
|      |                                    | <p><i>We note that both fixed and floating foundations are being considered at this stage. For floating platforms we would also expect the following to be scoped in:</i></p> <ul style="list-style-type: none"> <li><i>Fish aggregating around the Wind Turbines and other hard structures - to be considered as a change in prey availability, so other receptors would also need to be considered such as seabirds and marine mammals.</i></li> <li><i>Secondary entanglement with mooring lines – if netting or other debris becomes entangled in the mooring lines fish may also become entangled.</i></li> </ul> <p><i>We are content with the impacts that have been scoped out for fish and shellfish and the justifications provided (slide 77).</i></p> | <p>Fish aggregation around hard structures has been considered under the impact ‘introduction of artificial habitat and subsequent colonisation’ and the impact of changes in prey availability has been assessed in Volume 2, Chapter 10: Marine Mammals and Volume 2, Chapter 11: Offshore Ornithology.</p> <p>The impact of entanglement has been scoped into the assessment of the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12).</p> |
|      |                                    | <i>The Embedded Mitigation presented in slide 75 isn't directly related to fish and shellfish, however it will indirectly reduce the impacts of the development on fish and shellfish. We therefore agree with the Embedded Mitigation presented so far but should the EIA assessment show that further mitigation is needed for fish and shellfish this should be addressed.</i>                                                                                                                                                                                                                                                                                                                                                                                 | Embedded Mitigation is provided in Section 9.9 and referred to throughout the assessment, where relevant.                                                                                                                                                                                                                                                                                                                                                             |

| Date       | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                         |
|------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            |                                    | <i>We advise that further consideration should be given to potential impacts that are to be included within the fish and shellfish cumulative assessment. In our view, we consider that a project alone could have a negligible impact, but when combined with others, the overall magnitude could be greater and therefore result in a cumulative effect. As per our advice for benthic ecology, impacts from EMF are one such example of this and other impacts should also be considered. It would be useful to see context of impacts that have been considered within the Scoping Report.</i> | All impacts have been assessed for both the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12).                                                                                                                                                   |
| 02/10/2024 | MD-LOT: Scoping Opinion            | <i>The Scottish Ministers note that whilst there is no data that directly overlaps with the Proposed Development, various PMFs have been recorded in adjacent areas. As such, the Scottish Ministers advise the Developer to further consider PMFs and possible impact pathways in the EIA Report. The Developer should engage with NatureScot on this matter as the Proposed Development progresses through the EIA process.</i>                                                                                                                                                                  | Relevant PMFs are identified in Table 9.14. Sections 9.10 and 9.12 include assessments of the significance of the effects of the Proposed Development, alone and cumulatively, on PMFs within the Fish and Shellfish Ecology Study Area, where an impact pathway exists. |
|            |                                    | <i>The Scottish Ministers advise that the EIA Report must clearly articulate mitigation measures that are informed by the EIA, or the HRA and are necessary to avoid or reduce predicted significant adverse environmental effects of the Proposed Development. The Scottish Ministers advise that the full range of mitigation and monitoring measures, and published guidance, is considered and</i>                                                                                                                                                                                             | Embedded Mitigation relevant to the assessment on fish and shellfish ecology are outlined in Section 9.9, with proposed monitoring outlined in Section 9.13. Where mitigation is relevant specifically to basking shark, this has been stated.                           |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Response to Issue Raised and/or Where Considered in this Chapter |
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|      |                                    | <i>discussed within the EIA Report. Additionally, the Scottish Ministers advise the Developer to engage with relevant stakeholders, including but not limited to NatureScot, when developing such mitigation and monitoring measures.</i>                                                                                                                                                                                                                                                                                                                                                                                         |                                                                  |
|      |                                    | <i>The Scottish Ministers acknowledge Section 10.5.1 within the Scoping Report which notes the relevant Embedded Mitigation to fish and shellfish ecology. These measures do not directly relate to fish and shellfish but will indirectly reduce the impacts of the Proposed Development on fish and shellfish receptors. The Scottish Ministers acknowledge that these measures will evolve throughout the EIA process and, therefore, are content with what is presented; however, should the EIA assessment show that further mitigation is needed for fish and shellfish this should be addressed within the EIA Report.</i> |                                                                  |
|      | NatureScot:<br>Scoping Response    | <i>The Embedded Mitigation presented in Section 10.5 and summarised in Appendix A (Draft Schedule of Mitigation and Commitments) isn't directly related to fish and shellfish, however it will indirectly reduce the impacts of the development on fish and shellfish. Therefore, we currently agree with the embedded mitigation presented. However, should the EIA assessment show that further mitigation is needed for fish and shellfish, this should be addressed.</i>                                                                                                                                                      |                                                                  |
|      |                                    | <i>For basking shark – we advise that any mitigation for marine mammals should also be applied to basking sharks. Also, if Uncrewed</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                  |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      |                                    | <i>Surface Vehicles (USVs) or Autonomous Underwater Vehicles (AUVs) are to be used, we recommend further consultation to agree on appropriate mitigation for basking sharks (and also marine mammals).</i>                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|      | MD-LOT: Scoping Opinion            | <i>In Table 8.2 of the Scoping Report, the Developer summarises the subsea noise impacts to be scoped in for further assessment within the EIA Report. The Scottish Ministers note that injury ranges for marine mammals and fish will be estimated for clearance of Unexploded Ordnance (UXO). The Scottish Ministers advise that disturbance is also assessed using Temporary Threshold Shift (TTS) as a proxy. This is supported by NatureScot.</i>                                                                                               | For fish receptors, it is of note that TTS and recoverable injury criteria due to exposure to explosives from Popper <i>et al.</i> (2014) are qualitative only (i.e. near, intermediate and far field for high, moderate and low risk, respectively), therefore the assessment for subsea noise effects associated with UXO clearance was based upon criteria for mortality/potential mortal injury only for Groups 1-4 fish to allow modelling of impact ranges (Section 9.10). These ranges are therefore considered highly precautionary in the context of behavioural effects. |
|      |                                    | <i>The Scottish Ministers acknowledge the MPA screening assessment included in Appendix D of the Scoping Report. This assessment concludes that underwater noise will not be capable of affecting, other than insignificantly, the qualifying sandeel species of the North-West Orkney MPA, and is therefore proposed to be screened out. As underwater noise modelling is still to be undertaken the Scottish Ministers consider it premature to scope out effects on the North-West Orkney MPA at this stage. This is supported by NatureScot.</i> | Sandeel (the qualifying feature) of this MPA have been included within the Fish and Shellfish Ecology EIA Chapter as an IEF and will be assessed accordingly, noting that sandeel species lack a swim bladder and are therefore considered Group 1 fish by Popper <i>et al.</i> (2014) with sensitivity to particle motion only, to a narrow band of frequencies (Section 9.10).                                                                                                                                                                                                   |
|      | NatureScot: Scoping Response       | <i>The North-West Orkney MPA is located 55.2 km from the Scoping boundary, within the 100 km buffer for subsea noise. Appendix D (Marine</i>                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                       | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                           |
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|      |                                    | <i>Protected Area Screening) concludes that underwater noise will not be capable of affecting (other than insignificantly) the qualifying sandeel species of the MPA and is therefore proposed to be screened out. However, we note that underwater noise modelling is still to be undertaken, and we consider it premature to scope out effects on the North-West Orkney MPA at this stage.</i> |                                                                                                                                                                                                            |
|      | MD-LOT: Scoping Opinion            | <i>The Scottish Ministers acknowledge Section 10.2.1 of the Scoping Report which notes that the fish and shellfish study area has been defined as a 100 km buffer around the Proposed Development, which includes the offshore export cable corridor. The Scottish Ministers, in line with the NatureScot representation, are content with the study area proposed.</i>                          | This response was noted, and no changes were made to the Fish and Shellfish Ecology Study Area (see Figure 9.1).                                                                                           |
|      | NatureScot: Scoping Response       | <i>The study area is defined as a 100 km buffer around the proposed development, which includes the offshore Export Cable Corridor. The study area is large, including all of Orkney, North Coast and the Moray Firth. We are content that this study area will cover all potential impacts for fish and shellfish receptors.</i>                                                                |                                                                                                                                                                                                            |
|      | MD-LOT: Scoping Opinion            | <i>The Scottish Ministers are broadly content with the data sources considered in Table 10.1 of the Scoping Report. The NatureScot representation provides additional data sources recommended for use when considering basking sharks. The Scottish Ministers advise the Developer to</i>                                                                                                       | The additional data sources provided by NatureScot have been incorporated into the baseline for basking shark, presented in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report. |

| Date | Consultee and Type of Consultation       | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                       |
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|      |                                          | <i>consider these additional data sources as part of its EIA Report.</i>                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                        |
|      | NatureScot: Scoping Response             | <i>For basking shark, we recommend including the following data sources: Witt et al. (2012), Witt et al. (2014), Witt et al. (2016), Austin et al. (2019), and Pikesley et al. (2024).</i>                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                        |
|      | MD-LOT: Scoping Opinion                  | <i>With regards to basking sharks, the Scottish Ministers note this species is briefly discussed within Appendix C of the Scoping Report, but there is no discussion within the baseline characterisation in either the fish and shellfish receptor chapter or the marine mammal's receptor chapter. The Scottish Ministers would expect to see further consideration of basking sharks and potential impact pathways within the EIA Report. This is supported by NatureScot.</i> | A detailed account on basking shark within the Fish and Shellfish Ecology Study area has been provided in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report. Basking shark has been defined as an IEF of international importance and assessed throughout the assessment of the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12). |
|      | NatureScot: Scoping Response             | <i>Basking shark are briefly discussed in Appendix C (Subsea Noise Modelling Method Statement) but there is no discussion within the baseline characterisation in either fish and shellfish or marine mammals. As raised in our post Scoping Workshop advice (issued 30th April 2024), we would expect to see further consideration of basking shark and potential impact pathways within the Scoping Report, and it is disappointing that this has been missed.</i>              |                                                                                                                                                                                                                                                                                                                                                                                        |
|      | Orkney Islands Council: Scoping Response | <i>Basking sharks are regularly seen in Orkney waters. An assessment should be undertaken of the likely effects of the proposal on this species and, where necessary, mitigation</i>                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                        |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                          |
|------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | MD-LOT: Scoping Opinion            | <i>measures should be identified which would avoid or minimise any adverse impacts.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                           |
|      |                                    | <i>As noted in Section 5.4.2 of this Scoping Opinion, the results of the site-specific subtidal benthic ecology data are not provided within the Scoping Report. The Scottish Ministers advise that once the data is analysed and if it indicates that other species are present, then these additional species should be included in the EIA Report. Additionally, the benthic ecology survey sampling should be used to determine suitable sandeel habitat and/or herring spawning habitat. This is supported by NatureScot.</i>                   | The results of the site-specific benthic surveys have been included in the baseline presented in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report, where relevant. The Particle Size Analysis (PSA) data collected during the benthic subtidal survey has been used to inform habitat suitability for sandeel and herring (see Section 9.6). |
|      |                                    | <i>The results of the site-specific benthic ecology surveys are not presented in the Scoping Report, instead, data from other offshore wind farm projects within the study area are used to provide evidence for likely species present. Once analysed, if the site-specific benthic ecology survey data indicates other species are present, then we advise that these additional species are included in the EIA Report. Benthic ecology survey sampling should be used to determine suitable sandeel habitat and/or herring spawning habitat.</i> |                                                                                                                                                                                                                                                                                                                                                                           |
|      |                                    | <i>Table 10.6 and Table 10.7 within the Scoping Report note the impacts proposed to be scoped into and scoped out of the fish and shellfish ecology assessment. The Scottish Ministers, in line with the Scottish Fishing Federation (SFF) representation, advise that the accidental pollution to the surrounding</i>                                                                                                                                                                                                                               | The impact of accidental pollution to the surrounding environment has been scoped back in for all three phases, and the Maximum Design Scenario (MDS) based on the maximum number of vessels on site at any one time due to the concerns raised by the SFF about a vessel sinking.                                                                                        |



| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                            | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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|      |                                    | <i>environment is scoped in for further assessment within the EIA Report.</i>                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|      |                                    | <i>Additionally, the Scottish Ministers, in line with the Caithness District Salmon Fishery Board (DSFB) and the Fisheries Management Scotland (FMS) representations, advise that shadow flicker from moving turbines and the direct visual effects of moving turbines should be scoped in for further assessment within the EIA Report.</i>                                                          | Caithness DSFB, FMS and MD-LOT were consulted regarding the potential impact of shadow flicker and visual effects. The outcomes of this consultation are summarised below (for full response, see Volume 3, Technical Appendix 4.3: Scoping Gap Analysis):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|      | Caithness DSFB: Scoping Response   | <i>It should be noted that NatureScot has formally conceded that shadow flicker from moving turbine blades (and also the direct visual effects of moving blades) may adversely affect salmonids in freshwater habitat. Since exactly the same physical principles apply in the marine environment, surface-orientated fish like salmonids are likely to be exposed to equivalent adverse effects.</i> | <p>The Applicant concluded that shadow flicker and visual effects would not generate a significant effect for fish receptors, both on an individual and population-level scale. The only published study on the effect of shadow flicker on a diadromous fish species focussed on Atlantic salmon within rivers (Dodd and Briers, 2021). This study concluded that there is no specific evidence available to support or refute any biological or ecological impact of shadow flicker from wind turbine blades on Atlantic salmon and that any potential impact of offshore wind turbines was outwith the scope of the study (Dodd and Briers, 2021).</p> <p>Literature investigating the potential impacts from wind turbine shadow flicker (in the form of flickering light) relates to research on possible human impacts (Haac <i>et al.</i>, 2022, Harding <i>et al.</i>, 2008, Nordman, 2010). In the offshore environment, Atlantic salmon and sea trout commonly swim from near the surface down to multiple tens of metres in</p> |



| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------|------------------------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      |                                    |                            | <p>depth (Godfrey <i>et al.</i>, 2015, Holm <i>et al.</i>, 2006), and therefore have the potential to be exposed and/or receptive to visual stimuli, associated with offshore infrastructure. Taking into consideration the distance of the wind turbines from the coast (where it is anticipated that visual, olfactory, and or magnetic stimuli for diadromous fish returning to natal rivers play an important navigational role (Cresci <i>et al.</i>, 2017, Hasler and Scholz, 1983, Hedger <i>et al.</i>, 2008, Keefer and Caudill, 2014), it is not expected that the Wind Turbines will result in behavioural responses in diadromous species during migration. Furthermore, considering the height of the turbine blades above the surface of the water, in the context of other visual stimuli such as distortions of the water surface, rough and turbid sea state, annual daylight hours and cloud cover, it is unlikely that shadow flicker effects will have significant adverse effects on diadromous fish.</p> <p>The Caithness DSFB and FMS referred to the recent study by Williamson <i>et al.</i> (2024) as justification for scoping this impact in. However, this study concluded that, based on an evaluation of theory, wind turbines could generate visual cues for aquatic receptor organisms and that the cues have the potential to be aversive (Williamson <i>et al.</i>, 2024). The authors noted that further research is required to generate direct</p> |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                       | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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|      |                                    |                                                                                                                                                                                                                                                                                                                                                                  | <p>evidence, and that the paper presented the physics involved to support the formulation and testing of a biological hypotheses to investigate the direct visual and flicker effects (Williamson <i>et al.</i>, 2024). This additional reference provided by the Caithness DSFB and FMS, therefore, does not present any new information nor evidence to adequately assess this impact for diadromous fish receptors.</p> <p>The purpose of this EIA is to identify and proportionately assess significant impacts upon fish and shellfish receptors using strong scientific evidence. Where available, industry guidance has also been utilised (such as the Scottish Government's Wild Salmon Strategy (2022) or Wild Salmon Strategy Implementation Plan (2023b)). The Applicant considers the information presented to be sufficient evidence to scope out the impact of shadow flicker on fish and shellfish receptors, with a particular emphasis on diadromous fish. This aligns with the approach taken by other OWFs in the area, such as Muir Mhor OWF (2024).</p> |
|      | FMS: Scoping Response              | <i>FMS request that, in addition to the evidence gaps identified by Scottish Marine Energy Research (ScotMER), the EIA considers the effects of predator aggregation (e.g. large gadoids/ grey seals) around the proposed development on migrating salmonids at both the smolt and adult stages and, additionally, physical barrier effects on salmon during</i> | Key prey species have been identified within the Fish and Shellfish Ecology Technical Report, and as part of the determination of IEFs (Table 9.13 and Table 9.14). Impacts to the spawning and nursery grounds of these species has been factored into the assessment of the Proposed Development alone (Section 9.10) and cumulatively (Section                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                  |
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|      |                                    | <i>construction and operation (e.g. noise, shadow flicker). In this regard, it should be noted that NatureScot has formally conceded that shadow flicker from moving turbine blades (and also the direct visual effects of moving blades) may adversely affect salmonids in freshwater habitat. Since exactly the same physical principles apply in the marine environment, surface-orientated fish like salmonids are likely to be exposed to equivalent adverse effects.</i>                                                                                                      | 9.12), in order to determine population level effects to these prey species. The results of the Fish and Shellfish Ecology assessment have been drawn into the assessments for other receptor groups, such as marine mammals and offshore ornithology to consider specific effects relating to specific prey species and prey availability.<br><br>The potential impact of shadow flicker and visual effects has been discussed in the row above. |
|      | SFF: Scoping Response              | <i>SFF is not content with scoping out the 'Accidental pollution to the surrounding environment' because if a vessel sank during any phase, then an accidental release of pollutants would occur. Therefore, we would propose the 'Accidental pollution to the surrounding environment' to be scoped in.</i>                                                                                                                                                                                                                                                                        | The impact of accidental pollution to the surrounding environment has been scoped back in for all three phases, and the Maximum Design Scenario (MDS) based on the maximum number of vessels on site at any one time due to the concerns raised by the SFF about a vessel sinking (Section 9.10).                                                                                                                                                 |
|      | MD-LOT: Scoping Opinion            | <i>The Scottish Ministers acknowledge the subsea noise modelling method statement included in Appendix C of the Scoping Report. Table C1.7 within this appendix notes the assessment of swim speeds of marine mammals and fish that are likely to occur within the North Sea for exposure modelling. The Scottish Ministers, in line with the NatureScot representation, are content that most fish will flee from disturbance; however, if sandeel habitat or spawning herring grounds are identified, the Scottish Ministers recommend that these are assessed as stationary.</i> | As the most precautionary approach, and in line with SNCB advice on other recent OWFs (such as Ossian (Ossian OWFL, 2024), Morgan OWF (Morgan Offshore Wind Ltd, 2023), and Mona OWF (Mona Offshore Wind Ltd, 2023)), fish have been modelled as both fleeing and stationary receptors as part of the subsea noise modelling (see Section 9.10 and Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report).                             |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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|      | NatureScot: Scoping Response       | <i>Section 8 and Appendix C (Subsea Noise Modelling Method Statement) discuss the approach to underwater noise modelling. We note that underwater noise modelling will be based on the impact thresholds reported in Popper et al. (2014). Table C1.7 shows swim speeds of marine mammals and fish species. We agree that most fish will flee from disturbance, however, if sandeel habitat or spawning herring grounds are identified, we recommend that these are assessed as stationary.</i>                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|      | MD-LOT: Scoping Opinion            | <i>The Scottish Ministers, in line with the NatureScot representation, advise that the EIA Report should clearly set out the impacts to key prey species and their habitats arising from the Proposed Development alone and cumulatively with other wind farms. The Scottish Ministers acknowledge the need to understand impacts at the ecosystem scale; therefore, advise that consideration across key trophic levels will enable a better understanding of the consequences of any potential changes in prey distribution and abundance on marine mammal interests and how this may influence population level impacts. Additionally, the Scottish Ministers advise that consideration of how this loss and or disturbance may affect the recruitment of key prey (fish) species through impacts to important spawning or nursery ground habitats should also be assessed within the EIA Report.</i> | Key prey species have been identified within the Fish and Shellfish Ecology Technical Report, and as part of the determination of IEFs (Table 9.13 and Table 9.14). Impacts to the spawning and nursery grounds of these species has been factored into the assessment of the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12), in order to determine population level effects to these prey species. The results of the Fish and Shellfish Ecology assessment have been drawn into the assessments for other receptor groups, such as marine mammals and offshore ornithology to consider specific effects relating to specific prey species and prey availability. |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Response to Issue Raised and/or Where Considered in this Chapter                                                                                     |
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|      | NatureScot: Scoping Response       | <i>Potential interrelated effects are briefly discussed in Section 10.8, which mentions that fish and shellfish ecology may also impact other receptors. The EIA Report should clearly set out impacts to key prey species (such as sandeel, herring, mackerel and sprat) and their habitats arising from the proposed development alone and cumulatively with other wind farms. Increasingly we need to understand impacts at the ecosystem scale. Therefore, consideration across key trophic levels will enable better understanding of the consequences (positive or negative) of any potential changes in prey distribution and abundance on marine mammal (and other top predator) interests and how this may influence population level impacts. Consideration of how this loss and or disturbance may affect the recruitment of key prey (fish) species through impacts to important spawning or nursery ground habitats should also be assessed.</i> |                                                                                                                                                      |
|      | MD-LOT: Scoping Opinion            | <i>With regards to EMF, the Scottish Ministers, in line with the NatureScot representation, advise that EMF impacts should be assessed on a cumulative basis for fish and shellfish ecology.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | The impact of EMF has been assessed for the Proposed Development alone (Section 9.10) and cumulatively with other plans and projects (Section 9.12). |
|      | NatureScot: Scoping Response       | <i>With the proposed number of offshore wind developments in Scottish waters, we are noting tendency for developers to indicate no likely significant effect from EMF impacts from a cumulative basis. However, we are concerned that the spatial and temporal scale is not being considered cumulatively across the network of cables, including those outwith the</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                      |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                             | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                       |
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|      |                                    | <i>Proposed Development. Thus, we advise that EMF impacts are considered in the cumulative assessment.</i>                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                        |
|      | MD-LOT: Scoping Opinion            | <i>The Scottish Ministers, in line with the NatureScot representation, agree that transboundary impacts can be scoped out from further consideration within the EIA Report.</i>                                                                                                                                                        | In line with the Scoping report, transboundary impacts were not predicted to occur within the assessment for fish and shellfish ecology (see Section 9.14).                                                                                                                                                            |
|      | NatureScot: Scoping Response       | <i>Potential transboundary impacts are discussed in Section 10.10 and also in Appendix B (Transboundary Screening). We agree that transboundary impacts can be scoped out from further consideration.</i>                                                                                                                              |                                                                                                                                                                                                                                                                                                                        |
|      |                                    | <i>The potential impacts proposed to be scoped in and out for fish and shellfish are summarised in Tables 10.6 and 10.7, respectively and we are content with what is proposed.</i>                                                                                                                                                    | Impacts scoped in and out of the assessment for fish and shellfish ecology are presented in Table 9.15 and Table 9.16, respectively.                                                                                                                                                                                   |
|      |                                    | <i>Section 10.9 discusses potential cumulative effects. All impacts scoped in for the proposed alone (Table 10.6) will be assessed as potential impacts within the cumulative assessment. A buffer of 100km will be used for subsea noise, with all other impacts applying a buffer of 50km. We are content with what is proposed.</i> | This has been incorporated into the cumulative effects assessment, presented in Section 9.12.                                                                                                                                                                                                                          |
|      | Caithness DSFB: Scoping Response   | <i>Caithness DSFB has a statutory duty to protect salmon and sea trout in its area of responsibility. In this regard, the Proposed Development has the potential to adversely affect adult salmon migrating inwards towards their Caithness home rivers (Rivers Forss to Langwell) (including the River Thurso SAC and</i>             | Atlantic salmon and sea trout are considered IEFs of international and national importance within this assessment (Table 9.14). Impacts upon these species (and upon their migratory pathways) has been fully considered for the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12). A detailed |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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|      |                                    | <i>Berriedale/ Langwell SAC) via any migration route that exists along the east coast of the Orkney Islands. All the East Coast rivers further south (including several additional salmon SACS) will be affected in the same way and the rivers of the Northern District Salmon Fishery Board to the west (Halladale to Kinloch) (including the River Borgie SAC and River Naver SAC) will be affected, too.</i>                                                                                                                                                                                                                | characterisation of these species has also been provided in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report to inform the baseline environment. In addition, adverse effects on integrity of European sites with Annex II diadromous fish features have been assessed in accordance with the Habitats Regulations in the RIAA (TWP-AYR-RPS-ENV-RPT-00019).                                                                                                                                  |
|      |                                    | <i>The outwards route(s) for salmon smolts leaving the rivers of the north coast (eg the River Thurso) are presently unknown but if they mirror the patterns evident for smolts leaving the Inner Moray Firth rivers, and more recently Wick River, they will pass eastwards through the Pentland Firth to cross the export cable route and, plausibly, then move through the Ayre turbine array.</i>                                                                                                                                                                                                                           | Information on the migration of Atlantic salmon through the Pentland Firth has been presented in the Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report as part of the baseline characterisation. Impacts on Atlantic salmon with the potential to occur within the entire Fish and Shellfish Ecology Study Area have been fully considered for the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12).                                                                 |
|      |                                    | <i>The River Wester is a noted sea trout river that is sometimes overlooked. The Wester enters the sea around the midpoint of Sinclair Bay and is potentially, therefore, the river most directly at risk from works associated with the export cable and its landfall. A marine sports fishery for seatrout is active in the vicinity of the river mouth. Indeed, similar to cases elsewhere, the entirety of Sinclair Bay may be utilised as a sheltered feeding habitat by adult seatrout from Wester (and perhaps elsewhere). Sinclair Bay and the River Wester and its sea trout should therefore receive specific and</i> | Where possible, specific design parameters for impact at the Landfall have been included in the MDS (i.e. for Horizontal Directional Drilling (HDD); see Table 9.15). These have been incorporated into the assessment of effects in order to assess specific impacts to the Landfall location in Sinclair's Bay (for example in the impacts of 'Temporary habitat loss and/or disturbance' in Paragraph 9.10.9 and 'Increased Suspended Sediment Concentrations (SSCs) and associated deposition' in Paragraph 9.10.115. |



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|      |                                    | <i>detailed consideration in the EIA; the exact location of the cable landfall site will be a critical consideration.</i>                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|      |                                    | <i>Accordingly, the Boards require that the EIA considers the effects of predator aggregation (e.g. large gadoids/seals) around the Proposed Development on migrating salmonids at both the smolt and adult stages and, additionally, physical barrier effects on salmon during construction and operation (e.g. noise, shadow flicker).</i>                                                                                                                                                                       | <p>The effects of predator aggregation are considered within the impact of ‘Introduction of artificial habitat and subsequent colonisation of hard structures’ with specific reference to fish and shellfish receptors (Section 9.10). Subsea noise during all phases is considered under the impact of ‘Subsea noise impacting fish and shellfish’, with O&amp;M phase impacts focusing on operational noise from Wind Turbines (Section 9.10). The assessment considers the potential for sound to cause barrier effects between natal rivers and offshore habitats for salmonids.</p> <p>Limited evidence exists for impacts to fish from shadow flicker generated by Wind Turbines (see previous response on this topic), therefore, this impact has not been included in the assessment.</p> |
|      |                                    | <i>The Boards are not naïve enough to imagine that the issues they have raised can be unequivocally addressed in the conventional EIA framework (i.e.. consideration of impacts and assessment of significance of resultant effects). This is because the pace of offshore development has outstripped the capacity of researchers to supply critical information. In this context and with regard to West of Orkney Wind Farm, Marine Scotland Science (MSS) stated that they “do not consider it appropriate</i> | <p>Current evidence pertaining to all impacts assessed has been referenced to inform both Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report, the final scoping in/out of impacts for assessment (Table 9.15 and Table 9.16), and the assessment alone (Section 9.10) and cumulatively (Section 9.12).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |



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|      |                                    | <i>for an EIA/HRA to conclude there is no or negligible impact just because no evidence exists of the impact. MSS advise that impacts to diadromous fish must be adequately investigated, rather than relying on a lack of evidence to claim there is no impact”.</i>                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                         |
|      | FMS: Scoping Response              | <i>We note, and support, the recent position that the Marine Directorate have taken - “MSS do not consider it appropriate for an EIA/HRA to conclude there is no or negligible impact just because no evidence exists of the impact. MSS advise that impacts to diadromous fish must be adequately investigated, rather than relying on a lack of evidence to claim there is no impact”.</i>                                                                                                                                                    |                                                                                                                                                                                                                                                                         |
|      | Caithness DSFB: Scoping Response   | <i>The Boards wholeheartedly support Marine Directorate’s position and rather than the usual blanket series of assessments of “no significant effect” the Boards propose that assessments for the Ayre Wind Farm proposal should include a new category - “Assessment not possible due to lack of information”. This need not hamper development, and it would have the triple advantages of being honest and even handed, pinpointing crucial data gaps to be filled and drawing a sharper focus on measures for precautionary mitigation.</i> | This response is noted by the Applicant; however, the proposed category will not be implemented in order to align with the approach to assessment for the whole EIA set out in Volume 1, Chapter 4: EIA Methodology.                                                    |
|      | SFF: Scoping Response              | <i>SFF note from sections 3.5 and 3.6 [of the Offshore Scoping Report] that a total length of c.610 km inter-array cables, interconnector and export cables will be utilised, with a 25 m maximum width of seabed disturbed by cable installation (per cable). This results to a total</i>                                                                                                                                                                                                                                                      | The MDS for temporary habitat loss and disturbance includes parameters for seabed disturbance from cable installation, alongside other construction activities (see Table 9.15). These do not represent a significant portion of the area of the Site Boundary (a total |

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|      |                                    | <i>area of c.15.25 km<sup>2</sup> seabed to be disturbed which will have vast environmental impacts especially destruction of spawning ground. SFF wonder how this impact is considered/calculated and addressed as the overall impact of the Development on seabed. It should be noted that similar seabed disturbance will also result from Offshore Substation Platforms (OSPs) and anchor footings.</i>                                                   | footprint of up to 18 km <sup>2</sup> in the construction phase, which equates to 4.64% of the Site Boundary; Table 9.15). It is also important to note that the footprint of temporary habitat loss and disturbance in this phase will not represent one continuous area and will be spread spatially and temporally (i.e. over the construction phase) over the Site Boundary. The impact of temporary habitat loss and disturbance has been fully assessed in Section 9.10 for the Proposed Development alone and cumulatively in Section 9.12. Further, this impact has been fully considered within the inter-related effects assessment in Section 9.11. |
|      | SFF: Scoping Response              | <i>SFF furthermore note from sub-section 10.4.14 (page 169 [of the Offshore Scoping Report]) that the Scoping Boundary totally overlaps with the spawning and nursery grounds of some commercially important demersal and pelagic fish species. Therefore, we propose any survey activities and other seabed disturbances should be undertaken outwith spawning and nursery periods of the above-mentioned fish species to avoid juvenile fish mortality.</i> | The spawning and nursery grounds within the Fish and Shellfish Ecology Study Area are presented in Table 9.10, and spawning periods are presented in Table 9.11. Further information (and figures) is presented in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report. Should any surveys be undertaken then the spawning and nursery periods will be considered.                                                                                                                                                                                                                                                                   |
|      |                                    | <i>SFF note from sub-sections 9.4.3 (page 128, Benthic Ecology [of the Offshore Scoping Report]) that the Local Benthic Ecology Study Area seabed is suitable for herring spawning. As the mentioned areas are suitable for herring spawning, the SFF are concerned about the Proposed Development impacts on all</i>                                                                                                                                         | A herring spawning habitat suitability assessment has been undertaken using site-specific sediment composition data along with publicly available sediment composition data, where available. This is presented within Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report and                                                                                                                                                                                                                                                                                                                                                       |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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|      |                                    | <i>commercial value fish species in the area, especially the impacts on the herring which are also particularly sensitive to noise impacts as they have swim bladders which are involved in hearing.</i>                                                                                                                                  | summarised in Section 9.6. Impacts to herring spawning habitat have been fully assessed under the impacts of temporary and long term habitat loss, and increased SSCs and associated deposition (Sections 9.10 and 9.12). The impact of subsea noise has also been assessed for all phases, with herring considered throughout (Sections 9.10 and 9.12).                                                                                                                                                                                                                                                                                                                      |
|      |                                    | <i>We are of the view that any activities on herring spawning habitat are prohibited based on the 'ICES Advice on fishing opportunities, catch, and effort Greater North Sea ecoregion' published 31 May 2024. Therefore, SFF propose the above-mentioned ICES advice to be taken into account and acted upon at determination stage.</i> | It should be noted that the advice published 31 May 2024, has since been replaced on the 13 November 2024 (ICES, 2024a) and 30 April 2025 (ICES, 2025c) This advice states that: <i>"no activities on spawning habitats should be allowed unless the effects of these activities have been assessed and shown not to be detrimental."</i><br><br>Potential impacts on herring are considered within Sections 9.10 and 9.12 of this chapter. As no significant effects upon herring are concluded from the assessment of the Proposed Development, alone or cumulatively with other plans and projects, the Proposed Development is considered to align with this ICES advice. |
|      | FMS: Scoping Response              | <i>Across Scotland, wild salmon populations are in crisis, and face a range of pressures, some of which are under human control. The Scottish Government have published a wild salmon strategy and implementation plan, which sets out the actions to be taken over a five year period to 2028. The implementation plan</i>               | The Wild Salmon Strategy and Implementation Plan (Scottish Government, 2023b) has been considered throughout the assessment, where relevant. The assessments presented in Sections 9.10 and 9.12 consider the potential for all impacts to                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Response to Issue Raised and/or Where Considered in this Chapter                                   |
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|      |                                    | <i>includes a number of actions under the heading of understanding and mitigating pressures in the marine and coastal environment.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | cause barriers to migration to and from freshwater habitats.                                       |
|      |                                    | <i>Where salmon populations are below their conservation limits, any additional pressure, including from marine renewables, cannot be considered sustainable. Scottish salmon rivers are categorised by the Scottish Government under The Conservation of Salmon (Scotland) Regulations 2016, according to the likelihood of them meeting their conservation limits. The most recent river gradings have been published for 2024. There are now 112 rivers across Scotland graded as Category 3, meaning there is a less than 60% probability of meeting their conservation limit. It is now well-recognised that populations of Atlantic salmon have rapidly deteriorated across their native range. In the latest species reassessment by the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species, released in December 2023, Atlantic salmon have been reclassified from 'Least Concern' to 'Endangered' in Great Britain (as a result of a 30-50% decline in British populations since 2006 and 50-80% projected between 2010-2025), and from 'Least Concern' to 'Near Threatened' in terms of global populations (as a result of global populations declines of 23% since 2006).</i> | The most recent IUCN status has been included to determine IEF status (Table 9.13 and Table 9.14). |
|      |                                    | <i>There are 17 Special Areas of Conservation for which Atlantic salmon are either a primary</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | A total of eight SACs were identified within the Fish and Shellfish Ecology Study Area             |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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|      |                                    | <i>reason (11 sites) or a qualifying feature (six sites). For sea lamprey, there are six SAC sites (three primary and three qualifying) and for river lamprey, there are six SAC sites (three primary and three qualifying). For freshwater pearl mussel, there are 19 SAC sites (14 primary and five qualifying). Given what is currently known about salmon migration routes, we consider that all of these SACs are relevant to the proposed development, and the export cable route.</i> | (Table 9.12). The total number of SACs are noted, and the Applicant acknowledges the importance of these species, however the assessment is focussed only on those sites within the defined Fish and Shellfish Ecology Study Area to ensure a proportionate approach to assessment. The Fish and Shellfish Ecology Study Area is suitably sized to incorporate the migration routes of diadromous fish in the North of Scotland (see Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report for further details). |
|      |                                    | <i>Whilst there is often a focus on rivers designated at SACs, it is important to recognise that the drivers behind declines in wild salmon and sea trout, and other species of migratory fish, affect all rivers to a greater or lesser extent. It is important to emphasise that the marine phases of both Atlantic salmon and sea trout are included on the list of PMFs – the habitats and species of greatest conservation importance in inshore waters.</i>                            | Within Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report, the PMF status of all diadromous fish has been discussed (alongside other conservation designations) and used as part of the determination of their IEF status for assessment (Table 9.14).                                                                                                                                                                                                                                                        |
|      |                                    | <i>Under ScotMER, the Diadromous Fish Receptor Group has identified evidence gaps related to the health, distribution, and impacts on Diadromous fish. The Scottish Government has published an ‘evidence map’ which identifies and scores these evidence gaps according to a specific prioritisation process. It is important that each of these evidence gaps is considered in full by the Applicant, and developers should</i>                                                            | This evidence map has been consulted and used to inform the impacts considered in the assessment of diadromous fish, where appropriate. For example, based on evidence gaps and key research questions in this ScotMER resource, the following impacts have been considered for diadromous fish receptors: <ul style="list-style-type: none"> <li>• impacts due to EMF;</li> </ul>                                                                                                                                                       |

| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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|      |                                    | <i>contribute to filling these evidence gaps as a specific condition of consent.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>fish aggregation around renewable energy devices (under ‘introduction of artificial habitat and subsequent colonisation’); and</li> <li>impacts associated with subsea noise.</li> </ul> <p>The impacts have been assessed for the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12). In addition, the assessment on diadromous fish considers whether migration (and thus connectivity between marine and freshwater habitats) may be impacted. This is a key research question highlighted throughout the evidence map.</p>                                                                                                                                                              |
|      |                                    | <i>In order to properly assess Environmental Statements for developments, information on the use of the development area by diadromous fish should be provided. If such information is lacking then a suitable monitoring strategy should be devised, either for the site in question or through contributing to strategic projects undertaken through ScotMER. Any monitoring strategies must include preconstruction monitoring in order that baseline information on movement, abundance, swimming depth, feeding behaviour etc. can be collected.</i> | <p>The most recent desktop outputs from ScotMER have been used in the baseline characterisation (Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report). At the time of writing, this included Honkanen <i>et al.</i> (2024), which provided a detailed literature review about the potential for diadromous species to overlap with offshore wind projects in Scotland (including the Proposed Development).</p> <p>The need for any monitoring has not yet been confirmed; however the Applicant notes the upcoming ScotMER projects regarding diadromous fish. When available, any relevant results from this will be included within the Project Environmental Monitoring Programme (PEMP), to be developed post-consent.</p> |



| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                                      |
|------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      |                                    | <p><i>Offshore renewable developments have the potential to directly and indirectly impact diadromous fish. We would therefore expect developers to assess and, where necessary, mitigate the potential impacts of deployed devices on such fish during the deployment, operation and decommissioning phases. These potential impacts have been highlighted through ScotMER, and include:</i></p> <ul style="list-style-type: none"> <li><i>• Avoidance (including exclusion from particular rivers and subsequent impacts on local populations);</i></li> <li><i>• Disorientation effects that could potentially affect behaviour, susceptibility to predation or by-catch; and</i></li> <li><i>• Impaired ability to locate normal feeding grounds or river of origin; and delayed migration.</i></li> </ul> | <p>The potential for diadromous fish migration to be impaired has been considered throughout the assessment of the Proposed Development alone (Section 9.10) and cumulatively (Section 9.12). Mitigation measures are detailed in Section 9.9.</p>    |
|      |                                    | <p><i>It should be emphasised that we have no wish to prevent or delay any proposed development unnecessarily and we remain keen to work constructively with the developers and Marine Scotland to identify appropriate monitoring programmes which will allow us to be able to assess the acknowledged risks of this development, and other proposed developments in a more appropriate manner. There is a clear and urgent need to fund, plan and start strategic research on the movement, abundance, swimming depth, feeding behaviour and impact pathways relevant to diadromous fish. Such research would clearly feed into the potential mitigation measures that might be deemed appropriate, and the</i></p>                                                                                          | <p>Monitoring studies have not yet been confirmed; however the Applicant notes the upcoming ScotMER projects regarding diadromous fish. When available, the results of these will be presented in the PEMP, which will be developed post-consent.</p> |



| Date | Consultee and Type of Consultation | Summary of Issue(s) Raised                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Response to Issue Raised and/or Where Considered in this Chapter                                                                                                                                                                               |
|------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      |                                    | <i>conditions under which such mitigation should be enacted. Developers should be required to work together to fund strategic monitoring, in order to allow more certainty for all involved.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                |
|      |                                    | <i>The scale of proposed offshore developments and other technical approaches to marine renewables development represents a step-change in the exposure of marine animals of high cultural and economic significance to attendant risks. As highlighted above, understanding of many of these risks is insufficient to support proposals for mitigation even at this late stage when substantial developments are being submitted for licensing. The cumulative impact of this proposal alongside those developments already submitted or likely to follow in the near future is potentially even greater. We believe that more needs to be done to ensure that the best scientific talent is made available to find practicable ways to address the unresolved uncertainties. FMS would welcome an opportunity to constructively engage with any such process.</i> | Monitoring studies have not yet been confirmed; however the Applicant notes the upcoming ScotMER projects regarding diadromous fish. When available, the results of these will be presented in the PEMP, which will be developed post-consent. |

## 9.5 Data Sources

9.5.1 Relevant desktop datasets and the results of site-specific surveys for the Proposed Development have been reviewed and analysed to inform this fish and shellfish ecology baseline.

### Desktop Study

9.5.2 Information on fish and shellfish ecology within the Fish and Shellfish Ecology Study Area was collected through a detailed desktop review of existing studies and datasets which are summarised in Table 9.8.

**Table 9.8: Summary of Key Data Sources**

| Title                                                                                          | Source                                                             | Extent                  | Author                                                             |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-------------------------|--------------------------------------------------------------------|
| <b>The Marine Life Information Network (MarLIN)</b>                                            | MarLIN and the Marine Biological Association (MBA)                 | UK waters               | MarLIN (2025)                                                      |
| <b>MPA Mapper</b>                                                                              | Joint Nature Conservation Committee (JNCC)                         | UK waters               | JNCC (2025b)                                                       |
| <b>National Biodiversity Network (NBN) Atlas</b>                                               | NBN Atlas                                                          | UK waters               | NBN Atlas (2025)                                                   |
| <b>Diadromous Fish in the Context of Offshore Wind – Review of Current and Future Research</b> | The Scottish Government                                            | Scottish waters         | Honkanen <i>et al.</i> (2024)                                      |
| <b>Volume 2 Proposed Development (Offshore): Chapter 5 Fish and Shellfish Ecology</b>          | Caledonia Offshore Wind Farm (OWF)                                 | Caledonia OWF           | Caledonia OWF Ltd (2024c)                                          |
| <b>International Bottom Trawl Survey (IBTS) and International Herring Larvae Study (IHLS)</b>  | International Council for the Exploration of the Seas (ICES)       | UK waters               | ICES (2025a), ICES (2025b), ICES (2024b), ICES (2023), ICES (2022) |
| <b>Scottish Salmon and Sea Trout Fishery Statistics 2023</b>                                   | Scottish Government                                                | Scottish waters         | Scottish Government (2024)                                         |
| <b>Developing Essential Fish Habitat Maps for Fish and Shellfish Species in Scotland</b>       | Marine Directorate – Science, Evidence, Data and Digital (MD-SEDD) | Scottish waters         | Franco <i>et al.</i> (2023)                                        |
| <b>North-East Scotland Salmon and Sea Trout Tracking Array</b>                                 | River Dee Trust and MSS                                            | Scottish waters         | River Dee Trust and MSS (2023)                                     |
| <b>UK Sea Fisheries Annual Statistics Report 2022 and Accompanying Datasets</b>                | Marine Management Organisation (MMO)                               | UK waters               | MMO (2023)                                                         |
| <b>West of Orkney Windfarm EIA Report, Volume 1,</b>                                           | West of Orkney Windfarm                                            | West of Orkney Windfarm | West of Orkney Windfarm (2023a)                                    |

| Title                                                                                                                                             | Source                                                        | Extent                  | Author                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|-------------------------|---------------------------------------------------------------|
| <b>Chapter 11 – Fish and Shellfish Ecology</b>                                                                                                    |                                                               |                         |                                                               |
| <b>West of Orkney Windfarm EIA Report, Volume 2, Supporting Study 7: Fish and Shellfish Ecology Baseline Report</b>                               | West of Orkney Windfarm                                       | West of Orkney Windfarm | West of Orkney Windfarm (2023b)                               |
| <b>West of Orkney Windfarm EIA Report, Volume 2, Supporting Study 8: Digital Video Aerial Survey Methodology and Marine Mammal Survey Results</b> | West of Orkney Windfarm                                       | West of Orkney Windfarm | West of Orkney Windfarm (2023c)                               |
| <b>Essential spawning grounds of Scottish herring: current knowledge and future challenges</b>                                                    | Reviews in Fish Biology and Fisheries                         | Scottish waters         | Frost and Diele (2022)                                        |
| <b>Pentland Floating OWF EIA, Volume 2: Chapter 10: Fish and Shellfish Ecology</b>                                                                | Pentland Floating OWF                                         | Pentland Floating OWF   | Pentland Floating OWF (2022b)                                 |
| <b>UK Offshore Energy Strategic Environmental Assessment 4. Appendix 1a.4 Fish and Shellfish</b>                                                  | Department for Business Energy and Industrial Strategy (BEIS) | UK waters               | BEIS (2022)                                                   |
| <b>A Verified Distribution Model for the Lesser Sandeel</b>                                                                                       | Marine Ecology Progress Series                                | UK waters               | Langton <i>et al.</i> (2021)                                  |
| <b>Beatrice OWF Post-Construction Cod <i>Gadus morhua</i> and Sandeel Survey Reports</b>                                                          | Beatrice OWF                                                  | Beatrice OWF            | Beatrice OWF Limited (2021a) and Beatrice OWF Limited (2021b) |
| <b>Moray East OWF – Environmental Statement: statement: Chapter 4.2 Benthic Ecology and Chapter 4.3 Fish and Shellfish Ecology</b>                | Moray East OWF                                                | Moray East OWF          | Moray Offshore Renewables Limited (2019a)                     |
| <b>Moray West OWF Offshore EIA Report: Chapter 8 Fish and Shellfish Ecology</b>                                                                   | Moray West OWF                                                | Moray West OWF          | Moray West OWF Limited (2018)                                 |
| <b>Spawning grounds of whiting <i>Merlangius merlangus</i></b>                                                                                    | ICES Journal of Marine Science                                | UK waters               | González-Irusta and Wright (2017)                             |
| <b>Descriptions of Scottish PMFs</b>                                                                                                              | Scottish Natural Heritage (now NatureScot)                    | Scottish waters         | Tyler-Walters <i>et al.</i> (2016)                            |
| <b>Spawning grounds of Atlantic cod in the North Sea</b>                                                                                          | ICES Journal of Marine Science                                | The North Sea           | González-Irusta and Wright (2016a)                            |

| Title                                                                                                                                                                                      | Source                                                             | Extent                             | Author                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------|-------------------------------------------------------------|
| <b>Spawning grounds of haddock <i>Melanogrammus aeglefinus</i> in the North Sea and West of Scotland</b>                                                                                   | ICES Journal of Marine Science                                     | The North Sea and West of Scotland | González-Irusta and Wright (2016b)                          |
| <b>Beatrice OWF Pre-Construction Cod and Sandeel Survey Reports</b>                                                                                                                        | Beatrice OWF                                                       | Beatrice OWF                       | Beatrice OWF Limited (2014) and Beatrice OWF Limited (2015) |
| <b>Updating Fisheries Sensitivity Maps in British Waters</b>                                                                                                                               | Marine Scotland                                                    | UK waters                          | Aires <i>et al.</i> (2014)                                  |
| <b>Beatrice OWF Environmental Statement: Section 10 Windfarm Benthic Ecology</b>                                                                                                           | Beatrice OWF                                                       | Beatrice OWF                       | Beatrice OWF Limited (2012a)                                |
| <b>Beatrice OWF Environmental Statement: Section 11 Windfarm Fish and Shellfish Ecology</b>                                                                                                | Beatrice OWF                                                       | Beatrice OWF                       | Beatrice OWF Limited (2012b)                                |
| <b>Spawning and Nursery Grounds for Selected Fish Species in UK Waters</b>                                                                                                                 | Centre for Environment, Fisheries, and Aquaculture Science (Cefas) | UK waters                          | Ellis <i>et al.</i> (2012)                                  |
| <b>Scotland's Marine Atlas: Information for the National Marine Plan</b>                                                                                                                   | Scottish Government                                                | Scottish Waters                    | Baxter <i>et al.</i> (2011)                                 |
| <b>Review of Migratory Routes and Behaviour of Atlantic Salmon, Sea Trout, and European Eel in Scotland's Coastal Environment: Implications for the Development of Offshore Renewables</b> | MD-SEDD                                                            | Scottish waters                    | Malcolm <i>et al.</i> (2010)                                |
| <b>North Sea Elasmobranchs: distribution, abundance, and biodiversity</b>                                                                                                                  | ICES                                                               | The North Sea                      | Daan <i>et al.</i> (2005)                                   |
| <b>Fisheries Sensitivity Maps in British Waters</b>                                                                                                                                        | Cefas                                                              | UK waters                          | Coull <i>et al.</i> (1998)                                  |

### Identification of Designated Sites

9.5.3 A three-step process was used to identify all designated sites within the Fish and Shellfish Ecology Study Area and qualifying interest features that could be affected by the construction, O&M, and decommissioning phases of the Proposed Development. This process is described below:

- Step 1: All designated sites of international, national, and local importance within the Fish and Shellfish Ecology Study Area were

identified using sources such as the JNCC mapper tool (JNCC, 2025b).

- Step 2: Information was compiled on the relevant fish and shellfish features for each of these sites.
- Step 3: Using the above information and professional judgement, sites were included for further consideration if:
  - a designated site directly overlaps with the Proposed Development and therefore has the potential to be directly affected by the Proposed Development; or
  - sites and associated features were located within the Fish and Shellfish Ecology Study Area (see Figure 9.1), and therefore the potential ZOI for impacts associated with the Proposed Development.

9.5.4 Adverse effects on integrity of European sites with Annex II diadromous fish features have been assessed in accordance with the Habitats Regulations in the RIAA (TWP-AYR-RPS-ENV-RPT-00019).

#### **Site-Specific Surveys**

9.5.5 Site-specific surveys were undertaken to inform the benthic intertidal and subtidal ecology, marine mammal, and ornithology baselines. Some of the outputs of these surveys were of relevance to fish and shellfish ecology and have been used to inform the baseline and assessment. A summary of these surveys is outlined in Table 9.9. PSA conducted during the benthic subtidal ecology survey was used to assess spawning habitat suitability for herring *Clupea harengus* and sandeel (*Ammodytes* spp.).

**Table 9.9: Summary of Site-Specific Survey Data**

| Title                                     | Extent of Survey                                                                                          | Overview of Survey                                                                                                                           | Survey Contractor  | Date                        | Reference                                                                      |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------------------|--------------------------------------------------------------------------------|
| <b>Benthic Subtidal Ecology Survey</b>    | Across the Array Area and Export Cable Corridor                                                           | Grab sampling, Drop Down Video (DDV), and Environmental Deoxyribonucleic Acid (eDNA) sampling.                                               | Ocean Ecology Ltd. | Spring 2024                 | Volume 3, Technical Appendix 8.1: Benthic Ecology Technical Report             |
| <b>Phase 1 Intertidal Walkover Survey</b> | Intertidal (from Mean High Water Springs (MHWS) to approx. Mean Low Water Springs (MLWS) at the Landfall) | Walkover survey to characterise the intertidal benthic baseline. Involved quadrat sampling along transects, and dig-overs.                   | RPS                | September 2023              | Volume 3, Technical Appendix 8.1: Benthic Ecology Technical Report             |
| <b>DAS</b>                                | Across the Plan Option Area (POA) plus a 12 km buffer                                                     | Monthly DASs conducted to characterise the marine mammal and ornithology baseline; however large fish species (such as sharks) were visible. | APEM               | March 2022 to February 2024 | Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report. |

## 9.6 Baseline Environment

### Overview of Baseline Environment

- 9.6.1 The following sections provide a summary of the fish and shellfish ecology baseline environment. Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report, includes full details of the analysis undertaken to develop the baseline and information on fish and shellfish ecology, including results of site-specific surveys for the Proposed Development and other projects within the Fish and Shellfish Ecology Study Area.

- 9.6.2 The fish and shellfish receptors that could be potentially impacted by the Proposed Development have been determined through a thorough review of available desktop data sources (detailed in Table 9.8), and through site-specific surveys, as detailed in Table 9.9. The baseline data sources used cover a broad spatial and temporal scale, and present data that were collected using a wide range of methods. Therefore, the baseline presented in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report is considered to represent a comprehensive and robust description of likely species that could be present within the Fish and Shellfish Ecology Study Area.
- 9.6.3 The Fish and Shellfish Ecology Study Area is situated within the Northern North Sea, towards the East of Orkney. The fish and shellfish baseline is comprised of various taxa, including marine fish (e.g. teleosts (bony fish) and elasmobranchs (sharks, skates, and rays)), diadromous fish (i.e. those which migrate between freshwater and seawater), and shellfish (e.g. commercial crustaceans and molluscs). Although there are shellfish species such as the ocean quahog *Arctica islandica* and horse mussel *Modiolus modiolus* present within the Fish and Shellfish Ecology Study Area, these are considered to be non-commercial shellfish species, and are therefore assessed within Volume 2, Chapter 8: Benthic Ecology. Fish and shellfish species have been assessed from a commercial fisheries perspective in Volume 2, Chapter 13: Commercial Fisheries, with the assessment presented here focussing on ecology.

#### **Marine Fish: Teleosts**

- 9.6.4 Teleost fish are ray-finned fishes with skeletons made of bone. They comprise of 96% of all extant fish species. The teleost fish in the Fish and Shellfish Ecology Study Area include both demersal and pelagic species. Typical North Sea demersal fish species include:
- Gadoids (e.g. blue whiting *Micromesistius poutassou*, cod, European hake *Merluccius merluccius*, haddock, ling *Molva molva*, Norway pout *Trisopterus esmarkii*, poor cod *Trisopterus minutus*, saithe *Pollachius virens* and whiting);
  - Flatfish (e.g. common dab *Limanda limanda*, lemon sole *Microstomus kitt*, long rough dab *Hippoglossoides platessoides*, plaice *Pleuronectes platessa*, sole *Solea solea*, and thickback sole *Microchirus variegatus*);
  - Sandeel (e.g. lesser sandeel *Ammodytes tobianus* and Raitt's sandeel *Ammodytes marinus*);
  - Anglerfish *Lophius piscatorius*;
  - Gobies (Family: Gobiidae); and
  - Gurnards (Family: Triglidae) (Aires *et al.*, 2014, Coull *et al.*, 1998, Ellis *et al.*, 2012, Franco *et al.*, 2023, González-Irusta and Wright, 2016a, González-Irusta and Wright, 2016b, González-Irusta and Wright, 2017).
- 9.6.5 Demersal fish species typically live on or around the seabed. In contrast, pelagic fish inhabit the mid-levels of the open ocean, away from the seabed and the shore. They can form large shoals and exhibit highly



migratory behaviour. Pelagic species present within the Fish and Shellfish Ecology Study Area include herring, horse mackerel *Trachurus trachurus*, mackerel *Scomber scombus* and sprat *Sprattus sprattus* (Aires *et al.*, 2014, Coull *et al.*, 1998, Ellis *et al.*, 2012, Franco *et al.*, 2023). In addition, there were six Atlantic bluefin tuna *Thunnus thynnus* recorded during the site-specific DAS (Table 9.9).

#### **Marine Fish: Elasmobranchs**

9.6.6 Elasmobranchs are a group of fish species with skeletons made of cartilage as opposed to bone, such as sharks, skates, and rays. There are over 30 species known to occur in UK waters, with the most abundant being the small spotted catshark *Scyliorhinus canicula*, spurdog *Squalus acanthias*, nursehound *Scyliorhinus stellaris*, tope shark *Galeorhinus galeus*, thornback ray *Raja clavata*, and cuckoo ray *Leucoraja naevus* (Baxter *et al.*, 2011, BEIS, 2022). These species were considered to have the potential to occur within the Fish and Shellfish Ecology Study Area. Other elasmobranchs that may be present within the Fish and Shellfish Ecology Study Area include (Coull *et al.*, 1998, Daan *et al.*, 2005, Ellis *et al.*, 2012):

- Basking shark (listed by the IUCN as endangered);
- Blue shark *Prionace glauca*;
- Common skate complex (flapper skate *Dipturus intermedius* and common blue skate *Dipturus batis*, hereafter referred to as ‘common skate’) (listed by the IUCN as critically endangered);
- Porbeagle shark *Lamna nasus* (listed by the IUCN as critically endangered);
- Spotted ray *Raja montagui* and
- Thorny skate *Amblyraja radiata*

9.6.7 Within the site-specific DAS for the Proposed Development, several of these elasmobranch species were recorded: basking shark, blue shark, flapper skate, and porbeagle shark, as well as two unidentifiable sharks.

#### **Diadromous Fish**

9.6.8 Diadromous fish are those which migrate between freshwater and seawater habitats in order to complete their life cycle. There are numerous rivers along the coast of the Fish and Shellfish Ecology Study Area, such as the River Spey, River Oykel, and River Thurso, which have been designated as SACs for diadromous species (see Figure 9.4). Diadromous fish species are known to migrate to and from rivers within the Fish and Shellfish Ecology Study Area and through the Site Boundary throughout the year. Based on the desktop review, the following diadromous species have the potential to migrate within the Fish and Shellfish Ecology Study Area (Baxter *et al.*, 2011, Malcolm *et al.*, 2010, Malcolm *et al.*, 2015, Newton *et al.*, 2021, Newton *et al.*, 2017, River Dee Trust and MSS, 2023, Smith and Smith, 1997):

- Atlantic salmon *Salmo salar* (listed by the IUCN as endangered);

- European eel *Anguilla anguilla* (listed by the IUCN as critically endangered);
- River lamprey *Lampetra fluviatilis*
- Sea lamprey *Petromyzon marinus*
- Sea trout *Salmo trutta* and
- Shads: Allis shad *Alosa alosa* and Twaite shad *Alosa fallax*

9.6.9 Although residing entirely in freshwater, the freshwater pearl mussel *Margaritifera margaritifera* (listed as critically endangered by the IUCN) shares a symbiotic life history with Atlantic salmon and sea trout (Taeubert and Geist, 2017) and may, therefore, be indirectly affected if Atlantic salmon or sea trout are impacted by the Proposed Development. This species has therefore been considered as part of the assessment of potential impacts on diadromous fish.

### Shellfish

9.6.10 Based on a desktop review and the results of site-specific surveys for the Proposed Development and other OWF projects, the following shellfish species have been identified as having the potential to present within the Fish and Shellfish Ecology Study Area:

- Common whelk *Buccinum undatum* (listed by the IUCN as of least concern);
- Crab species, including: common shore crab *Carcinus maenas*, edible crab *Cancer pagurus*, and velvet swimming crab *Necora puber* (least concern);
- Lobster species, including: European lobster *Homarus gammarus* and Norway lobster *Nephrops norvegicus* (least concern);
- Scallop, including: king scallop *Pecten maximus* and queen scallop *Aequipecten opercularis* (least concern);
- Cephalopod species, including: squid (Lolignid and Ommastrephid) and octopi (curled octopus *Eledone cirrhosa* and common octopus *Octopus vulgaris*) (least concern).

### Spawning and Nursery Grounds

9.6.11 There are spawning and nursery grounds for many different species within the Fish and Shellfish Ecology Study Area and/or overlapping with the Site Boundary, as presented in Table 9.10. The spawning and peak spawning periods of these species are presented in Table 9.11.

9.6.12 Figures presenting these spawning and nursery grounds are presented in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report. Further, more recent data sources (Aires *et al.*, 2014, Franco *et al.*, 2023, González-Irusta and Wright, 2016a, González-Irusta and Wright, 2016b, González-Irusta and Wright, 2017, ICES, 2025a, ICES, 2025b) were also explored in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report, which broadly aligned with the spawning and nursery grounds identified by Coull *et al.* (1998) and Ellis *et al.* (2012).

9.6.13 In particular, the Site Boundary overlaps with undetermined intensity spawning grounds of herring and low intensity spawning grounds of sandeel (Table 9.10). Whilst most fish and shellfish species release pelagic eggs that drift within the water column, herring and sandeel are demersal spawners and require specific sediment compositions to spawn successfully. These species are therefore considered substrate-specific and at higher risk to habitat disturbance. Herring require sediment comprised of less than 5% mud and greater than 10% gravel (Reach *et al.*, 2013). Sandeel habitation and spawning requires sediment comprised of less than 10% mud and greater than 70% sand (Latto *et al.*, 2013). The PSA data collected during the site-specific benthic subtidal ecology survey (Paragraph 9.5.5) was used to assess spawning habitat suitability for herring and sandeel as per the sediment classifications outlined Reach *et al.* (2013) and Latto *et al.* (2013), respectively (summarised in Paragraphs 9.6.14 *et seq.*). In addition, the grab sampling data was also used to assess the egg laying habitat for critically endangered flapper skate (see Paragraph 9.6.17).

**Table 9.10: Species with Spawning and/or Nursery Grounds within the Fish and Shellfish Ecology Study Area (adapted from Coull *et al.* (1998) and Ellis *et al.* (2012), N/A = Not Applicable)**

| Species              | Spawning Grounds | Spawning Intensity <sup>†</sup> | Nursery Grounds | Nursery Intensity <sup>†</sup> |
|----------------------|------------------|---------------------------------|-----------------|--------------------------------|
| <b>Teleost Fish</b>  |                  |                                 |                 |                                |
| Anglerfish           | O                | N/A                             | ü*              | High                           |
| Blue whiting         | O                | N/A                             | ü*              | Low                            |
| Cod                  | ü                | Low                             | ü*              | Low                            |
| European hake        | O                | N/A                             | ü*              | Low                            |
| Haddock              | ü                | Undetermined                    | ü*              | Low                            |
| Herring              | ü*               | Undetermined                    | ü*              | High                           |
| Horse mackerel       | O                | N/A                             | ü*              | Not specified                  |
| Lemon sole           | ü*               | Undetermined                    | ü*              | Not specified                  |
| Ling                 | O                | N/A                             | ü*              | Low                            |
| Norway pout          | ü                | Low                             | ü               | Not specified                  |
| Plaice               | ü                | Undetermined                    | ü               | Low                            |
| Saithe               | O                | N/A                             | ü*              | Not specified                  |
| Sandeel              | ü*               | Low                             | ü*              | Low                            |
| Sprat                | ü*               | Undetermined                    | ü*              | Not specified                  |
| Whiting              | ü*               | Low                             | ü*              | High                           |
| <b>Elasmobranchs</b> |                  |                                 |                 |                                |
| Common skate         | O                | N/A                             | ü*              | Low                            |
| Spotted ray          | O                | N/A                             | ü*              | Low                            |
| Spurdog              | O                | N/A                             | ü*              | Low                            |
| Thornback ray        | O                | N/A                             | ü               | Low                            |
| Tope shark           | O                | N/A                             | ü*              | Low                            |
| <b>Shellfish</b>     |                  |                                 |                 |                                |
| Norway lobster       | ü                | Undetermined                    | ü               | Not specified                  |

\*Asterisk signifies that grounds overlap with the Site Boundary; no asterisk signifies that grounds are present within the Fish and Shellfish Ecology Study Area but do not overlap with the Site Boundary.

<sup>†</sup>Colours refer to the intensity of the grounds that overlap with the Site Boundary (if any), otherwise they refer to the intensity of the grounds within the Fish and Shellfish Ecology Study Area if there is no overlap with the Site Boundary.

**Table 9.11: Spawning Periods for Species with Spawning and/or Nursery Grounds within the Fish and Shellfish Ecology Study Area (Adapted from Coull *et al.* (1998) and Ellis *et al.* (2012))**

| Species                               | Month |   |   |   |   |   |   |   |   |   |   |   |
|---------------------------------------|-------|---|---|---|---|---|---|---|---|---|---|---|
|                                       | J     | F | M | A | M | J | J | A | S | O | N | D |
| <b>Teleost Fish</b>                   |       |   |   |   |   |   |   |   |   |   |   |   |
| Anglerfish                            |       |   |   |   |   |   |   |   |   |   |   |   |
| Blue whiting                          |       |   |   | P | P |   |   |   |   |   |   |   |
| Cod                                   |       | P | P |   |   |   |   |   |   |   |   |   |
| European hake                         |       | P | P |   |   |   |   |   |   |   |   |   |
| Haddock                               |       | P | P | P |   |   |   |   |   |   |   |   |
| Herring<br>(Buchan/Shetland<br>Stock) |       |   |   |   |   |   |   |   |   |   |   |   |
| Horse mackerel                        |       |   |   |   | P | P |   |   |   |   |   |   |
| Lemon sole                            |       |   |   |   |   |   |   |   |   |   |   |   |
| Ling                                  |       |   |   |   |   |   |   |   |   |   |   |   |
| Norway pout                           |       | P | P |   |   |   |   |   |   |   |   |   |
| Plaice                                | P     | P |   |   |   |   |   |   |   |   |   |   |
| Saithe                                | P     | P |   |   |   |   |   |   |   |   |   |   |
| Sandeel                               |       |   |   |   |   |   |   |   |   |   |   |   |
| Sprat                                 |       |   |   |   | P | P |   |   |   |   |   |   |
| Whiting                               |       |   |   |   |   |   |   |   |   |   |   |   |
| <b>Elasmobranchs</b>                  |       |   |   |   |   |   |   |   |   |   |   |   |
| Common skate                          | ?     | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| Spotted ray                           |       |   |   | ? | P | P | P | ? |   |   |   |   |
| Spurdog                               |       |   |   |   |   |   |   |   |   |   |   |   |
| Thornback ray                         |       |   | P | P | P | P | P |   |   |   |   |   |
| Tope shark                            |       |   |   |   |   |   |   |   |   |   |   |   |
| <b>Shellfish</b>                      |       |   |   |   |   |   |   |   |   |   |   |   |
| Norway lobster                        |       |   |   | P | P | P |   |   |   |   |   |   |

**Key:**      Spawning period      Peak spawning      P      Unknown      ?

### ***Herring, Sandeel and Flapper Skate Spawning Habitat Suitability Assessment***

- 9.6.14 As presented in Figure 9.2, the sampling sites which represented preferred or marginal spawning habitat suitability for herring were located along the Export Cable Corridor. These intersect with areas of gravelly sand and sandy gravel substrates from the European Marine Observation and Data Network (EMODnet) broad-scale seabed habitat map for Europe (EMODnet, 2025). These EMODnet seabed substrates fit the spawning suitability classifications from Reach *et al.* (2013) and Kyle-Henney *et al.* (2024), further supporting the conclusions that the majority of the Site Boundary consists of unsuitable spawning habitat for herring. To help characterise the Fish and Shellfish Ecology Study Area further, PSA data available on the One Benthic Data Portal (Cefas, 2024) were assessed using the same methodology as for the site-specific grab samples. There were 46 available data points within the Fish and Shellfish Ecology Study Area on the One Benthic Data Portal (Cefas, 2024) at the time of writing. These points are also illustrated in Figure 9.2 and are largely concentrated within the Moray Firth. There were also some samples several kilometres south of the Landfall and in the Orkney islands. The earliest survey date for these data was 2011, and thus these data are still considered temporally relevant to the baseline. All samples from within the Moray Firth represented unsuitable herring spawning habitat, with marginal and preferred habitats present south of the Landfall and in the Orkney islands (Figure 9.2). These correspond to the EMODnet seabed substrates, further emphasising that the majority of the Array Area does not contain preferred spawning habitat for herring.
- 9.6.15 For sandeel, of the 95 site-specific grab samples collected across the Site Boundary, the PSA results indicate that 14 sites comprised of sediments unsuitable for sandeel spawning (14.7%). These samples had mud compositions that were over 10%, with an average of 16.3%. Higher mud content prevents sandeel from maintaining their burrows as the burrows are more likely to collapse and can also reduce respiration due to fine particulate clogging their gill tissues. There were 44 out of 95 samples classified as suitable (therefore a marginal sediment habitat preference), representing 46.3% of the dataset. Finally, there were 37 samples classified as sub-prime (therefore a preferred sediment habitat), representing the remaining 38.9% of the dataset. There were no samples that met the Latta *et al.* (2013) and Reach *et al.* (2024) classification of 'prime' (Figure 9.3). As illustrated in Figure 9.3, the areas of preferred, marginal, and unsuitable habitat are clustered together, with all the grab samples classified as 'preferred' located in the northern portion of the Array Area and towards the Landfall.
- 9.6.16 The 46 available grab samples from the One Benthic Data Portal (Cefas, 2024) were also assessed for sandeel spawning habitat suitability. The majority of the samples from the Moray Firth represented unsuitable

sandeel spawning habitat, with some marginal points towards the south-east (Figure 9.3). In comparison, marginal and preferred spawning habitats were identified from the samples several kilometres south of Landfall and at the Orkney islands (Figure 9.3). These correspond to the EMODnet seabed substrate: Sandy Gravel.



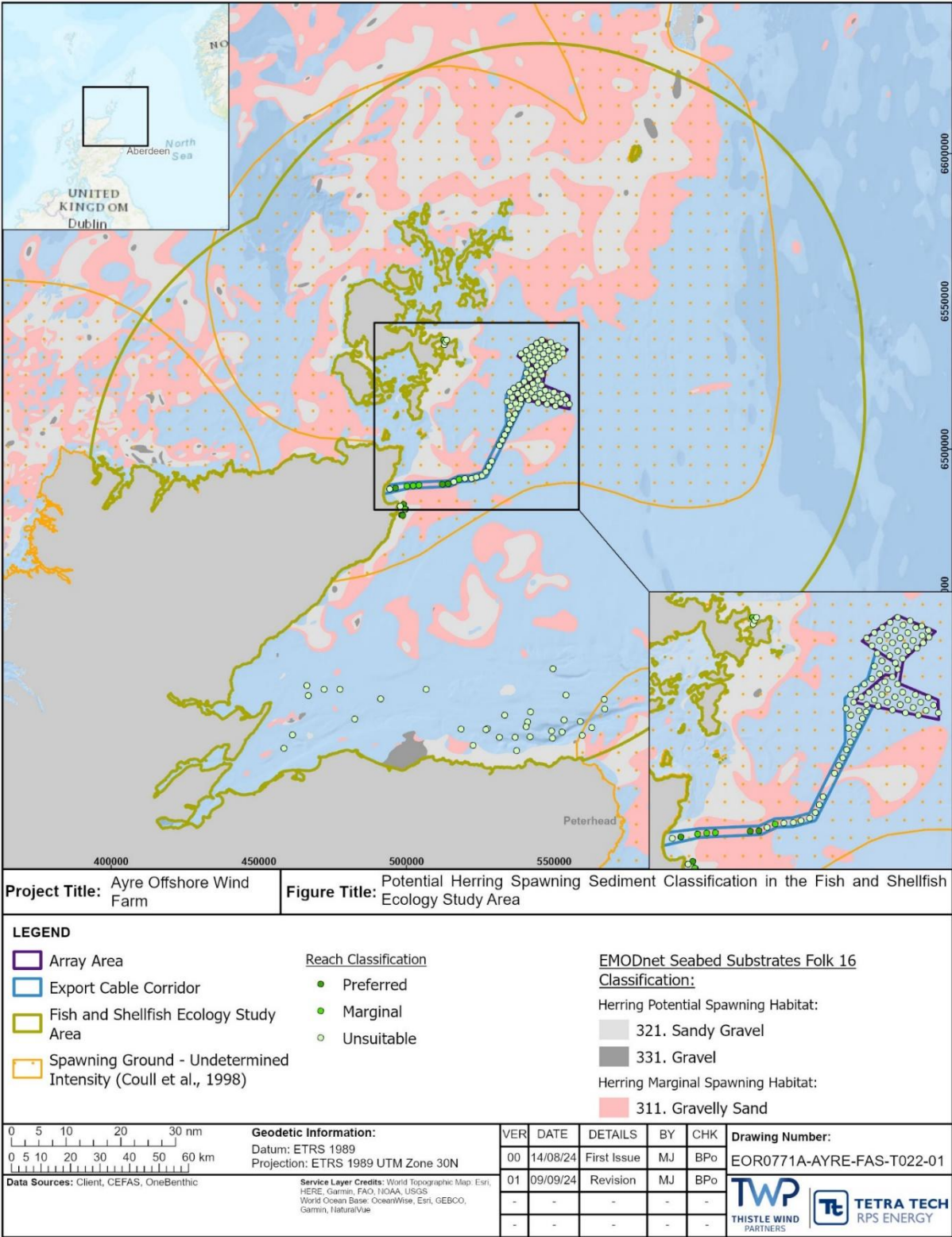


**Figure 9.2: Potential Herring Spawning Sediment Classification in the Fish and Shellfish Ecology Study Area**

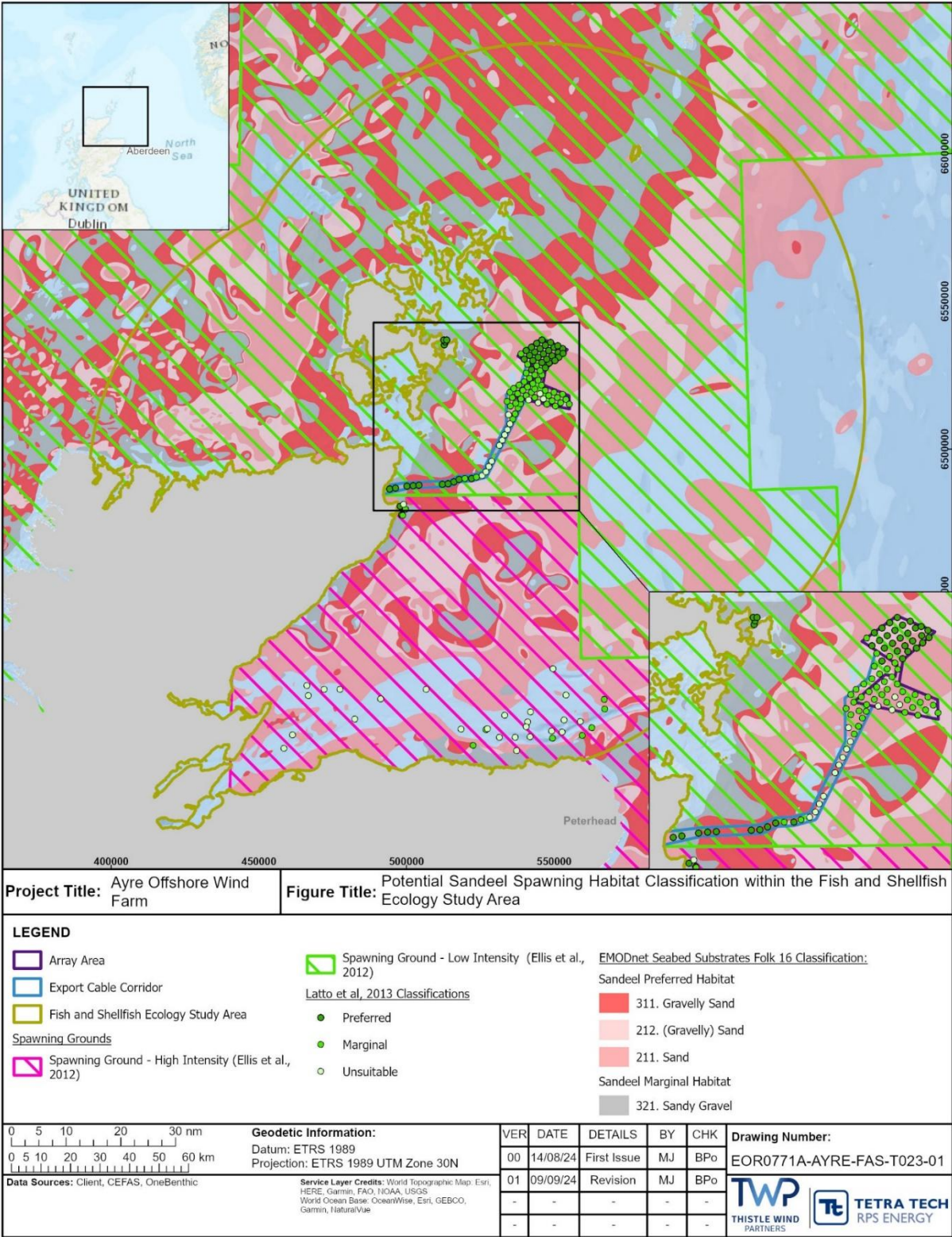


**Figure 9.3: Potential Sandeel Spawning Habitat Classification within the Fish and Shellfish Ecology Study Area**



- 9.6.17 The critically endangered flapper skate has the potential to occur within the Fish and Shellfish Ecology Study Area. This species has specific egg laying habitats, however, a quantitative approach for identifying potential suitable habitat has not yet been devised. Recently, Phillips *et al.* (2021) and the Scottish Government (2021) have suggested that suitable habitats for flapper skate egg laying were boulder, rocky, cobble and/or mixed substrates, with water depths of between -20 m to -50 m, and with significant current flow. While site-specific current flow data were not available from the site-specific surveys for the Proposed Development, the sediment classifications derived from the grab samples provided information on the presence of boulder, rocky, cobbles, and/or mixed sediments.
- 9.6.18 Out of a total of 102 sampling stations, there were seven where grab sampling was not possible, due to the presence of rocky substrates identified in the DDV imagery. However, the sediment composition in the remaining 95 sampling stations was comprised predominantly of sand, with some fractions of gravel and mud recorded along the Export Cable Corridor. The Folk (1954) sediment classifications of each grab sample site illustrated that Slightly Gravelly Sand was the dominant sediment classification throughout the Site Boundary, with variations in the gravel and mud fractions along the Export Cable Corridor. While there were rocky substrates identified in seven possible sample locations, this only represented 7% of the total number of sampling stations (i.e. seven out of 102). Therefore, while some rocky (and potentially suitable egg laying substrates) are present within the Site Boundary, they represent a minority of the overall sediment classification.
- 9.6.19 Water depths were recorded at each grab sampling station, and ranged from a minimum of -20 m to a maximum of -85 m. The average and median water depths were -74.4 m and -76 m, respectively, highlighting that the frequency of waters deeper than -50 m across the sampling sites. Considering the high sand content and consistent depths of over -50 m recorded throughout the Site Boundary, it was concluded that this area is unlikely to represent suitable egg laying habitat for flapper skate according to Phillips *et al.* (2021) and Scottish Government (2021).

#### **Designated Sites**

- 9.6.20 Designated sites and relevant qualifying features identified for fish and shellfish ecology are summarised in Table 9.12 and presented in Figure 9.4. These include eight SACs and one MPA.

**Table 9.12: Designated Sites and Relevant Qualifying Features for the Fish and Shellfish Ecology Study Area**

| <b>Designated Site</b>                   | <b>Distance to the Array Area (km)</b> | <b>Distance to the Export Cable Corridor (km)</b> | <b>Relevant Protected Fish and Shellfish Features</b>              |
|------------------------------------------|----------------------------------------|---------------------------------------------------|--------------------------------------------------------------------|
| <b>River Thurso SAC</b>                  | 71.6                                   | 43.7                                              | Annex II Atlantic salmon                                           |
| <b>North-West Orkney MPA</b>             | 56.8                                   | 59.7                                              | Sandeel (Scottish PMF)                                             |
| <b>Berridale and Langwell Waters SAC</b> | 94.7                                   | 46.6                                              | Annex II Atlantic salmon                                           |
| <b>River Borgie SAC</b>                  | 113.8                                  | 86.0                                              | Annex II Atlantic salmon and freshwater pearl mussel               |
| <b>River Naver SAC</b>                   | 115.8                                  | 88.0                                              | Annex II Atlantic salmon and freshwater pearl mussel               |
| <b>River Spey SAC</b>                    | 131.6                                  | 91.9                                              | Annex II Atlantic salmon, freshwater pearl mussel, and sea lamprey |
| <b>River Evelix SAC</b>                  | 149.5                                  | 101.4                                             | Annex II freshwater pearl mussel                                   |
| <b>River Oykel SAC</b>                   | 164.1                                  | 116.0                                             | Annex II Atlantic salmon and freshwater pearl mussel               |
| <b>Foinaven SAC</b>                      | 157.0                                  | 129.4                                             | Annex II freshwater pearl mussel                                   |

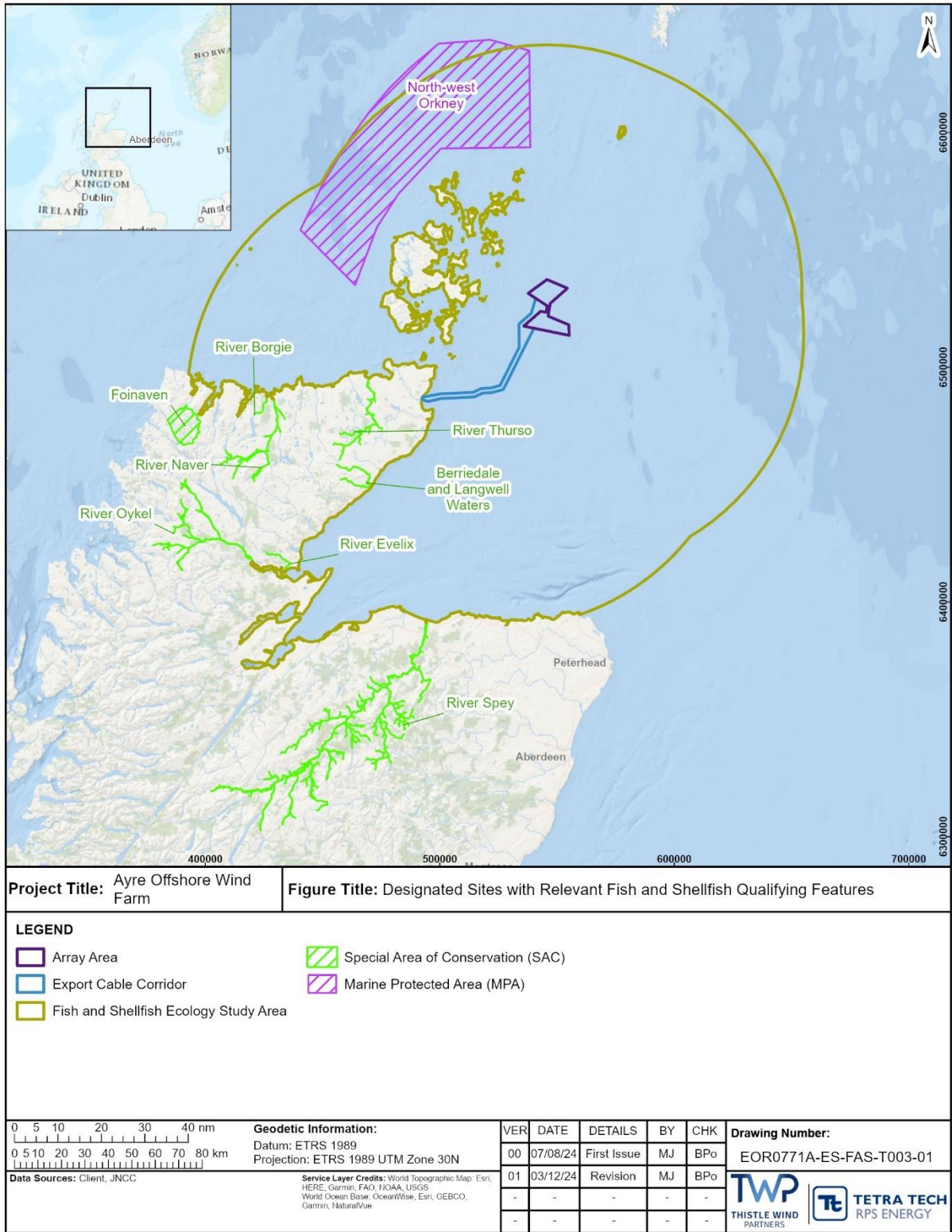


Figure 9.4: Designated Sites with Relevant Fish and Shellfish Qualifying Features

### **Important Ecological Features**

- 9.6.21 IEFs have been identified for the purposes of this chapter as per best practice guidelines (Chartered Institute for Ecology and Environmental Management (CIEEM, 2022)). The potential impacts of the Proposed Development which have been scoped into the assessment (Table 9.15) have been assessed against the IEFs to determine whether or not they are significant, therefore, the IEFs assessed are those that are considered to be important and potentially impacted by the Proposed Development. Importance may be assigned due to quality or extent of habitats, habitat or species rarity or the extent to which they are threatened (CIEEM, 2022). For species to be considered IEFs, they must have a specific biodiversity importance recognised through international or national legislation or through local, regional, or national conservation plans (e.g. Annex II species under the Habitats Directive, Oslo Paris [Convention] (OSPAR) List of Threatened and/or Declining Species, National Biodiversity Plan or the Marine Strategy Framework Directive, Scottish PMFs and Species of Principal Importance (SPI) on the Scottish Biodiversity List (SBL)). Further information on conservation policy and legislation is provided in Section 9.3. The criteria used for determining the importance of the fish and shellfish IEFs are presented in Table 9.13.
- 9.6.22 Table 9.14 lists all of the IEFs within the Fish and Shellfish Ecology Study Area that have been carried forward for assessment.

**Table 9.13: Criteria used to define the IEFs for Fish and Shellfish Ecology**

| Value                | Defining Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>International</b> | <ul style="list-style-type: none"> <li>Species protected under international law that are listed as a qualifying feature of an internationally designated site within the Fish and Shellfish Ecology Study Area (e.g. Annex II species).</li> <li>Species listed under Appendix I and II of the Bonn Convention.</li> <li>Species listed under Annex II (strictly protected fauna) or Annex III (protected fauna) of the Bern Convention.</li> <li>Species listed under Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).</li> </ul>                                                                                                                                                                                                                                             |
| <b>National</b>      | <ul style="list-style-type: none"> <li>Species protected under national law (e.g. SPIs listed on the SBL, species listed as qualifying features of MPAs, Wildlife and Countryside Act 1981).</li> <li>Scottish PMF species.</li> <li>Species listed on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea that have nationally important populations within the Fish and Shellfish Ecology Study Area.</li> <li>Species listed on the IUCN Red List as ‘vulnerable’ or higher that have nationally important populations within the Fish and Shellfish Ecology Study Area.</li> <li>Species that have spawning and/or nursery areas within or in the immediate vicinity of the Site Boundary that are nationally important (e.g. may be primary spawning/nursery areas for that species).</li> </ul> |
| <b>Regional</b>      | <ul style="list-style-type: none"> <li>Species that provide key prey items for other species of conservation value (e.g. forage fish).</li> <li>Species listed on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea that have regionally important populations within the Fish and Shellfish Ecology Study Area.</li> <li>Species listed on the IUCN Red List as ‘vulnerable’ or higher that have regionally important populations within the Fish and Shellfish Ecology Study Area.</li> <li>Species with spawning and/or nursery areas within the Fish and Shellfish Ecology study Area which are important regionally (i.e. they may spawn elsewhere, but these are key spawning/nursery areas).</li> </ul>                                                                                      |
| <b>Local</b>         | <ul style="list-style-type: none"> <li>Species which are not protected under any conservation legislation and may be common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.</li> <li>Species with spawning and/or nursery grounds within the Fish and Shellfish Ecology Study Area.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |



**Table 9.14: IEFs Within the Fish and Shellfish Ecology Study Area**

| IEF                          | Importance | Justification                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Marine Fish: Teleosts</b> |            |                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Anglerfish</b>            | National   | Scottish PMF. There are also high intensity nursery grounds for anglerfish overlapping with the Site Boundary.                                                                                                                                                                                                                                                                                     |
| <b>Atlantic bluefin tuna</b> | National   | Listed as a SPI on the SBL.                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Blue whiting</b>          | National   | Scottish PMF and listed as a SPI on the SBL. There are low intensity nursery grounds for blue whiting overlapping with the Site Boundary.                                                                                                                                                                                                                                                          |
| <b>Cod</b>                   | National   | OSPAR List of Threatened and/or Declining Species, Scottish PMF and listed as a SPI on the SBL. There are also low intensity nursery and spawning grounds within the Fish and Shellfish Ecology Study Area, with the nursery grounds overlapping with the Site Boundary. It should also be noted that the cod stock within the Moray Firth is reproductively isolated from other North Sea stocks. |
| <b>European hake</b>         | National   | Listed as a SPI on the SBL. There are low intensity nursery grounds for European hake overlapping with the Site Boundary.                                                                                                                                                                                                                                                                          |
| <b>Haddock</b>               | Regional   | Haddock spawning and nursery areas have been identified within the Fish and Shellfish Ecology Study Area, with the nursery grounds overlapping with the Site Boundary. These are of undetermined intensity, so it is not determined if these are important regionally. As a precaution, haddock have been concluded to have 'regional' importance.                                                 |
| <b>Herring</b>               | National   | Scottish PMF, listed as a SPI on the SBL, and has spawning grounds in the immediate vicinity of the Site Boundary (around Orkney) which are nationally important. Further, herring are a key forage fish species for other species of conservation value within the Fish and Shellfish Ecology Study Area (such as other fish, marine mammals and seabirds).                                       |
| <b>Horse mackerel</b>        | National   | Scottish PMF. Further, horse mackerel are a key forage fish species for other species of conservation value within the Fish and Shellfish Ecology Study Area (such as other fish, marine mammals and seabirds). There are nursery grounds for horse mackerel overlapping with the Site Boundary.                                                                                                   |
| <b>Lemon sole</b>            | Regional   | Lemon sole spawning and nursery areas have been identified within the Fish and Shellfish Ecology Study Area, which also overlap with the Site Boundary. These are of undetermined intensity, so it is not determined if these are important regionally. As a precaution, lemon sole have been concluded to have 'regional' importance.                                                             |

| IEF                                                        | Importance | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Ling</b>                                                | National   | Scottish PMF and listed as a SPI on the SBL. There are also low intensity nursery grounds for ling overlapping with the Site Boundary.                                                                                                                                                                                                                                                                                                                                                              |
| <b>Mackerel</b>                                            | National   | Scottish PMF and listed as a SPI on the SBL. Further, mackerel are a key forage fish species for other species of conservation value within the Fish and Shellfish Ecology Study Area (such as other fish, marine mammals and seabirds).                                                                                                                                                                                                                                                            |
| <b>Norway pout</b>                                         | National   | Scottish PMF and listed as a SPI on the SBL. There are spawning and nursery grounds for Norway pout within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                                                                                                                                                               |
| <b>Other flatfish species (common dab, long rough dab)</b> | Local      | These species are not protected under any conservation legislation and are typically common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                                                                                                             |
| <b>Plaice</b>                                              | National   | Listed as a SPI on the SBL. There are spawning and nursery grounds for plaice within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Poor cod</b>                                            | Local      | This species is not protected under any conservation legislation and is typically common in UK waters but forms a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                                                                                                               |
| <b>Saithe</b>                                              | National   | Scottish PMF. There are also nursery grounds for saithe overlapping with the Site Boundary.                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Sandeel species</b>                                     | National   | Scottish PMF, listed as a SPI on the SBL, and a feature of an MPA within the Fish and Shellfish Ecology Study Area. Further, sandeels are key forage fish for other species of conservation value within the Fish and Shellfish Ecology Study Area (such as other fish, marine mammals and seabirds). There are also low intensity spawning and nursery grounds for sandeel overlapping with Site Boundary, and the PSA results suggest that this area could largely be suitable habitat substrate. |
| <b>Sole</b>                                                | National   | Listed as a SPI on the SBL.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Sprat</b>                                               | Regional   | Sprat spawning and nursery areas have been found within the Fish and Shellfish Ecology Study Area that overlap with the Site Boundary. These may be important regionally. Further, sprat are a key forage fish species for other species of conservation value within the Fish and Shellfish Ecology Study Area (such as other fish, marine mammals and seabirds).                                                                                                                                  |
| <b>Whiting</b>                                             | National   | Scottish PMF and listed as a SPI on the SBL. There are low intensity spawning grounds and high intensity nursery grounds overlapping with the Site Boundary.                                                                                                                                                                                                                                                                                                                                        |

| IEF                               | Importance    | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Marine Fish: Elasmobranchs</b> |               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Basking shark</b>              | International | Listed under Appendix II of the Bern Convention, under the Bonn Convention, and CITES. Basking shark are also protected under the Wildlife and Countryside Act 1981 and listed on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea and SBL. This species is also a Scottish PMF. Basking shark has an IUCN Status of 'Endangered'.                                                                                      |
| <b>Blue shark</b>                 | International | Listed under Appendix III of the Bern Convention and under the Bonn Convention. Blue shark are also listed on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea and the SBL, and have an IUCN Status of 'Near Threatened'.                                                                                                                                                                                               |
| <b>Common skate</b>               | National      | Listed on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea, the SBL, and as a Scottish PMF. Common skate also has an IUCN Status of 'Critically Endangered'. This species has nationally important populations in the north and north-west of Scotland (thus within the Fish and Shellfish Ecology Study Area). There are also low intensity nursery grounds for this species overlapping with the Site Boundary.       |
| <b>Cuckoo ray</b>                 | Local         | Cuckoo ray is not protected under any conservation legislation and are common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                                                                                      |
| <b>Flapper skate</b>              | National      | Flapper skate is listed as a SPI on the SBL and has an IUCN Status of 'Critically Endangered'. This species has nationally important populations in the north and north-west of Scotland (thus within the Fish and Shellfish Ecology Study Area). It should also be noted that the various other conservation designations for common skate could be extrapolated to flapper skate, as the two species have only recently been recognised as separate species. |
| <b>Nursehound</b>                 | Regional      | Nursehound are not protected under any conservation legislation but are listed on the IUCN Red List as 'vulnerable' and likely have regionally important populations within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                                                         |
| <b>Porbeagle shark</b>            | International | Listed under Appendix III of the Bern Convention, under the Bonn Convention, and CITES. Porbeagle shark are also listed on the SBL and the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea. This species is also a Scottish PMF. Porbeagle shark has an IUCN Status of 'Critically Endangered'.                                                                                                                            |

| IEF                                           | Importance    | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Small spotted catshark</b>                 | Local         | Small spotted catshark is not protected under any conservation legislation and are common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                                                                                                                                          |
| <b>Spotted ray</b>                            | Regional      | Spotted ray are listed on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea and likely have regionally important populations within the Fish and Shellfish Ecology Study Area. There are also low intensity nursery grounds for this species overlapping with the Site Boundary.                                                                                                                                                                                                         |
| <b>Spurdog</b>                                | International | Spurdog is protected under the Bonn Convention. Spurdog is also listed on the OSPAR List and SBL. This species is also a Scottish PMF. Spurdog has an IUCN Status of 'Vulnerable'. There are also low intensity nursery grounds for this species overlapping with the Site Boundary.                                                                                                                                                                                                                                           |
| <b>Thornback ray</b>                          | National      | Thornback ray is listed as a SPI on the SBL, and on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea. There are also low intensity nursery grounds for this species within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                                                                                   |
| <b>Thorny skate</b>                           | Local         | Thorny skate is not protected under any conservation legislation and are common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area. This species is also listed as 'Vulnerable' on the IUCN Red List, but there are no nationally or regionally important or recognised populations within the Fish and Shellfish Ecology Study Area.                                                                                                                                  |
| <b>Tope shark</b>                             | International | Tope shark is protected under the Bonn Convention. They are also listed as a SPI on the SBL. Tope shark an IUCN Status of 'Critically Endangered'. There are also low intensity nursery grounds for this species overlapping with the Site Boundary.                                                                                                                                                                                                                                                                           |
| <b>Diadromous fish and associated species</b> |               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Allis shad</b>                             | International | Listed under Annex II of the Habitats Regulations but not as a qualifying feature of any SACs within the Fish and Shellfish Ecology Study Area, and under Appendix III of the Bern Convention. Allis shad are also protected under national legislation, such as the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 and the Wildlife and Countryside Act 1981. This species is listed on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea and as a SPI on the SBL. |

| IEF                    | Importance    | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Atlantic salmon</b> | International | Listed under Annex II of the Habitats Regulations and as a qualifying feature of SACs within the Fish and Shellfish Ecology Study Area. Atlantic salmon are also listed under Appendix III of the Bern Convention and under national legislation, such as the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 and as a SPI on the SBL. Atlantic salmon are also on the OSPAR List and a Scottish PMF. In the latest species reassessment by the IUCN Red List of Threatened Species, released in December 2023, Atlantic salmon have been reclassified from 'Least Concern' to 'Endangered' in Great Britain (as a result of a 30-50% decline in British populations since 2006 and 50-80% projected between 2010-2025). |
| <b>European eel</b>    | International | Listed under Appendix II of CITES and the Bonn Convention. European eel is also listed under national legislation, such as the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 and as a SPI on the SBL. European eel is also on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea and a Scottish PMF. This species has an IUCN Status of 'Critically Endangered'.                                                                                                                                                                                                                                                                                                                  |
| <b>River lamprey</b>   | International | Listed under Annex II of the Habitats Regulations but not as a qualifying feature of any SACs within the Fish and Shellfish Ecology Study Area. River lamprey is also listed under Appendix III of the Bern Convention and under national legislation, such as the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 and as a SPI on the SBL. River lamprey is also a Scottish PMF.                                                                                                                                                                                                                                                                                                                                        |
| <b>Sea lamprey</b>     | International | Listed under Annex II of the Habitats Regulations and as a qualifying feature of SACs within the Fish and Shellfish Ecology Study Area. Sea lamprey is also listed under Appendix III of the Bern Convention and under national legislation, such as the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 and as a SPI on the SBL. Sea lamprey is on the OSPAR List of Threatened and/or Declining Species within OSPAR Region II: North Sea and are also a Scottish PMF.                                                                                                                                                                                                                                                 |
| <b>Sea trout</b>       | National      | Sea trout are protected under national legislation: the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 and as a SPI on the SBL. Sea trout are also a Scottish PMF.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Twaite shad</b>     | International | Listed under Annex II of the Habitats Regulations but not as a qualifying feature of any SACs within the Fish and Shellfish Ecology Study Area. Listed under Appendix III of the Bern Convention. Twaite shad is also protected under national legislation, such as the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 and the Wildlife and Countryside Act 1981. This species is also listed as a SPI on the SBL.                                                                                                                                                                                                                                                                                                      |

| IEF                            | Importance    | Justification                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Freshwater pearl mussel</b> | International | Listed under Annex II of the Habitats Regulations and as a qualifying feature of SACs within the Fish and Shellfish Ecology Study Area. Freshwater pearl mussel is also listed under Appendix III of the Bern Convention and under the Wildlife and Countryside Act 1981. Freshwater pearl mussel is also listed as a SPI on the SBL. This species has an IUCN Status of 'Critically Endangered'. |
| <b>Shellfish</b>               |               |                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Common whelk</b>            | Local         | Common whelk is not protected under any conservation legislation and may be common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                                    |
| <b>Crabs</b>                   | Local         | The crab species described in the shellfish baseline are not protected under any conservation legislation and may be common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.                                                                                                                                                           |
| <b>Lobsters</b>                | Local         | The lobster species described in the shellfish baseline are not protected under any conservation legislation and may be common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area. Norway lobster also has spawning and nursery grounds within the Fish and Shellfish Ecology Study Area.                                                 |
| <b>King and queen scallop</b>  | Local         | King and queen scallop are not protected under any conservation legislation and may be common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.                                                                                                                                                                                         |
| <b>Squid and octopi</b>        | Local         | The squid and octopi species described in the shellfish baseline are not protected under any conservation legislation and may be common in UK waters but form a key component of the biodiversity within the Fish and Shellfish Ecology Study Area.                                                                                                                                               |

### Future Baseline Scenario

- 9.6.23 The EIA Regulations require that ‘a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge’ is included within the Offshore EIA Report.
- 9.6.24 If the Proposed Development does not come forward, an assessment of the ‘without development’ future baseline conditions have also been carried out and are described within this section.
- 9.6.25 The fish and shellfish baseline environment is not static and may change naturally over time, even if the Proposed Development does not come forward. This is due to naturally occurring cycles and processes, such as spawning behaviour, primary production, and associated prey availability throughout the food web. In addition to this potential natural change, the potential effects of climate change on the marine environment should also be considered. Variability and long term changes on physical processes, ocean acidification, stratification, and water temperature may bring direct and indirect changes to fish and shellfish populations and communities in the mid to long term future (Heath *et al.*, 2012).
- 9.6.26 Increased sea surface temperatures have been predicted to occur due to climate change. A study by Hughes *et al.* (2018) illustrated that Scottish waters (coastal and oceanic) have warmed by between 0.05°C and 0.07°C per decade, from 1870 to 2016. Increased temperatures will likely have an effect on fish and shellfish species at all biological levels (cellular, individual, population, species, community and ecosystem) both directly and indirectly. As sea temperatures rise, species adapted to cold water (such as cod and herring) may spawn earlier in the year and/or demonstrate earlier larval development (McQueen and Marshall, 2017, Weigel *et al.*, 2021). Further, typical North Sea species may migrate further north towards cooler waters, while species adapted to warm water may become more established in their absence (Dahms and Killen, 2023, Hastings *et al.*, 2020).
- 9.6.27 It has also been predicted that changes in weather patterns under climate change (such as increased spring storms), could alter the stratification of water columns and primary production (Morison *et al.*, 2019). This could result in knock on impacts on fish and shellfish species due to altered food availability throughout trophic levels. Overall, climate change presents many uncertainties about the future fish and shellfish baseline.
- 9.6.28 In addition, changes to fisheries management measures may also affect the fish and shellfish baseline. For example, the Sandeel (Prohibition of Fishing) (Scotland) Order 2024 introduced a ban on sandeel fishing from



March 2024 within the Scottish zone (i.e. the sea adjacent to Scotland out to 200 nm), with similar measures in the English waters of the North Sea. This order was appealed by the EU during a tribunal in late 2024 and into 2025. The results of this tribunal were published in June 2025, with the ban on sandeel fishing retained in both Scottish and English waters of the North Sea. It is anticipated that this closure will provide wider direct benefits to sandeel populations (through reduction of pressures from fishing) and indirect benefits to a wide range of fish, seabird and marine mammal species, given that sandeel are important prey species for them.

### **Data Limitations and Assumptions**

- 9.6.29 The desktop data used were the most up to date publicly available information which could be obtained from the applicable data sources as presented in Table 9.8 at the time of writing. Data that have been collected are based on existing literature and consultation with stakeholders and SNCBs. It should be noted that some datasets are over a decade old, such as Coull *et al.* (1998), Ellis *et al.* (2012), and Aires *et al.* (2014). However, these are industry-standard datasets and have been included and assessed with the caveat that they are now quite dated. Long-term time series of data, such as the IBTS and IHLS have demonstrated the continued validity of these datasets, with spawning and nursery grounds continuing to remain broadly consistent with these studies (González-Irusta and Wright, 2016a, González-Irusta and Wright, 2016b, González-Irusta and Wright, 2017). A full assessment of the fish and shellfish baseline is presented in Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report.
- 9.6.30 It is always possible that not all potential fish and shellfish species within the Fish and Shellfish Ecology Study Area have been identified. However, given the detailed desktop study completed and the precautionary approach adopted, which has included the identification of a broad Fish and Shellfish Ecology Study Area, it is unlikely that any key species have been omitted from the baseline characterisation.

## **9.7 Key Parameters for Assessment**

### **Maximum Design Scenario**

- 9.7.1 The MDS identified in Table 9.15 are those parameters expected to have the potential to result in the greatest effect on an identified receptor or receptor group. Any other development scenario within the Project Design Envelope (PDE), will result in the same, or less, level of environmental effect. The scenario has been selected from the details provided in Volume 1, Chapter 3: Project Description.
- 9.7.2 The assessment of the impacts associated with the Proposed Development for fish and shellfish ecology has been informed by and will inform other chapters within the Offshore EIA Report. For example, the assessment on the impact of 'increased SSCs and associated deposition'

has been informed by Volume 2, Chapter 7: Physical Processes, and Volume 3, Technical Appendix 7.1: Physical Processes Technical Report. Further, the assessment of 'impacts to fish and shellfish due to subsea noise' has been informed by modelling presented in Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report. Finally, the assessment presented in this chapter for fish and shellfish ecology has been used to inform the assessment of 'changes in prey availability' in Volume 2, Chapter 10: Marine Mammals, and Volume 2, Chapter 11: Offshore Ornithology.

**Table 9.15: Maximum Design Scenario Considered for Each Potential Impact as Part of the Assessment of Likely Significant Environmental Effects on Fish and Shellfish Ecology**

| Potential Impact                                 | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------|-------|-----|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Temporary habitat loss and/or disturbance</b> | ✓     | ✓   | ✓ | <p><b>Construction Phase</b></p> <p>Up to <b>18,000,341.50 m<sup>2</sup> (18 km<sup>2</sup>)</b> of subtidal temporary habitat loss and/or disturbance in total, this represents up to <b>4.64%</b> of the total area of the Site Boundary, due to:</p> <p><u>HDD Exit Pit Excavation</u></p> <p>Up to 10,240 m<sup>2</sup> of habitat disturbance associated with excavation of exit pits compromising:</p> <ul style="list-style-type: none"> <li>Up to 7,040 m<sup>2</sup> from deposition of 3,520 m<sup>3</sup> of HDD excavation material; and</li> <li>Up to 3,200 m<sup>2</sup> of habitat disturbance from the installation of up to four HDD exit pits.</li> </ul> <p><u>Sandwave clearance</u></p> <p>Up to 342,176.60 m<sup>2</sup> of habitat disturbance associated with sandwave clearance compromising:</p> <ul style="list-style-type: none"> <li>Offshore Subsea Collector (SC): 2,144 m<sup>2</sup> for the installation of up to two SCs in areas of sandwaves;</li> <li>Inter-array Cables (IACs): up to 39,613.60 m<sup>2</sup> (assumes 0.37% requires clearance with a 58.60 m width of disturbance); and</li> </ul> | <p>The MDS for this impact considers the maximum seabed footprint of temporary habitat loss and/or disturbance during the construction, O&amp;M, and decommissioning phases of the Proposed Development.</p> <p><b>Construction Phase</b></p> <p><u>HDD Exit Pit Excavation</u></p> <p>Based on up to:</p> <ul style="list-style-type: none"> <li>800 m<sup>2</sup> width per exit pit.</li> </ul> <p><u>Sandwave clearance</u></p> <p>Based on up to:</p> <ul style="list-style-type: none"> <li>20 m width per SC;</li> <li>185 km total length of IACs; and</li> <li>360 km total length of Offshore Export Cables.</li> </ul> <p><u>Sandwave Clearance material deposition</u></p> <p>The area of seabed affected by the placement of sandwave clearance material has been calculated based on the maximum volume of sediment to be</p> |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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|                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                  |       |     |   | <ul style="list-style-type: none"> <li>Offshore Export Cables: up to 300,419 m<sup>2</sup> (assumes 1.42% requires clearance with a 58.60 m width of disturbance).</li> </ul> <p><u>Sandwave clearance material deposition</u><br/>Up to 2,724,790 m<sup>2</sup> of habitat disturbance associated with the deposition of sandwave clearance material compromising:</p> <ul style="list-style-type: none"> <li>IACs: up to 316,476 m<sup>2</sup> from deposition of 158,238 m<sup>3</sup> of sandwave clearance material;</li> <li>Offshore Export Cables: up to 2,4000,070.80m<sup>2</sup> from deposition of 1,200,035.40 m<sup>3</sup> of sandwave clearance material; and</li> <li>SCs: up to 8,234.20 m<sup>2</sup> from deposition of 4,121.60 m<sup>3</sup> of sandwave clearance material.</li> </ul> <p><u>Cable installation (including boulder clearance)</u><br/>Up to 14,679,934.90 m<sup>2</sup> of habitat disturbance associated with cable installation compromising:</p> <ul style="list-style-type: none"> <li>IACs: up to 4,308,100 m<sup>2</sup> disturbance from installation of up to 185 km of IACs (assumes 5.18% requires boulder clearance with a 25 m width of disturbance).</li> <li>Interconnector Cables: up to 1,500,000 m<sup>2</sup> from installation of up to 60 km of Interconnector Cables.</li> <li>Offshore Export Cables: up to 8,871,834.90 m<sup>2</sup> of disturbance from installation of up to 360 km of Offshore Export Cables (assumes 9.69% requires boulder clearance with a 25 m width of disturbance).</li> </ul> | <p>placed on the seabed, assuming all this sediment is coarse material (i.e. is not dispersed through tidal currents). The total footprint of seabed affected has been calculated, for the purposes of the MDS, assuming a mound of uniform thickness of 0.5 m height. Temporary loss of seabed habitat is assumed beneath this.</p> <p><u>Cable installation (including boulder clearance)</u><br/>The MDS assumes that up to 173 km of the IACs cable will be on the seabed, with up to 12 km in the water column.</p> <p>Based on the assumption that the width of disturbance for sandwave and boulder clearance also includes subsequent cable installation as repeat disturbance. As such up to 88.9% of the length of Offshore Export Cables, and up to 94.43% of the length of IACs will need burial only.</p> <p><u>Cable removal</u><br/>Based on the assumption that the width of disturbance is similar to that of installation: 25 m.</p> <p><u>Jack-up events</u></p> |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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|                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                  |       |     |   | <p><u>Cable removal</u><br/>Up to 50,000 m<sup>2</sup> from the removal of 2,000 m of disused cables.</p> <p><u>Jack-up events</u><br/><br/>Up to 193,200 m<sup>2</sup> of disturbance due to jack-up vessel use for the installation of up to two OSPs and up to 67 fixed Wind Turbine foundations.</p> <p><u>Additional Subtidal Information</u><br/><br/>In addition, up to 6,993.40 m<sup>2</sup> of temporary habitat loss and/or disturbance could occur due to crater formation from the clearance of UXOs. This value has not been included in the total disturbance presented above, as the footprint from UXO clearance will likely overlap with area subject to temporary habitat disturbance from other site preparation activities. Additionally, the footprint associated with UXO clearance has not been derived from Volume 1, Chapter 3: Project Description. Instead, it has been calculated based on appropriate crater sizes estimated in Ordtek (2018), and applied to the 20 UXOs that may require clearance during the construction phase of the Proposed Development.</p> <p><b>O&amp;M Phase</b><br/><br/>A total of <b>2,632,500 m<sup>2</sup> (2.63 km<sup>2</sup>)</b> of temporary subtidal habitat loss and/or disturbance, this represents up to</p> | <p>Based on the assumption that there will be up to a maximum of up to two jack-up positions per OSP and Wind Turbine foundation.</p> <p><u>Additional Subtidal Information</u><br/><br/>UXO clearance MDS calculated from the maximum estimated crater diameter of 21.10 m in Ordtek (2018).</p> <p><b>O&amp;M Phase</b><br/><br/><u>Disturbance caused by reburial of IACs, Interconnector Cables, and Offshore Export Cables</u><br/><br/>Based on the assumption of up to 1,170 m of cable per cable type each year, with repair and subsequent reburial/protection occurring at the same time.<br/>IACs cable reburial/protection events are only considered for static cables.</p> |

| Potential Impact                                 | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Justification                                                                                                                                                                                                                             |
|--------------------------------------------------|-------|-----|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                           |
|                                                  |       |     |   | <p><b>0.68%</b> of the total area of the Site Boundary, over the up to 30 year life cycle of the Proposed Development due to:</p> <p><u>Disturbance caused by reburial of IACs, Interconnector Cables, and Offshore Export Cables</u></p> <p>Up to 1,170 m of cable reburial/protection may be required per year for repair each for Offshore Export Cables, IACs and interconnector cables. The width of disturbance is up to 25 m.</p> <p><b>Decommissioning Phase</b></p> <p>A Decommissioning Programme will be submitted to MD-LOT for consultation and approval. The Decommissioning Programme will be updated during the Project's lifespan to take account of changing best practice and new technologies.</p> <p>The approach for decommissioning is yet to be determined, however, for the purposes of this MDS total removal of all infrastructure including buried cables and cable protection has been assumed, and as such the environmental impact of decommissioning will be the same if not lower than construction.</p> |                                                                                                                                                                                                                                           |
| <b>Long term habitat loss and/or disturbance</b> | ✓     | ✓   | ✓ | <p><b>Construction and O&amp;M Phases</b></p> <p>Up to <b>3,042,840 m<sup>2</sup> (3.04 km<sup>2</sup>)</b> of subtidal long term habitat loss and/or disturbance due to infrastructure installed in the construction phase, which will persist into the O&amp;M phase. This represents up to <b>0.78%</b> of the total area of the Site Boundary and comprises:</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <p><b>Construction and O&amp;M Phases</b></p> <p>The MDS for this impact considers the maximum seabed footprint of infrastructure installed during the construction phase. This will persist through the up to 30 year O&amp;M phase.</p> |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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|                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                  |       |     |   | <ul style="list-style-type: none"> <li>Footprint area of 230,240 m<sup>2</sup> due to floating TLP gravity based Wind Turbine foundations (up to 40 foundations with a seabed footprint of 5,756 m<sup>2</sup> each, including scour protection);</li> <li>Footprint area of 778,500 m<sup>2</sup> due to cable protection for IACs (up to 86.5 km of cable requiring protection, with a cable protection width of 9 m);</li> <li>Footprint area of 36,000 m<sup>2</sup> due to cable crossing protection for IACs (up to 8 crossings, with a length of 500 m and width of 9 m each);</li> <li>Footprint area of 270,000 m<sup>2</sup> due to cable protection for interconnector cables (up to 30 km of cable requiring protection, with a cable protection width of 9 m);</li> <li>Footprint area of 13,500 m<sup>2</sup> due to cable crossing protection for interconnector cables (up to 3 crossings, with a length of 500 m and width of 9 m each);</li> <li>Footprint area of 1,620,000 m<sup>2</sup> due to cable protection for export cables (up to 180 km of cable requiring protection, with a cable protection width of 9 m);</li> <li>Footprint area of 72,000 m<sup>2</sup> due to cable crossing protection for export cables (up to 16 crossings, with a length of 500.00 m and width of 9 m each);</li> <li>Footprint area of 13,800 m<sup>2</sup> due to OSP foundations (maximum of 2 OSPs) and their scour protection;</li> </ul> | <p>This impact considers the design parameters that will result in the greatest footprint of habitat loss and disturbance.</p> <p><b>Decommissioning Phase</b></p> <p>In the decommissioning phase, the MDS accounts for the maximum seabed footprint of infrastructure that could remain <i>in situ</i>. It should be noted that after an up to 30 year O&amp;M phase, these artificial hard structures left <i>in situ</i> on the seabed would represent established habitats within the Site Boundary.</p> <p>The MDS assumes that the scour protection is pre-installed, with the pile then installed through the scour protection. The total footprint therefore remains the same as with scour protection only.</p> |



| Potential Impact                                                                         | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Justification                                                                                                                                                                                                                                        |
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|                                                                                          | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                      |
|                                                                                          |       |     |   | <ul style="list-style-type: none"> <li>Footprint area of 800 m<sup>2</sup> of mud mats associated with the OSPs; and</li> <li>Footprint area of 8,000 m<sup>2</sup> due to offshore SCs (maximum 20, with a footprint of 400 m<sup>2</sup> each).</li> </ul> <p>The O&amp;M phase will last up to 30 years.</p> <p><b>Decommissioning Phase</b></p> <p>A Decommissioning Programme will be submitted to MD-LOT for consultation and approval. The Decommissioning Programme will be updated during the Proposed Development's lifespan to take account of changing best practice and new technologies.</p> <p>The approach for decommissioning is yet to be determined, however, for the purposes of this MDS it has been assumed that all scour protection, cable protection, and cable crossing protection will be left <i>in situ</i>. Therefore, up to <b>3,042,840 m<sup>2</sup> (3.04 km<sup>2</sup>)</b> of long term habitat loss will persist past the decommissioning phase. This value is the total footprint area for all scour protection, cable protection, and cable crossing protection. This represents up to <b>0.78%</b> of the total area of the Site Boundary.</p> |                                                                                                                                                                                                                                                      |
| <b>Introduction of artificial habitat and subsequent colonisation of hard structures</b> | ✓     | ✓   | ✓ | <p><b>Construction and O&amp;M Phases</b></p> <p>Introduction of up to <b>3,412,840 m<sup>2</sup> (3.41 km<sup>2</sup>)</b> of hard structure surface area installed throughout the construction phase and persisting into the up to 30 year O&amp;M phase. The MDS is for floating TLP gravity based</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | The MDS for this impact considers the maximum surface area of hard structures installed on the seabed during the construction phase and persisting into the O&M phase. This represents artificial habitat which may be colonised by benthic species. |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Justification                                                                                                                                                                                                                                                                         |
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|                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                       |
|                  |       |     |   | <p>Wind Turbine foundations (up to 40 foundations) and is due to:</p> <ul style="list-style-type: none"> <li>• Surface area of 585,000 m<sup>2</sup> from up to 360 gravity anchors (9 anchors per Wind Turbine foundation);</li> <li>• Footprint area of 19,840 m<sup>2</sup> from scour protection for turbines, OSPs and OSP mud mats;</li> <li>• Footprint area of 2,668,500 m<sup>2</sup> from cable protection;</li> <li>• Footprint area of 121,500 m<sup>2</sup> from cable crossings; and</li> <li>• Surface area of 18,000 m<sup>2</sup> from up to 20 SCs.</li> </ul> <p>In addition, floating Wind Turbine foundations, OSP jackets, dynamic cables, and anchor mooring lines represent hard substrate introduced into the water column. Given the complexity of calculating the surface area of this infrastructure and the uncertainty around final foundation design, it is not possible to provide a surface area like that provided for infrastructure installed on the seabed. In addition, marine growth may periodically be removed from the floating Wind Turbine foundations, mooring and dynamic cables as it could inhibit buoyancy.</p> <p>Therefore, the MDS for this impact is represented by a surface area of up to <b>3,412,840 m<sup>2</sup> (3.41 km<sup>2</sup>)</b> of hard structures installed on the seabed and an unquantified surface area present within the water column.</p> <p><b>Decommissioning Phase</b></p> | <p>Surface area has been calculated for gravity anchors and SCs based on the dimensions given within the PDE.</p> <p>Footprint areas for scour protection, cable crossings and cable protection have been calculated as per the long term habitat loss and/or disturbance impact.</p> |

| Potential Impact                                | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------|-------|-----|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                 | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                 |       |     |   | <p>A Decommissioning Programme will be submitted to MD-LOT for consultation and approval. The Decommissioning Programme will be updated during the Project's lifespan to take account of changing best practice and new technologies.</p> <p>The approach for decommissioning is yet to be determined, however, for the purposes of this MDS it has been assumed that all gravity anchors, scour protection, cable protection, and cable crossing protection will be left <i>in situ</i>. Therefore, up to <b>3,412,840 m<sup>2</sup> (3.41 km<sup>2</sup>)</b> of hard structures will be left <i>in situ</i> on the seabed, allowing this impact to persist past the decommissioning phase.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Increased SSCs and associated deposition</b> | ✓     | ✓   | ✓ | <p><b>Construction Phase</b></p> <p><u>Drilling for anchor installation</u></p> <p>Up to 692,701 m<sup>3</sup> of drill arising for all piles, for the 25 MW semi-submersible or Tension Leg Platform (TLP) floating Wind Turbine layout, comprising:</p> <ul style="list-style-type: none"> <li>• Maximum number of drilled piles: 360 (max foundations = 40; max piles per foundation = 9);</li> <li>• Maximum dimensions of drilled pile section: 5 m diameter, 98 m max. penetration depth;</li> <li>• Maximum volume of drill arisings per pile: 1,924 m<sup>3</sup>; and</li> <li>• Maximum concurrent drilling events: 2.</li> </ul> <p><u>IAC installation</u></p>                        | <p><b>Construction Phase</b></p> <p>The MDS corresponds to (a combination of) the greatest amount of material disturbed and the greatest geographical extent of the impact.</p> <p><u>Drilling for anchor installation</u></p> <p>Based on the greatest total amount of material disturbed, considering the largest pile dimension, number of pile anchors and number of concurrent drilling events. Assumes two concurrent drilling events can occur for the same foundation, resulting in the MDS for instantaneous SSC.</p> |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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|                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                  |       |     |   | <ul style="list-style-type: none"> <li>Maximum number of IACs: 133 (15 MW Wind Turbine layout);</li> <li>Maximum total length of IACs in contact with seabed: 173 km;</li> <li>Trench dimensions: up to 6 m wide; 1.5 m deep (average); 'V' shape profile;</li> <li>Excavation method: Jetting, Mass Flow Excavation (MFE), Ploughing/Pre-Ploughing, Trenching/Pre-Trenching (incl. dredging, cutting); and</li> <li>MFE pre-lay trenching rate: 400 m/hour.</li> </ul> <p><u>Offshore Export Cable installation</u></p> <ul style="list-style-type: none"> <li>Maximum number of Export Cables: 4</li> <li>Maximum total length of each Export Cable: 90 km</li> <li>Trench dimensions: Up to 6 m wide; 1.5 m deep (average); 'V' shape profile</li> <li>Excavation method: Jetting, MFE, Ploughing/Pre-Ploughing, Trenching/Pre-Trenching (incl. dredging, cutting)</li> <li>MFE Pre-lay trenching rate: 400 m/hour.</li> </ul> <p><u>Sandwave clearance</u></p> <ul style="list-style-type: none"> <li>Sandwave clearance width along IAC: 58.6 m;</li> <li>Area of IAC sandwave clearance: 39,613.6 m<sup>2</sup>;</li> <li>Sandwave clearance width for SCs: 53.6 m;</li> </ul> | <p>Piles relating to OSPs are smaller in diameter and require less drilling depth than Wind Turbine foundations therefore do not represent the MDS.</p> <p><u>Inter-Array Cable installation</u></p> <p>Pre-lay trenching by MFE will give MDS for sediment disturbance. Conservatively assumes 100% fluidisation of material expelled from trench. In reality, pre-lay jetting will move a proportion of material rather than bringing it fully into suspension. Modelling was carried out for sediment release along a section of an indicative cable route which runs parallel and then perpendicular to the tidal axis for two full tidal cycles.</p> <p><u>Offshore Export Cable installation</u></p> <p>Pre-lay trenching by MFE will give MDS for sediment disturbance. Conservatively assumes 100% fluidisation of material expelled from trench. In reality pre-lay jetting will move a proportion of material rather than bringing it fully into suspension. Export Cable Corridor pre-lay trenching modelling assumes sediment release along the whole Export Cable Corridor.</p> <p><u>Sandwave clearance</u></p> |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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|                  |       |     |   | <ul style="list-style-type: none"> <li>Area of SC sandwave clearance: 2,144 m<sup>2</sup>;</li> <li>Sandwave clearance width along Export Cable: 58.6 m;</li> <li>Area of Export Cable area of export cable coming sandwave clearance: 300,419 m<sup>2</sup>; and</li> <li>Clearance method: Mass Flow Excavator and/or Dredger.</li> </ul> <p><u>HDD exit pit excavation</u></p> <ul style="list-style-type: none"> <li>Number of exit pits: 4; and</li> <li>880 m<sup>3</sup> excavated material for each pit (3,520 m<sup>3</sup> for all pits).</li> </ul> <p><u>HDD drilling fluid release (at Landfall)</u></p> <ul style="list-style-type: none"> <li>Number of exit/release events: up to 4;</li> <li>Up to 1,030 m<sup>3</sup> drilling mud generated per HDD duct, based on bore diameter of 1.05 m and duct length of 1,190 m (4,120 m<sup>3</sup> total for all four ducts);</li> <li>100,000 mg/l (100 kg/m<sup>3</sup>) assumed conservative maximum concentration of Bentonite in drilling mud; and</li> <li>Wet punch-out.</li> </ul> <p><b>O&amp;M Phase</b></p> <p><u>Cable repairs</u></p> <ul style="list-style-type: none"> <li>Number of annual static IAC repairs: 1;</li> </ul> | <p>Sandwave clearance/levelling activities may be undertaken using a range of techniques – MFE and suction hopper dredging. Releases via both are modelled. A conservative MFE near-bed sediment release rate of 1,000 kg/s conservatively estimated based on the MDS trench cross section dimensions, the speed of progress of the tool, and the bulk density of the local sediment type. Dredge spoil release is simulated as an instantaneous release at the water surface. 10% of a 11,000 m<sup>3</sup> hopper is assumed to form the passive phase of the plume. Other seabed preparation such as boulder clearance is not considered here as the activity does not represent the MDS in terms of potential increases in SSC and associated changes to seabed substrate.</p> <p><u>HDD exit pit excavation</u></p> <p>Based on maximum exit pit dimensions.</p> <p><u>HDD drilling fluid release (at landfall)</u></p> <p>Based on maximum HDD duct dimensions. Assumes a conservative Bentonite concentration of 100 kg/m<sup>3</sup> in drilling mud. Other stages of drilling (pilot hole drilling and stages of reaming) may result in smaller release events</p> |

| Potential Impact                                           | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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|                                                            |       |     |   | <ul style="list-style-type: none"> <li>Number of annual dynamic IAC repairs: 1;</li> <li>Maximum annual length of IAC reburial: 1,170 m;</li> <li>Number of annual static Export Cable repairs: 1; and</li> <li>Maximum annual length of Export Cable reburial: 1,170 m.</li> </ul> <p><b>Decommissioning Phase</b></p> <p>A Decommissioning Programme will be submitted to MD-LOT for consultation and approval. The Decommissioning Programme will be updated during the Proposed Development's lifespan to take account of changing best practice and new technologies.</p> <p>The approach for decommissioning is yet to be determined, however, for the purposes of this MDS total removal of all infrastructure including buried cables and cable protection has been assumed, and as such the environmental impact of decommissioning will be the same if not lower than construction.</p> | <p>separated in time. But the MDS is considered as a release of drilling mud from a single conduit.</p> <p><b>O&amp;M Phase</b></p> <p>The MDS for sediment disturbance during operation will be no greater than that set out for the construction phase of the Proposed Development.</p> <p><u>Cable repairs</u></p> <p>These limited activities would disturb a much smaller volume of material for each repair/reburial event than simulated for the construction phase.</p> <p><b>Decommissioning Phase</b></p> <p>The MDS for sediment disturbance during decommissioning will be no greater than that set out for the construction phase of the Proposed Development.</p> |
| <b>Subsea noise impacting fish and shellfish receptors</b> | ✓     | ✓   | ✓ | <p><b>Construction Phase</b></p> <p><u>Piling</u></p> <p><i>Floating Foundations – 25 MW Semi-sub:</i></p> <ul style="list-style-type: none"> <li>Number of floating foundations: 40;</li> <li>Maximum number of piles: 360;</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p><b>Construction Phase</b></p> <p><u>Piling</u></p> <p>The impact assessment will consider the worst-case impact ranges from both single and concurrent piling scenarios. Noise modelling will estimate impact ranges for instantaneous auditory injury, accumulated auditory injury (over the</p>                                                                                                                                                                                                                                                                                                                                                                            |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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|                  |       |     |   | <ul style="list-style-type: none"> <li>Maximum pile diameter: 5 m;</li> <li>Maximum pile length: 100 m, with final pile penetration of 98 m;</li> <li>Maximum hammer energy: 4,500 kJ; and</li> <li>Maximum duration of piling: 20 hours.</li> </ul> <p><i>Fixed Foundations – 25 MW 3-legged jacket:</i></p> <ul style="list-style-type: none"> <li>Number of fixed foundations: 40;</li> <li>Maximum number of piles: 120;</li> <li>Maximum pile diameter: 4.8 m;</li> <li>Maximum pile length: 75 m, with final pile penetration of 70 m;</li> <li>Maximum hammer energy: 4,500 kJ; and</li> <li>Maximum duration of piling: 14 hours.</li> </ul> <p><i>Realistic– 25 MW semi-submersible (Average):</i></p> <ul style="list-style-type: none"> <li>Number of floating foundations: 40;</li> <li>Maximum number of piles: 360;</li> <li>Maximum pile diameter: 5 m;</li> <li>Maximum pile length: 100 m, with final pile penetration of 98 m;</li> <li>Maximum hammer energy: 4,275 kJ; and</li> <li>Maximum duration of piling: 10 hours.</li> </ul> <p><i>Concurrent piling – all three scenarios:</i></p> <ul style="list-style-type: none"> <li>Up to 2 vessels piling concurrently; and</li> </ul> | <p>duration of the installation period) and disturbance.</p> <p>Three scenarios have been chosen for modelling purposes that will encompass all potential foundation options.</p> <p><i>Floating foundations</i><br/>The key parameters used for the noise modelling for both the semi-submersible and TLP options are almost identical. With the exception that the maximum piling duration is 1 hour longer in the semi-submersible option than the TLP. Therefore, the MDS for floating foundations is based on the 25 MW semi-submersible.</p> <p><i>Fixed foundations</i><br/>The MDS for fixed foundations is based on the 25 MW, 3-legged jacket option. The parameters modelled for this option will encompass the OSPs.</p> <p><i>Realistic Scenario</i><br/>This is based on the 25 MW semi-submersible option, using the average hammer energy and average piling duration (instead of maximums) in order to provide context. A key parameter in the estimation of accumulated injury, is the duration of impact piling.</p> |



| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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|                  |       |     |   | <ul style="list-style-type: none"> <li>Minimum 1 km and maximum 15 km distance between concurrent piling events.</li> </ul> <p><u>UXO clearance</u></p> <ul style="list-style-type: none"> <li>Maximum realistic charge weight of UXO - 720 kg (Net Explosive Quantity (NEQ));</li> <li>A maximum of 20 UXOs are anticipated to require clearance (based on most probable case for Array Area and Export Cable Corridor combined);</li> <li>A maximum of 2 detonations during 24 hrs; and</li> <li>The maximum number of days – 20 assuming two clearance events per day.</li> </ul> <p><u>Site investigation surveys</u></p> <p>Typical Geotechnical equipment:</p> <ul style="list-style-type: none"> <li>Boreholes; and</li> <li>Vibrocore.</li> </ul> <p>Site investigation surveys will take place during the pre-construction period, involving up to 15 vessels on site at any one time and up to 140 vessel movements (return trips) in total.</p> <p><u>Vessel noise and other noise producing activities</u></p> <p>A total of 19 vessels will be on site at any one time during the pre-construction phase, resulting in a total of 170 return trips.</p> | <p>Concurrent piling will be modelled in addition to single pile events. In all cases concurrent piling would lead to a larger spatial extent of ensonification in total, in comparison to a single piling event.</p> <p>Minimum spacing between concurrent piling represents the highest risk of auditory injury to animals as noise from adjacent foundations could combine to produce a greater radius of effect compared to a single piling event. This represents the MDS for concurrent piling injury impacts.</p> <p>Maximum spacing between concurrent piling represents a larger area of ensonification. This represents the MDS for concurrent piling disturbance impacts.</p> <p><u>UXO clearance</u></p> <p>Maximum number used in the MDS (reflecting the most probable worst case) and the maximum size of UXOs encountered within the Site Boundary is based on the UXO Hazard Assessment undertaken for the Array. The actual detail of any possible UXO that may need clearance is not known at this stage.</p> <p>Although not specific to fish and shellfish, the JNCC (2025a) guidelines for</p> |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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|                  |       |     |   | <p>A total of 16 vessels will be working on the export cable at any one time, with an estimated 642 return trips in total.</p> <p>Vessel activity for the Array Area predicted for the floating foundation type is considered to present the worst case in terms on the number of vessels onsite at any one time, and the total number of return trips, 30 and 2,181 respectively.</p> <p>Vessel types include jack-up, heavy transport, scour protection, grouting, drilling, support vessels (dive, trenching), tugs, cable laying (and burial), guard, survey, Crew Transfer Vessels (CTV), and boulder and UXO clearance vessels.</p> <p>Other noise producing activities (if required):</p> <ul style="list-style-type: none"> <li>• Drilling of up to a maximum of 1,470 days (25 MW TLP option).</li> </ul> <p><b>O&amp;M Phase</b></p> <p><u>Site investigation surveys</u></p> <p>MDS based on the same geotechnical equipment used for the construction phase.</p> <p><u>Vessel noise and other noise producing activities</u></p> <p>For the Array Area, a total of 10 vessels at any one time will be involved over the duration of O&amp;M phase (up to</p> | <p>minimising the risk of injury to marine mammals from UXO clearance, states that the default method for clearance should be a low noise method, as required by the Government's Joint Position Statement (UK Government, 2025). The MDS represents the maximum charge weight likely to be present, noise modelling will estimate impact ranges for low order as the default, with high order impact ranges for context.</p> <p><u>Site investigation surveys</u></p> <p>Site investigation surveys are conducted in the pre-construction phase. However, details of the specific equipment types are not yet known. The assessment will be based on literature/known acoustic characteristics associated with typical equipment used for site surveys.</p> <p><u>Vessel noise and other noise producing activities</u></p> <p>Maximum numbers of vessels on site at any one time and largest numbers of return trips during each phase will result in the greatest potential impact.</p> <p>Range of other activities producing underwater noise, including maximum timescales were also included.</p> |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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|                  |       |     |   | <p>30 years) making a total of up to 643 return trips per year. Vessels will be associated with a range of O&amp;M activities, including routine inspections, repairs and replacements, removal of marine growth and painting.</p> <p>For the Export Cable Corridor, a total of 2 vessels at any one time will be involved over the duration of the O&amp;M phase (up to 30 years) at any one time making a total of up to 19 return trips per year. Vessels will be associated with a range of O&amp;M activities, including routine inspections, repairs and replacements, removal of marine growth and painting.</p> <p><u>Operational noise from Wind Turbines</u></p> <ul style="list-style-type: none"> <li>Fixed foundation 4-legged jacket structure with a maximum number of 67 WTG; and</li> <li>Floating foundation with a maximum of 67 floating foundations, with a total of 402 catenary mooring lines</li> </ul> <p>The O&amp;M phase will last up to 30 years.</p> <p><b>Decommissioning Phase</b></p> <p><u>Vessel noise and other noise producing activities</u></p> <p>A Decommissioning Programme will be submitted to MD-LOT for consultation and approval. The Decommissioning Programme will be updated during the Project's lifespan</p> | <p>Drilling noise will be assessed using an appropriate source level and modelled as continuous noise over a 24-hour period.</p> <p>Injury and disturbance from vessel use during UXO clearance and site investigation surveys is included under this potential impact pathway.</p> <p><b>O&amp;M Phase</b></p> <p><u>Site investigation surveys</u></p> <p>Site investigation surveys may also be required during the O&amp;M phase. The assessment conducted for the pre-construction phase will be applied to the O&amp;M phase as the same types of equipment are typically used.</p> <p><u>Vessel noise and other noise producing activities</u></p> <p>As above for the construction phase.</p> <p><u>Operational noise from Wind Turbines</u></p> <p>Operational subsea noise from fixed foundations and floating foundations is expected to be broadly similar, as most noise will be generated from the above water structures (e.g., tower, nacelle, turbine and rotors). Additional noise from floating structures emanates from the moorings and cables.</p> |

| Potential Impact                                          | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Justification                                                                                                                                                                                                                                                                                                                                                                                           |
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|                                                           | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                           |       |     |   | <p>to take account of changing best practice and new technologies.</p> <p>The approach for decommissioning is yet to be determined, however, for the purposes of this MDS it is assumed there will be a range of vessels used for decommissioning activities such as removal of foundations, cables and cable.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>The MDS for both fixed and floating reflects the maximum scale of the Array (based upon the maximum number of Wind Turbines) as well as the type and dimensions of the floating Wind Turbines and anchor mooring lines.</p> <p>Floating using catenary mooring line types selected as worst case as these lines may be subject to more tension release ‘snaps’ than taut mooring configurations.</p> |
| <b>Impacts to fish and shellfish receptors due to EMF</b> | x     | ✓   | x | <p><b>O&amp;M Phase</b></p> <p>EMFs may be emitted to the marine environment from IAC, interconnector cables, and Export Cables. Where feasible, a minimum burial depth of 0.5 m applies to all cables, however, there will be a target burial depth of 1.5 m. Where burial is not feasible, cable protection will be used. There will be a total of <b>605 km</b> of High Voltage Alternating Current (HVAC) cables, comprised of:</p> <ul style="list-style-type: none"> <li>• Up to 185 km of 132 kV IAC (up to 173 km at the seabed and up to 12 km within the water column);</li> <li>• Up to 60 km of 275 kV interconnector cables (a maximum of 3 Interconnector Cables); and</li> <li>• Up to 360 km of 275 kV export cables (up to 4 export cables, with a maximum length of 90 km each).</li> </ul> <p>The O&amp;M phase will last up to 30 years.</p> | <p>The MDS for this impact is based on the greatest cable lengths proposed, in the water column, buried in the seabed, and protected where burial is not possible.</p>                                                                                                                                                                                                                                  |

| Potential Impact                                                   | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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|                                                                    | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Impacts to fish and shellfish receptors due to entanglement</b> | x     | ✓   | x | <p><b>O&amp;M Phase</b></p> <p>There will be a total of 135,816 m (135.82 km) of mooring lines and dynamic IACs within the water column.</p> <p>IACs:</p> <ul style="list-style-type: none"> <li>Maximum total length of dynamic IACs in the water column: 12 km, with a minimum diameter of 155 mm and a maximum external diameter of 200 mm.</li> </ul> <p>Floating Wind Turbine foundations – Semi-submersible, a maximum of 67 foundations:</p> <ul style="list-style-type: none"> <li>Up to 402 catenary mooring lines in total;</li> <li>Comprised of synthetic materials (nylon, dyneema, and polyester) and chains; and</li> <li>Length of mooring line in water column during normal operations – up to six mooring lines per foundation of 308 m each, with a total of 1,848 m per foundation (therefore 123,816 m (123.82 km) for all 67 foundations).</li> </ul> <p>The O&amp;M phase will last up to 30 years.</p> | <p>The MDS for this impact considers the maximum number of mooring lines and dynamic cables within the water column. While primary entanglement is not likely (i.e. individuals becoming entangled in the mooring lines and/or dynamic cables themselves due to their diameters, and relative stiffness), secondary entanglement has been considered as part of this assessment. This involves entanglement in marine debris (such as lost and discarded fishing nets) that have become entangled with the mooring lines and/or dynamic cables themselves.</p> <p>Note that the MDS is based on the total length in the water column, because the majority of IAC length will be on the seabed, rather than within the water column.</p> |
| <b>Accidental pollution to the surrounding environment</b>         | ✓     | ✓   | ✓ | <p><b>Construction Phase</b></p> <p>Vessel activity for the Array Area predicted for the floating foundation type is considered to present the worst-case in terms on the number of vessels onsite at any one time, and the total number of return trips, 30 and 2,181 respectively.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>The MDS is based on the maximum number of vessels that may be on site at any one time and the number of return trips, alongside the number of structures within the Site Boundary that could increase vessel collision/allision risk. 'Collision' refers to the impact between two moving vessels or a vessel and</p>                                                                                                                                                                                                                                                                                                                                                                                                                 |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Justification                                                                                                                                                                                                                                                                                                                                                                        |
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|                  |       |     |   | <p>A total of 16 vessels will be working on the Export Cable Corridor at any one time, with an estimated 642 return trips in total.</p> <p>Vessel types include jack-up, heavy transport, scour protection, grouting, drilling, support vessels (dive, trenching), tugs, cable laying/installation (and burial), guard, survey, CTVs, boulder/sandwave/UXO clearance vessels.</p> <p><u>Structures - Maximum extent of Array Area infrastructure to remain within Array Area boundary:</u></p> <ul style="list-style-type: none"> <li>• Up to 67 Wind Turbines;</li> <li>• Minimum spacing between Wind Turbines of 1,086 m;</li> <li>• Maximum number of HVAC OSPs: 2 (fixed) assumed to be located on the Array Area perimeter (position not defined);</li> <li>• OSP topsides up to 80 m length and 60 m width; and</li> <li>• Up to 8 legs per OSP jacket foundation.</li> </ul> <p><u>Consumables:</u><br/>The following consumables are associated with the Wind Turbines and/or OSPs, which will be installed during the construction phase:</p> <ul style="list-style-type: none"> <li>• grease;</li> <li>• synthetic and mineral oil;</li> <li>• transformer silicon/ester oil;</li> <li>• diesel fuel</li> <li>• Sulphur Hexafluoride (SF6); and</li> <li>• glycol/coolants.</li> </ul> | <p>another object in motion, while ‘allision’ refers to the impact between a moving vessel and a stationary object, such as a Wind Turbine or OSP. Both could result in vessel damage/loss and subsequent pollution to the surrounding environment. The MDS also considers the consumables associated with Proposed Development which could pollute the environment if released.</p> |

| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Justification |
|------------------|-------|-----|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
|                  |       |     |   | <p><b>O&amp;M Phase</b></p> <p>For the Array Area, a total of ten vessels at any one time will be involved over the duration of the O&amp;M phase (30 years) making a total of up to 643 return trips per year. Vessels will be associated with a range of O&amp;M activities, including routine inspections, repairs and replacements, removal of marine growth and painting.</p> <p>For the Export Cable Corridor, a total of two vessels at any one time will be involved over the duration of O&amp;M phase (up to 30 years) at any one time making a total of up to 19 return trips per year. Vessels will be associated with a range of O&amp;M activities, including routine inspections, repairs and replacements, removal of marine growth and painting.</p> <p>The structures within the Site Boundary are as detailed above for the construction phase.</p> <p><u>Consumables:</u><br/>The consumables detailed above for the construction phase will also be associated with Wind Turbine and OSP operation in the O&amp;M phase.</p> <p><b>Decommissioning Phase</b></p> <p>A Decommissioning Programme will be submitted to MD-LOT for consultation and approval. The Decommissioning Programme will be updated during the lifespan of the Proposed Development to take account of changing best practice and new technologies.</p> <p>The approach for decommissioning is yet to be determined, however, for the purposes of this MDS it is</p> |               |



| Potential Impact | Phase |     |   | Maximum Design Scenario                                                                                                                                                                                                                                                                                               | Justification |
|------------------|-------|-----|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|                  | C     | O&M | D |                                                                                                                                                                                                                                                                                                                       |               |
|                  |       |     |   | <p>assumed there will be a range of vessels used for decommissioning activities such as removal of foundations, cables and cable protection.</p> <p><u>Consumables:</u><br/>The consumables detailed above for the construction phase could also be spilled during the decommissioning of Wind Turbines and OSPs.</p> |               |

\* Proposed Development Phase refers to construction (C), O&M (O) and decommissioning (D).

### Impacts Scoped Out of the Assessment

- 9.7.3 The Scoping Workshop (see Table 9.7) was used to facilitate stakeholder engagement on topics to be scoped out of the assessment.
- 9.7.4 On the basis of the baseline environment and the Project Description outlined in Volume 1, Chapter 3: Project Description, a number of impacts are scoped out of the assessment for fish and shellfish ecology. These were either agreed with key stakeholders through consultation (Table 9.7) or the impact was proposed to be scoped out in the Offshore Scoping Report (Thistle Wind Partners (TWP, 2024)) and this was confirmed in the Scoping Opinion received.
- 9.7.5 This impact is outlined, together with a justification for scoping it out, in Table 9.16.

**Table 9.16: Impacts Scoped Out of the Assessment for Fish and Shellfish Ecology (Tick Confirms the Impacts is Scoped Out)**

| Potential Impact                                              | Phase |     |   | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------|-------|-----|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                               | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Release of sediment-bound contaminants</b>                 | ✓     | ✓   | ✓ | Sediment chemistry analyses from the recent site-specific benthic subtidal ecology survey for the Proposed Development recorded low levels of contamination (see Volume 3, Technical Appendix 8.1: Benthic Ecology Technical Report). The likelihood of contaminant release from sediment due to seabed disturbance and the remobilisation of sediment-bound contaminants is therefore considered to be low. This impact has, therefore, been scoped out of further consideration within the Offshore EIA Report, and this approach was agreed upon by stakeholders in the Scoping Opinion (Table 9.7).                          |
| <b>Subsea noise from vessels impacting fish and shellfish</b> | ✓     | ✓   | ✓ | The presence of vessels associated with all three phases of development is not likely to represent a significant change from the baseline vessel traffic in the Fish and Shellfish Ecology Study Area (see Volume 2, Chapter 14: Shipping and Navigation for more information). Therefore, this impact was scoped out of further consideration within the Offshore EIA Report, and this approach was agreed upon by stakeholders in the Scoping Opinion (Table 9.7).                                                                                                                                                             |
| <b>Impacts to fish and shellfish from INNS</b>                | ✓     | ✓   | ✓ | There is potential for the increased risk of introduction and spread of INNS during all phases of development. This is due to vessel movement which may act as vectors facilitating the spread of INNS. In addition, the installation of artificial hard structures (such as foundations, scour protection, and cable protection) may represent increased available habitat for INNS to colonise in the O&M phase. This impact has been scoped in for benthic ecology (see Volume 2, Chapter 8: Benthic Ecology). However, given the wider ranging nature and habitat use of fish and shellfish species in comparison to benthic |

| Potential Impact                                      | Phase |     |   | Justification                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------|-------|-----|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                       | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                       |       |     |   | species, this impact is not likely to represent a significant impact to fish and shellfish ecology. This, in combination with the Embedded Mitigation of an INNS management plan, was deemed sufficiently rational to scope this out of further assessment within the Offshore EIA Report, and this approach was agreed upon by stakeholders in the Scoping Opinion (Table 9.7).                     |
| <b>Impacts to diadromous fish from shadow flicker</b> | x     | ✓   | x | Although not considered in the Offshore Scoping Report, this impact was raised by some consultees during the Scoping Opinion (Table 9.7). As this is a novel impact for the OWF industry, the justification to scope this out was based on expert technical judgement and consultation with MD-LOT, post-Scoping Opinion. The full justification to scope this impact out is presented in Table 9.7. |

## 9.8 Methodology for Assessment of Effects

### Overview

9.8.1 The fish and shellfish assessment of effects has followed the methodology set out in Volume 1, Chapter 4: EIA Methodology. Specific to the fish and shellfish ecology assessment, the following guidance documents have also been considered:

- Guidelines for Ecological Impact Assessment (EcIA) in the UK and Ireland (CIEEM, 2022);
- Marine Evidence Based Sensitivity Assessment (MarESA) – A Guide (Tyler-Walters *et al.*, 2018);
- Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.*, 2014);
- Screening Spatial Interactions between Marine Aggregate Application Areas and Atlantic Herring Potential Spawning Habitat (Kyle-Henney *et al.*, 2024, Reach *et al.*, 2013);
- Screening Spatial Interactions between Marine Aggregate Application Areas and Sandeel Habitat (Latto *et al.*, 2013, Reach *et al.*, 2024); and
- Guidance on Environmental Considerations for OWF Development (OSPAR Commission, 2008).

### Criteria for Assessment

9.8.2 Information about the Proposed Development (including the MDS discussed in Section 9.6.29 above) and the proposed activities within all stages of the Proposed Development life cycle (construction, O&M, and decommissioning) have been combined with information about the fish

and shellfish baseline to identify the potential interactions between the Proposed Development and fish and shellfish ecology.

- 9.8.3 Impacts are categorised through various characteristics as shown in Table 9.17.

**Table 9.17: Descriptions of Categories Related to EIA Impacts**

| <b>Impact Categories</b>          | <b>Description</b>                                                                                                                                                                          |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Direct or Indirect</b>         | Direct impacts occur at the same time as an action and occur within the same area, as opposed to indirect impacts which still result from an action but arise later or in a different area. |
| <b>Adverse or Beneficial</b>      | Adverse impacts have an adverse effect on the environment while beneficial impacts have a beneficial effect on the environment.                                                             |
| <b>Reversible or Irreversible</b> | Reversible impacts are temporary, with natural recovery possible, unlike irreversible impacts, where natural recovery is not possible.                                                      |
| <b>Cumulative</b>                 | Impacts that arise from a combination of the Proposed Development and other projects.                                                                                                       |
| <b>Transboundary</b>              | When an impact has an effect on an area that falls within the boundary of another European Economic Area (EEA).                                                                             |
| <b>Inter-related</b>              | The potential effects of multiple impacts from the construction, O&M and decommissioning of the Proposed Development, affecting one receptor.                                               |

- 9.8.4 The criteria for defining magnitude in this chapter are outlined in Table 9.18. Each assessment considered the spatial extent, duration, frequency and reversibility of impact when determining magnitude which are outlined within the magnitude section of each impact assessment (e.g. a duration of hours or days would be considered for most receptors to be of short-term duration, which is likely to result in a low magnitude of impact).

**Table 9.18: Definition of Terms relating to Magnitude of Impact**

| <b>Magnitude of Impact</b> | <b>Definition</b>                                                                                                                                                                             |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>High</b>                | Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse)                                                               |
|                            | Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial)                                               |
| <b>Medium</b>              | Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements (Adverse)                                            |
|                            | Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial)                                                                          |
| <b>Low</b>                 | Some measurable change in attributes, quality or vulnerability, minor loss or, or alteration to, one (maybe more) key characteristics, features or elements (Adverse)                         |
|                            | Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial) |
| <b>Negligible</b>          | Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse)                                                                                      |
|                            | Very minor benefit to, or positive addition of one or more characteristics, features or elements (Beneficial)                                                                                 |

9.8.5 The criteria for defining sensitivity in this chapter are outlined in Table 9.19. The Feature Activity Sensitivity Tool (FeAST) and/or a MarESA are available for some fish and shellfish species. The FeAST and MarESA provide assessments of sensitivity against a set of defined pressures. Where available, species-specific FeASTs and MarESAs have been used to inform the sensitivity of some IEFs. For IEFs that do not have a FeAST or MarESA, the sensitivity has been informed by the best available scientific literature and through expert judgement of the technical specialist(s). Not all impacts assessed in Section 9.10 have relevant sensitivity pressures associated with them on FeAST and MarESA, so these have not been used for some impacts. For potential impacts wherein there are no relevant FeAST or MarESA pressures (or where they haven't been assessed due to limited information), the best available scientific literature and expert judgement has been used to inform the sensitivity of the receptor.

9.8.6 There are only two relevant fish and shellfish IEFs listed as features on the FeAST: common skate and sandeels, however the assessments provided on FeAST are limited for many pressures as this tool is still in development. There are MarESAs for the following IEFs: basking shark, common skate (and by extrapolation, flapper skate), common shore crab, edible crab, Norway lobster, and king scallop. It should be noted that all the aforementioned species except basking shark have an outdated

MarLIN sensitivity assessment, which was superseded for some species by the MarESA in 2014. There are some slight differences in the pressures included and the naming of some pressures between the MarLIN sensitivity assessment and the more recent MarESA. However, the MarLIN sensitivity assessments are still relevant to define the sensitivity of the receptor and have been referred to as ‘MarESA’ throughout to increase readability and prevent confusion.

**Table 9.19: Definition of Terms Relating to the Sensitivity of the Receptor**

| <b>Sensitivity of the Receptor</b> | <b>Definition</b>                                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------------|
| <b>Very High</b>                   | Very high importance and rarity, international receptor with no potential or very limited potential for recovery |
| <b>High</b>                        | High importance and rarity, international and/or national receptor and limited potential for recovery            |
| <b>Medium</b>                      | High or medium importance and rarity, regional receptor, and potential for recovery                              |
| <b>Low</b>                         | Low or medium importance and rarity, local receptor and high potential for recovery                              |
| <b>Negligible</b>                  | Very low importance and rarity, local receptor and very high potential for recovery                              |

- 9.8.7 The magnitude of the impact and the sensitivity of the receptor are combined when determining the likely significance of the effect upon fish and shellfish ecology. The particular method employed for this assessment is presented in Table 9.20 and Table 9.21.
- 9.8.8 Where a range is suggested for the likely significance of effect, for example, minor to moderate, it is possible that this may span the significance threshold. The technical specialist’s professional judgement has been applied to determine which outcome defines the most likely effect, which takes into account the sensitivity of the receptor and the magnitude of impact. Where professional judgement is applied to quantify final likely significance from a range, the assessment will set out the factors that resulted in the final assessment of likely significance. These factors may include the likelihood that an effect will occur, data certainty and relevant information about the wider environmental context.
- 9.8.9 The EIA Regulations require the identification and reporting of significant environmental effects. For the purposes of this assessment:
- a level of moderate or more will be considered a likely ‘significant’ effect in terms of the EIA Regulations; and
  - a level of minor or less will be considered likely ‘not significant’ in terms of the EIA Regulations.

**Table 9.20: Matrix Used for the Assessment of the Likely Significance of the Effect**

| Sensitivity of Receptor | Magnitude of Impact |                     |                     |                   |
|-------------------------|---------------------|---------------------|---------------------|-------------------|
|                         | Negligible          | Low                 | Medium              | High              |
| <b>Negligible</b>       | Negligible          | Negligible or Minor | Negligible or Minor | Minor             |
| <b>Low</b>              | Negligible or Minor | Negligible or Minor | Minor               | Minor or Moderate |
| <b>Medium</b>           | Negligible or Minor | Minor               | Moderate            | Moderate or Major |
| <b>High</b>             | Minor               | Minor or Moderate   | Moderate or Major   | Major             |
| <b>Very High</b>        | Minor               | Moderate or Major   | Major               | Major             |

**Table 9.21: Definition of Likely Significance**

| Impact            | Justification                                                                                                                                                                                                                                                                                                                                               |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Negligible</b> | No effects or those that are beneath levels of perception, within normal bounds of variation, or within the margin of forecasting error.                                                                                                                                                                                                                    |
| <b>Minor</b>      | These beneficial or adverse effects are generally, but not exclusively, raised as local factors. They are unlikely to be critical in the decision-making process but are important in enhancing the subsequent design of the Proposed Development.                                                                                                          |
| <b>Moderate</b>   | These beneficial or adverse effects have the potential to be important and may influence the decision-making process. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse or beneficial effect on a particular resource or receptor.                                                    |
| <b>Major</b>      | These beneficial or adverse effects are very important and are likely to be material in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national, or regional importance. However, a major change in a site or feature of local importance may also enter this category. |

### Designated Sites

9.8.10 This fish and shellfish ecology chapter assesses the likely significant effects in EIA terms on the qualifying feature(s) of Natura 2000 sites (i.e. nature conservation sites in Europe designated under the Habitats or Birds Directives) and/or sites in the UK that comprise the National Site Network (collectively termed ‘European sites’). All relevant fish and shellfish qualifying features of European sites have been included in the assessment as IEFs: sandeel, Atlantic salmon, sea lamprey, and freshwater pearl mussel, and have therefore been considered (Table 9.14). The RIAA for the Proposed Development presents an assessment of the



potential adverse effects on the integrity of European sites themselves. A summary of the outcomes reported in the RIAA is provided in RIAA, Part 1: Introduction (TWP-AYR-RPS-ENV-RPT-00019)

- 9.8.11 Where locally designated sites and national designations (other than European sites) fall within the boundaries of a European site and where qualifying features are the same, only the European site and qualifying features have been taken forward for assessment. Potential impacts on the integrity and conservation status of the locally or nationally designated site are assumed to be inherent within the assessment of the European site so a separate assessment for the local or national site is not undertaken.

## **9.9 Embedded Mitigation**

- 9.9.1 As part of the Proposed Development design process, a number of embedded measures have been proposed to reduce the potential for impacts on fish and shellfish ecology (see Table 9.22). They are considered at every stage of the Proposed Development through design and best practice, and as there is a commitment to implementing these measures, these have been considered in the assessment presented in Section 9.10 (i.e. the determination of magnitude and therefore likely significance assumes implementation of these measures). These embedded measures are considered standard industry practice for this type of development.

**Table 9.22: Embedded Mitigation Adopted as Part of the Proposed Development of Relevance to Fish and Shellfish Ecology**

| ID* | Embedded Mitigation Adopted as Part of the Proposed Development                                                                                                                                                                                                                                                                                                                                                                            | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Development of, and adherence to, a Cable Specification and Installation Plan (CSIP) post-consent.                                                                                                                                                                                                                                                                                                                                         | The CSIP will outline the technical specifications of the cables in the Proposed Development and describe the relevant cable installation methodology, and identify risks of cable burial, and any measures required to address these risks to limit the disturbance of the seabed as far as practicable.                                                                                                                                                                                                                                                                                                                                                                                       |
| 3   | Development of, and adherence to, a Piling Strategy. This will detail use of Acoustic Deterrent Devices (ADDs), slow start, soft start, and ramp up procedures, as appropriate, as well as any Additional Mitigation measures, where determined to be required, in consultation with stakeholders including NatureScot and Marine Directorate-Licensing Operations Team (MD-LOT).                                                          | These measures will reduce the likelihood of injury from elevated subsea noise to sensitive fish and shellfish receptors the immediate vicinity of piling operations as far as practicable, by possibly allowing individuals to move away from the area before sound levels reach a level at which injury may occur.                                                                                                                                                                                                                                                                                                                                                                            |
| 4   | Development of, and adherence to, a Cable Burial Risk Assessment (CBRA) and the Cable Burial Assessment (CBA). Implementation, management and monitoring of cable protection, via burial or external protection where adequate burial depth is not feasible, will be undertaken as informed by these assessments. Results of these assessments, and commitments to post construction monitoring, will be provided in the Cable Plan (CaP). | The potential impacts of cable installation can be mitigated through burying cables to a target cable burial depth, as detailed in the CBRA and CBA. This, alongside the cable installation strategy, should provide sufficient depth to avoid most exposure through metocean processes. details of any required cable protection will be included in the CaP.                                                                                                                                                                                                                                                                                                                                  |
| 5   | Development of and adherence to an Environmental Management Plan (EMP), including a Marine Pollution Contingency Plan (MPCP) and a Biosecurity Plan with commitments to environmental monitoring and actions to minimise Invasive Non-Native Species (INNS).                                                                                                                                                                               | Measures will be adopted to ensure that the potential for release of pollutants from construction, O&M and decommissioning plant is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds. Adherence to the EMP and MPCP will decrease the risk of pollution as a result of a Wind Turbine breakout and vessel collision with Offshore Infrastructure and/or a collision. |

| ID* | Embedded Mitigation Adopted as Part of the Proposed Development                                                                                                                                                                                                                     | Justification                                                                                                                                                                                                                                                                                                    |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                                                                                                                                                                                                                                                                                     | Further detail on the mitigation of INNS is presented for its associated impact in Volume 2, Chapter 8: Benthic Ecology.                                                                                                                                                                                         |
| 7   | Development of, and adherence to a Construction Method Statement (CMS) along with a Code of Construction Practice (CoCP).                                                                                                                                                           | Construction procedures will follow the CMS and CoCP, with measures to control specific health and safety risks identified. The CMS and CoCP will also decrease the risk of collision and/or allision during the construction phase and vessel sinking.                                                          |
| 8   | All relevant Health and Safety Executive (HSE) procedures will be followed.                                                                                                                                                                                                         | As with the CMS, construction procedures will consider all relevant health and safety risks and follow HSE legislation and guidance to mitigate these potential identified risks.                                                                                                                                |
| 9   | Development of, and adherence to, a combined Navigational Safety and Vessel Management Plan (NSVMP), describing Project vessels' requirements, passages, monitoring and controls.                                                                                                   | Although more relevant to marine mammals to prevent vessel collisions, this mitigation will also help to mitigate against any collisions to basking shark. This measure will also decrease the risk of collision/allision and thus reduce the potential for accidental pollution to the surrounding environment. |
| 13  | Development of, and adherence to, a Lighting and Marking Plan (LMP). The LMP will confirm compliance with legal requirements with regards to shipping, navigation and aviation marking and lighting.                                                                                | Decreases the risk of collision with vessels or allision with Offshore Infrastructure and thus reduces the potential for accidental pollution to the surrounding environment.                                                                                                                                    |
| 16  | Application for, and use of, Safety Zones of up to 500 m during construction, major repairs, and decommissioning phases. Advisory safe passing distances of up to 500 m will also be applied for mobile installation vessels.                                                       | Decreases the risk of allision with Offshore Infrastructure or collision with construction vessels and thus reduces the potential for accidental pollution to the surrounding environment.                                                                                                                       |
| 18  | All vessels working on the Proposed Development will meet the required certification standards and carriage requirements along with following international marine regulations.                                                                                                     | Decreases the risk of allision/contact with Offshore Infrastructure or collision with vessels and thus reduces the potential for accidental pollution to the surrounding environment.                                                                                                                            |
| 20  | Suitable Aids to Navigation (AtoN) lighting and marking of the Proposed Development including construction buoyage and the use of a Cable Marker Board shall be implemented complying with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) | Decreases the risk of collision with vessels or allision with Offshore Infrastructure and thus reduces the potential for accidental pollution to the surrounding environment.                                                                                                                                    |

| ID* | Embedded Mitigation Adopted as Part of the Proposed Development                                                                                                                                                                                     | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | Recommendations G1162 (IALA, 2021), to be finalised and approved in consultation with the Maritime and Coastguard Agency (MCA) and Northern Lighthouse Board (NLB) through a LMP.                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 21  | Wind Turbine design to have a minimum lower blade tip height of 30 m above Lowest Astronomical Tide (LAT), and a minimum rotor diameter, accounting for pitch and roll as per Marine Guidance Note (MGN) 654.                                       | Decreases the risk of allision/contact with Offshore Infrastructure and thus reduces the potential for accidental pollution to the surrounding environment.                                                                                                                                                                                                                                                                                                                     |
| 23  | Development and adherence to an O&M Programme (OMP).                                                                                                                                                                                                | Decreases the risk of collision with vessels or allision with Offshore Infrastructure and thus reduces the potential for accidental pollution to the surrounding environment.                                                                                                                                                                                                                                                                                                   |
| 24  | Development of, and adherence to, a Development Specification and Layout Plan (DSLP). The development of the DSLP includes consultation with the relevant authorities for approval, including the MCA and NLB.                                      | Decreases the risk of collision with vessels or allision with Offshore Infrastructure and thus reduces the potential for accidental pollution to the surrounding environment.                                                                                                                                                                                                                                                                                                   |
| 35  | Drafting and implementation of a decommissioning programme, prepared in accordance with requirements of the Energy Act 2004, which will set out the extent of infrastructure to be removed as well as the methods and processes which will be used. | The aim of this plan is to adhere to the existing UK and international legislation and guidance (at the time of writing) during the decommissioning phase. This programme will be developed to reduce the amount of long-term disturbance to the environment as far as reasonably practicable.                                                                                                                                                                                  |
| 36  | The development of, and adherence to, an Entanglement Management Plan, or equivalent which will detail how the Applicant aims to monitor, assess, and reduce the risk of entanglement around mooring lines and submerged cables.                    | To reduce the risk of secondary entanglement of marine species, regular inspections of the mooring lines and dynamic IACs during the O&M phase. The inspections will be more frequent initially for the first two years and then decreasing to an annual schedule. The removal of marine debris from mooring lines and dynamic IACs will be undertaken as necessary following monitoring and further relevant action taken if required, based on findings from the inspections. |
| 39  | Where possible, the use of low order disposal of Unexploded Ordnance (UXOs) will be implemented (i.e. deflagration).                                                                                                                                | Low order techniques will be adopted wherever practicable (e.g. deflagration and clearance shots) as mitigation to reduce noise levels and thereby injury and disturbance to sound-sensitive receptors during UXO clearance. There is a small risk that low order disposal could unintentionally arise in a high order detonation and                                                                                                                                           |

| ID* | Embedded Mitigation Adopted as Part of the Proposed Development                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Justification                                                                                                                                                                                                                                |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | therefore this scenario has also been considered in the assessment.                                                                                                                                                                          |
| 45  | Compliance of project vessels with international marine regulations as adopted by the Flag State, including International Regulations for Preventing Collisions at Sea (COLREGS) (IMO, 1972) and International Convention for the Safety of Life at Sea (SOLAS) (IMO, 1974).                                                                                                                                                                                                                                                                                                        | Decreases the risk of allision with Offshore Infrastructure or collision with vessels and thus reduces the potential for accidental pollution to the surrounding environment.                                                                |
| 56  | Low order clearance techniques are the default method for UXO clearance (Mitigation measure 39) and would not require Additional Mitigation over and above the Embedded Mitigation measures within the outline MMMP (Volume 4, Appendix 27: Outline Marine Mammal Mitigation Protocol). However, should high order clearance be unavoidable Additional Mitigation may be required dependant on the results of the UXO Risk Assessment. Appropriate mitigation measures will be discussed and agreed with MD-LOT and NatureScot with the detail to be agreed for the finalised MMMP. | Establish a process to assess potential effects on receptors and outline a pragmatic approach with stakeholders and regulators if further Additional Mitigation is needed.                                                                   |
| 57  | Development of, and adherence to, a Project Environmental Monitoring Plan (PEMP) to include details of any agreed surveys or monitoring requirements.<br><br>The PEMP will provide the mechanism to validate the impact assessment, assess the effectiveness of mitigation measures, and inform adaptation of mitigation measures throughout the construction and O&M phases of the Proposed Development.                                                                                                                                                                           | The PEMP will provide the mechanism to validate the impact assessment, assess the effectiveness of mitigation measures, and inform adaptation of mitigation measures throughout the construction and O&M phases of the Proposed Development. |

\*see Volume 3, Technical Appendix 4.6: Schedule of Mitigation and Commitments

## 9.10 Assessment of Significance

9.10.1 Table 9.15 summarises the potential impacts arising from the construction, O&M and decommissioning phases of the Proposed Development, as well as the MDS against which each impact has been assessed. An assessment of the likely significance of the effects of the Proposed Development on the fish and shellfish receptors caused by each identified impact is given below.

### IMPACT 1 - TEMPORARY HABITAT LOSS AND/OR DISTURBANCE

9.10.2 Temporary habitat loss and/or disturbance may arise due to the activities associated with the construction, O&M, and decommissioning phases of the Proposed Development.

#### *Construction phase*

##### *Magnitude of impact*

9.10.3 The MDS for this impact accounts for up to 18,000,341.50 m<sup>2</sup> (18 km<sup>2</sup>) of temporary habitat loss and/or disturbance during the construction phase (Table 9.15). This represents 4.64% of the total area of the Site Boundary. The MDS has been defined based on the following site preparation and construction activities:

- HDD exit pit excavation;
- Sandwave and boulder clearance;
- Installation of IACs, interconnector cables, SC and the Offshore Export Cables;
- Removal of disused cables; and
- Footprints from jack-up vessels.

9.10.4 In addition, up to 6,993.40 m<sup>2</sup> of temporary habitat loss and/or disturbance could occur due to crater formation from the clearance of UXOs. This value has not been included in the total disturbance presented above, as the footprint from UXO clearance will likely overlap with the area subject to temporary habitat disturbance from other site preparation activities. Additionally, the footprint associated with UXO clearance has not been derived from Volume 1, Chapter 3: Project Description. Instead, it was calculated based on appropriate crater sizes estimated in Ordtek (2018), and applied to the 20 UXOs that may require clearance during the construction phase of the Proposed Development. It should be noted that this is only a precautionary estimation, and these parameters and calculations will be refined at a later stage. It is expected that the craters will erode and infill over time and that displaced material will re-join the natural sedimentary environment.

9.10.5 Cable installation will result in up to 14,679,934.90 m<sup>2</sup> (14.68 km<sup>2</sup>) of temporary habitat loss and disturbance within the construction phase, which represents the largest footprint of impact of all site preparation and construction activities (Table 9.15). This will include the installation of

up to 185 km of IACs, up to 60 km of interconnector cables, and up to 360 km of Offshore Export Cables, with a maximum 25 m width of disturbance from the installation tool. For the purposes of the MDS, the total footprint of affected seabed has been calculated, assuming a mound of sediment of uniform thickness of 0.5 m height. However, it should be noted that, mounds may be taller and more unevenly distributed. Any mounds of cleared material will, however, erode over time and displaced material will re-join the natural sedimentary environment, gradually reducing the size of the mounds and so this estimate can be considered precautionary.

- 9.10.6 A recent study reviewed the effects of cable installation on subtidal sediments and habitats, using monitoring reports from over 20 OWFs in the UK (RPS, 2019). After cable installation, sandy sediments were shown to recover quickly, with little to no evidence of disturbance in the years following cable installation (RPS, 2019). Although the report presented some evidence that cable trenches in coarse and mixed sediments were visible for several years after installation, they were shallow (i.e. tens of centimetres) relative to the surrounding seabed and spread over a horizontal distance of several metres and therefore did not represent a large shift from the baseline environment (RPS, 2019). Given that the seabed sediments within the Site Boundary are largely sandy (see Volume 3, Technical Appendix 8.1: Benthic Ecology Technical Report), the results of this study would suggest that disturbance to these sediments is likely to be temporary with seabed recovery in the relative short term (RPS, 2019). Furthermore, post-construction monitoring of the Block Island OWF (off the coast of Rhode Island, United States of America (USA)) demonstrated that 62% of the trenches that were formed during cable installation had recovered within four months, and the remainder was partially recovered (Bureau of Ocean Energy Management (BOEM), 2020), further highlighting the temporary nature of this impact.
- 9.10.7 Similar to cable installation, depressions on the seabed may occur due to the use of jack-up vessels. The MDS accounts for a total area of up to 193,200 m<sup>2</sup> (Table 9.15). Studies on comparable seabed substrates have shown that seabed impact following jack-up vessel usage is also likely to be temporary in nature with seabed recovery occurring in the relatively short term. For example, monitoring studies at Barrow OWF in the Irish Sea demonstrated that depressions were almost entirely infilled 12 months post construction (Barrow Offshore Windfarm Ltd., 2008). Similarly, post-construction seabed monitoring at the Block Island Wind Farm in the USA suggested that depressions from jack-up vessels were expected to fully recover after several months to several years (BOEM, 2020).
- 9.10.8 Seabed preparation activities associated with the Proposed Development include sandwave clearance (and deposition of cleared material) and boulder clearance. As detailed in Paragraph 9.10.4 above for UXO



clearance, any mounds of cleared material associated with sandwave clearance will erode over time with the displaced material re-joining the natural sedimentary environment, gradually reducing the size of the mounds. As the sediment that will be deposited on the seabed will be similar to that of the surrounding areas, displaced communities would be expected to recolonise in areas of temporary seabed disturbance.

9.10.9 The HDD exit pit extraction (at the Landfall at Sinclair's Bay) may result in up to 10,240 m<sup>2</sup> of temporary habitat loss and/or disturbance (Table 9.15). The predicted disturbance footprint for the exit pit is adjacent to the coast at Sinclair's Bay and for most fish and shellfish there is no pathway of potential impact. However, consultation received in the Scoping Opinion emphasised the importance of the River Wester, which flows into Sinclair's Bay (Table 9.7), for diadromous fish species (notably sea trout). The potential HDD exit pit locations are between 2.4 km to 2.7 km from the mouth of the River Wester. Therefore, due to this distance and the low disturbance footprint (10,240 m<sup>2</sup>), temporary habitat disturbance associated with HDD pit extraction is unlikely to cause significant impediment of migratory and/or foraging activity of diadromous fish (notably sea trout) within Sinclair's Bay and the River Wester.

9.10.10 The programme for the site preparation and construction works is scheduled to last for five years, inclusive from the start of 2030 to the end of 2034. Pre-construction surveys are scheduled to take place in advance of the site preparation and construction works in 2027. The site preparation and construction activities detailed in the preceding paragraphs will be phased intermittently over the construction phase. For example, boulder and UXO clearance activities will be undertaken a year prior to sandwave clearance for cable installation and other cable installation activities. It is also important to note that the 15.95 km<sup>2</sup> footprint of temporary habitat loss and disturbance in this phase will not represent one continuous area and will be spread spatially and temporally over the Array Area and Export Cable Corridor. Once construction in a localised area has been completed, this area will not be disturbed further during the construction phase. This area will start to recover following cessation of construction activities in the vicinity allowing mobile species, such as sandeel and other fish and shellfish species, to repopulate the areas of previous disturbance.

9.10.11 The impact is predicted to be of local spatial extent (4.64% of the total area of the Site Boundary), medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

9.10.12 Substrate type is the primary driver for recoverability and rate of recovery of an area after large scale seabed disturbance (Desprez, 2000, Newell *et al.*, 1998). For example, studies have shown that muddy or sandy habitats

(such as those recorded within the Site Boundary) can return to baseline species abundance after approximately one to two years (Desprez, 2000, Newell *et al.*, 1998). Further, post-construction monitoring of the Walney Wind Farm Extension in the Irish Sea reported a degraded benthic and demersal fish and shellfish community in comparison to pre-construction levels within its Array Area, but no significant difference within its export cable corridor (Centre for Marine and Coastal Studies (CMACS (2012))).

- 9.10.13 The fish and shellfish IEFs may be indirectly affected through temporary loss and disturbance of foraging habitat and associated prey items. For example, crabs and other crustaceans and smaller demersal fish species are considered important prey species for larger fish. However, since this impact is predicted to affect only a small proportion of seabed habitats in the Site Boundary at any one time, and given that there are similar habitats (and prey species) occurring throughout the Fish and Shellfish Ecology Study Area, these impacts are likely to be limited. Further, temporary habitat disturbance will also expose benthic infaunal species from the sediment, potentially offering foraging opportunities to opportunistic scavengers immediately after completion of works. The implications of changes in fish and shellfish prey species are also discussed for higher trophic level receptors (i.e. marine mammals and birds) in Volume 2, Chapter 10: Marine Mammals and Chapter 11: Offshore Ornithology.

Marine Fish IEFs

- 9.10.14 The marine fish IEFs that are likely to be most sensitive to temporary habitat loss and disturbance are those which live or spawn on or near the seabed sediment (e.g. herring, sandeel, some elasmobranchs). Other fish species identified as IEFs in Table 9.14 (particularly adults) are considered less vulnerable to temporary habitat loss as they can move away from impacted areas and recolonise quickly once activities have ceased, compared to species and life history stages (e.g. juveniles) which are less mobile.
- 9.10.15 Demersal species, such as anglerfish and flatfish IEFs, are not considered to be particularly vulnerable to this impact. For example, neither positive nor negative effects of construction and operation of the Block Island Wind Farm were observed for a range of north American flatfish species (Wilber *et al.*, 2018) suggesting a degree of resilience to this impact in flatfish, and an ability to move away from temporarily affected areas of the seabed.
- 9.10.16 As demersal spawners, temporary loss and disturbance to seabed habitats could lead to sandeel mortality if individuals cannot colonise their preferred sandy spawning habitats in the immediate vicinity, or where these habitats may be at carrying capacity (Wright *et al.*, 2000). The FeAST tool reports sandeel as having a medium sensitivity to 'surface abrasion' and high sensitivity to 'physical removal (extraction of

substratum)' and 'sub-surface abrasion/penetration' (NatureScot, 2025). Sandeel may also be particularly vulnerable during their winter hibernation period when they are less mobile and remain buried in the seabed substrates. The Site Boundary is located in an area of low intensity spawning and low intensity nursery grounds for sandeel and a mix of preferred, marginal and unsuitable habitat type (Figure 9.3 and Table 9.10).

- 9.10.17 Sandeel spawning and nursery grounds are also widespread throughout the Fish and Shellfish Ecology Study Area as a whole. However, only a small proportion of the maximum footprint of temporary habitat loss and disturbance will be occurring at any one time during the construction phase, with recovery of sediments, and associated sandeel populations into them, following cessation of activities. For example, site preparation activities (such as boulder, sandwave, and UXO clearance) will occur in parts of the Array Area and Export Cable Corridor in the year before construction activities begin. Further, the construction activities will be staggered both spatially and temporally throughout the remainder of the construction phase. Further detail on the construction programme is provided in Volume 1, Chapter 3: Project Description.
- 9.10.18 Short and long term monitoring studies at the Horns Rev offshore wind farm in the Baltic Sea have reported that OWF construction (Jensen *et al.*, 2004) and operation (Van Deurs *et al.*, 2012) did not lead to significant adverse effects on sandeel populations. In addition, sandeel populations recovered quickly following construction operations (Jensen *et al.*, 2004). Thus, recovery of sandeel populations in the Site Boundary would be expected following temporary habitat loss and disturbance, with the rate of recovery dependent on the recovery of sediments to a condition suitable for sandeel recolonisation. Recovery may also occur through larval recolonisation of suitable sandy sediments with larvae likely to be distributed during spring months following spawning in winter/spring (Ellis *et al.*, 2012).
- 9.10.19 Within the Fish and Shellfish Ecology Study Area, results of a post-construction monitoring study at the Beatrice OWF showed that sandeel abundance either increased or remained at similar levels when comparing abundance from 2014 to 2020, with the offshore construction phase of Beatrice OWF commencing in April 2017 (Beatrice OWF Limited, 2021b). This study reported no evidence that construction resulted in adverse impacts on the local sandeel population and builds upon previous work by Stenberg *et al.* (2011) which also concluded that the construction of the Horns Rev 1 OWF (southern North Sea) neither threatened nor directly benefitted sandeel over a seven year survey period.
- 9.10.20 Sandeel is likely to be impacted by temporary habitat loss, although recovery is expected to occur as the seabed sediments recover as well as via larval colonisation of the sandy sediments. The sandeel IEF is deemed to be of high vulnerability and national value but with high potential for

recovery. The sensitivity of the receptor is therefore, considered to be medium.

- 9.10.21 Herring are demersal spawners, with specific spawning substrate requirements. Therefore, temporary habitat loss and disturbance may lead to mortality in a similar manner to sandeel if spawning habitats are lost or disturbed due to the construction of the Proposed Development. Suitable spawning grounds are therefore vital for herring stock resilience, although these habitats can be adversely impacted by environmental impacts, such as storms, and anthropogenic pressures (Moll *et al.*, 2018, Thurstan and Roberts, 2010). Herring stocks have historically followed “boom and bust” cycles, with recolonisation of spawning grounds and subsequent population recovery not fully understood (Dickey-Collas *et al.*, 2010, Schmidt *et al.*, 2009, Trochta *et al.*, 2020). Herring have very particular spawning habitat preferences, however a degree of plasticity in spawning ground utilisation can buffer against temporary changes to their environment and increase population resilience (Frost and Diele, 2022, Schmidt *et al.*, 2009).
- 9.10.22 Based on site-specific herring spawning habitat suitability assessment, the habitats present within the Site Boundary are considered to be largely unsuitable for herring spawning (Figure 9.2). The potential for direct temporary loss and disturbance to herring spawning grounds within the Site Boundary is, therefore, unlikely. Spawning grounds have been recorded in the wider Fish and Shellfish Ecology Study Area (see Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report for more information), however there is not considered to be a pathway of potential impact for temporary habitat loss or disturbance.
- 9.10.23 The herring IEF is deemed to be of high vulnerability, high recoverability and national value. However, herring spawning grounds are not likely to be impacted by temporary habitat loss and disturbance associated with the construction of the Proposed Development, given the limited habitat suitability within the Site Boundary (wherein the impacts will be isolated). The sensitivity of the receptor is therefore considered to be low.
- 9.10.24 For many of the remaining marine fish IEFs, there are spawning and/or nursery grounds overlapping with the Site Boundary (and thus the Zol of temporary habitat loss and disturbance; Table 9.10). However, these are not unique to the Site Boundary and are largely widespread throughout the Fish and Shellfish Ecology Study Area as a whole (see Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report for more information). Further, as the remaining marine fish IEFs are highly mobile species (with many mainly occupying the pelagic zone, such as Atlantic bluefin tuna, mackerel, sprat, and various elasmobranchs), they are likely to be able to move away from areas of disturbance and temporary habitat loss. This rationale has been used by FeAST and MarESA

for two of the remaining marine fish IEFs, common skate and basking shark.

- 9.10.25 The common skate IEF and basking shark IEFs both have MarESAs, with the former also included on FeAST (NatureScot, 2025, Neal and Pizzolla, 2006, Wilson *et al.*, 2020). Common skate has been assessed as having medium sensitivity to ‘surface abrasion’, and no sensitivity to ‘sub-surface abrasion/penetration’ on FeAST (NatureScot, 2025). This medium sensitivity is based on the potential for surface abrasion to spawning habitats, however, data has shown that these are not likely to be present within the Fish and Shellfish Ecology Study Area (Table 9.10; Ellis *et al.* (2012)). The spawning (and egg-laying) habitats for flapper skate have been characterised as being rocky, boulder, cobble, and mixed substrates in water depths of between -20 m to -50 m (Phillips *et al.*, 2021, Scottish Government, 2021). These habitat types were not largely identified within the Site Boundary, and where they occurred, they were not high enough in abundance to support extensive egg-laying habitat (see Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report). It is likely that these habitat preferences are very similar for common skate, given the close relatedness and life histories of these two species within the common skate complex.
- 9.10.26 The MarESA for common skate presents low sensitivity to ‘substratum loss’ (Neal and Pizzolla, 2006). The MarESA for basking shark concludes that this IEF has no sensitivity to ‘removal of substratum’, ‘abrasion/disturbance of the surface of the seabed’ and ‘penetration or disturbance of the substratum subsurface’ (Wilson *et al.*, 2020). These sensitivities can reasonably be applied to the other marine fish IEFs, as they are all highly mobile and many either live and/or spawn in the pelagic zone.
- 9.10.27 Overall, the remaining marine fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

#### Diadromous Fish IEFs

- 9.10.28 As diadromous fish species are highly mobile and typically occupy the pelagic zone during their marine phase, they will be outwith the ZoI for temporary habitat loss and disturbance. Therefore, any temporary habitat loss and disturbance to the seabed within the Export Cable Corridor and the Array Area is not likely to cause any direct impact upon diadromous fish IEFs, nor is it likely to affect their migration patterns.
- 9.10.29 There is the potential for indirect impacts on diadromous fish IEFs due to potential changes in prey and host species from temporary habitat loss and disturbance. For example, adult sea lamprey are parasitic and known to prey on a wide range of larger fish and some cetacean species (Silva *et al.*, 2014). Like the marine fish IEFs, most large mobile host species are

likely to be able to avoid any potential effects associated with temporary seabed habitat loss due to their mobility but likely to return into the areas affected following cessation of construction activities.

- 9.10.30 The diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and of national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Shellfish IEFs

- 9.10.31 The shellfish IEFs (with the exception of squid and octopi IEFs) live directly on the seabed and are typically less mobile than fish IEFs making them potentially more vulnerable to impacts associated with temporary habitat loss and disturbance. For example, a mark and recapture study on berried European lobster reported that 84% of berried females remained within 500 m of their release site (Agnalt *et al.*, 2007). An earlier similar study by Smith *et al.* (2001) reported that tagged European lobsters did not appear to undertake extensive alongshore or on-/offshore migrations. Recapture distances ranged from 0 km to 45 km, but 95% of recaptured European lobsters moved less than 4 km from their original release positions over periods of up to 862 days (Smith *et al.*, 2001). Finally, Øresland and Ulmestrand (2013) demonstrated limited movement in this species, with only 58 out of 4,016 tagged European lobsters recaptured over 1 km away from the release site.
- 9.10.32 Similarly, Vigo *et al.* (2021) demonstrated that the home ranges of tagged Norway lobster were approximately 17.75 m<sup>2</sup> to 736.25 m<sup>2</sup>, once the individuals had settled in place. Norway lobster, European lobster and the other larger crustacean IEFs are classed as equilibrium species, meaning that they can only recolonise an area once the original substrate has recovered to baseline conditions (Newell *et al.*, 1998). For example, Norway lobster is considered to have a moderate recoverability and sensitivity to 'substratum loss' and a high recoverability and low sensitivity to 'abrasion and physical disturbance' according to its MarESA (Hill and Sabatini, 2008). Whilst there are Norway lobster spawning and nursery habitats within the Fish and Shellfish Ecology Study Area, these areas do not overlap with the Site Boundary (Table 9.10). The construction phase activities responsible for temporary habitat loss and disturbance within the Site Boundary are not considered to have a direct impact their spawning and nursery areas in the wider Fish and Shellfish Ecology Study Area.
- 9.10.33 Of the crab IEFs, there are MarESAs available for two species: common shore crab and edible crab (Neal and Pizzolla, 2008, Neal and Wilson, 2008). The common shore crab has a high recoverability and low sensitivity to 'substratum loss' and 'abrasion and physical disturbance' (Neal and Pizzolla, 2008). This is because this species can live across a



wide range of substrata, and is unlikely to be impacted by a temporary loss of substratum (Neal and Pizzolla, 2008). A capture-mark-recapture study at the Lillgrund OWF in Sweden found no evidence that the project had negative effects on common shore crab populations (Langhamer *et al.*, 2016). The edible crab also has a high recoverability and low sensitivity to ‘abrasion and physical disturbance’, due the high potential for population recovery (Neal and Wilson, 2008). This IEF has a moderate recoverability and sensitivity to ‘substratum loss’ as some individuals will be able to escape, and will quickly recolonize whatever seabed remains or migrate to new habitats if necessary (Neal and Wilson, 2008).

- 9.10.34 This impact will only represent a small temporary loss and disturbance to seabed habitats within the Site Boundary, and sediments are likely to recover rapidly, with recolonisation of associated communities afterwards (RPS, 2019). Seabed substrate type largely dictates the potential for and rate of recovery of an area after large scale seabed disturbance (e.g. dredging or trawling activities) (Desprez, 2000, Newell *et al.*, 1998). For example, muddy or sandy habitats (such as those recorded within the Site Boundary) can return to baseline species abundance after approximately one to two years (Desprez, 2000, Newell *et al.*, 1998). A recent study at the Westernmost Rough OWF within a European lobster fishing ground reported that the size and abundance of European lobsters increased following temporary closure of the area for the construction of the OWF (Roach *et al.*, 2018). This study implies wind farm construction activities did not impact European lobster populations and instead allowed some relief from fishing activity (Roach *et al.*, 2018).
- 9.10.35 The king and queen scallop IEFs, whilst predominantly sessile, can swim limited distances, typically as an escape response, by ejecting water around the hinge of their shells (Marshall and Wilson, 2008, Schalkhauser *et al.*, 2014). King scallop have been documented to swim up to 30 m, with a tagging study in western Scotland demonstrating that the majority of adults were within this distance of their release point after 18 months (Howell and Fraser, 1984). Thus, king and queen scallop may have improved resilience to this impact, as they could potentially flee localised areas of disturbance. Scallop tend to aggregate, as their larval distribution is reliant on relatively unpredictable hydrographic features (Delargy *et al.*, 2019). For example, Le Pennec *et al.* (2003) reported that king scallop larvae could travel up to 40 km in 18 days, while Sinclair *et al.* (1985) proposed that their larvae could also undertake vertical migrations and retain self-sustaining populations. Nonetheless, the king and queen scallop IEFs are expected to continue spawning outwith the ZoI for this impact. As suitable settlement habitat will remain following cessation of construction activities, it is expected that king and queen scallop will continue to be recruited within the Site Boundary and the wider Fish and Shellfish Ecology Study Area, either through vertical or horizontal larval transport. King and queen scallop are therefore likely to recover well from



disturbance due to temporary habitat loss and disturbance. This is supported by the MarESA (only available for king scallop), which concluded that this species has a high recovery potential against the pressure of 'substratum loss' (Marshall and Wilson, 2008).

- 9.10.36 The shellfish IEFs are deemed to be of medium vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

*Significance of the Effect*

- 9.10.37 Overall, for the sandeel IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor considered to be medium. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.10.38 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and Residual Effect*

- 9.10.39 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms.

***O&M phase***

*Magnitude of Impact*

- 9.10.40 The MDS accounts for up to a total of 2,632,500 m<sup>2</sup> (2.63 km<sup>2</sup>) of temporary habitat loss and disturbance during the 30 year O&M phase due to cable repair and reburial (Table 9.15). The impacts of cable repair and reburial will be similar to those identified for cable installation in the construction phase above. This represents up to 0.68% of the total area of the Site Boundary. However, it should be noted that only a small proportion of the total temporary habitat loss and disturbance is likely to occur at any one time, with the MDS for this impact calculated over the 30 year lifecycle of the Proposed Development. Therefore, individual cable maintenance activities will be small scale and intermittent events.
- 9.10.41 The spatial extent of this impact in the O&M phase is small in relation to the Fish and Shellfish Ecology Study Area, although there is the potential for repeated disturbance to the habitats in the immediate vicinity of the infrastructure because of these activities. The effects associated with this phase of the Proposed Development are expected to be similar to the construction phase, but of a much lower magnitude.
- 9.10.42 The impact is predicted to be of local spatial extent (0.68% of the total area of the Site Boundary), long term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the Receptor*

- 9.10.43 The sensitivity of the receptor is as already presented for the construction phase (in Paragraphs 9.10.14 *et seq.*) and is not repeated here.

*Significance of the effect*

- 9.10.44 Overall, for the sandeel IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.10.45 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and Residual Effect*

- 9.10.46 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms.

***Decommissioning Phase***

*Magnitude of Impact*

- 9.10.47 As the approach for decommissioning is yet to be determined, no footprint of temporary habitat loss and disturbance could be calculated for this phase. However, for the purposes of this MDS, the total removal of all infrastructure including buried cables and cable protection has been assumed, and as such the environmental impact of decommissioning will be the same if not lower than construction (Table 9.15).

- 9.10.48 The impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

- 9.10.49 The sensitivity of the receptor is as already presented for the construction phase (in Paragraphs 9.10.14 *et seq.*) and is not repeated here.

*Significance of the effect*

- 9.10.50 Overall, for the sandeel IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.10.51 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse

significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.52 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms.

**IMPACT 2 - LONG TERM HABITAT LOSS AND/OR DISTURBANCE**

- 9.10.53 Long term habitat loss and/or disturbance may arise due to the installation of infrastructure in the construction phase and persist into the O&M phase (hence these two phases have been combined for this impact). While some infrastructure will be removed during the decommissioning of the Proposed Development, any infrastructure that is proposed to be left *in situ* represents the MDS for this impact in the decommissioning phase.

***Construction and O&M phases***

*Magnitude of Impact*

- 9.10.54 The MDS accounts for up to a total of 3,042,840 m<sup>2</sup> (3.04 km<sup>2</sup>) of long term habitat loss and disturbance as infrastructure is installed during the construction phase, which will persist into the 30 year O&M phase (Table 9.15). The represents 0.78% of the total area of the Site Boundary. The MDS has been based on the installation of the following infrastructure on the seabed:

- Wind Turbine foundations and associated scour protection;
- OSP foundations and associated scour protection and mud mats;
- Cable protection and cable crossing protection for IACs, interconnector and Offshore Export Cables; and
- Offshore SCs (Table 9.15).

- 9.10.55 It should be noted that the MDS footprint for this impact will be spread out over the Array Area and Exportable Corridor, within the Site Boundary, and does not represent one continuous area of 3.04 km<sup>2</sup> of long term habitat loss.

- 9.10.56 Overall, the impact is predicted to be of local spatial extent (0.78% of the total area of the Site Boundary), long term duration, continuous, and of low reversibility during the construction and O&M phases. It is predicted that the impact will affect the receptor directly. This impact presents some measurable, but minor long term loss of and alteration to areas of seabed within the Site Boundary, but not within the Fish and Shellfish Ecology Study Area. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

- 9.10.57 Fish and shellfish IEFs that rely on the presence of suitable sediment and subtidal habitats for their survival would typically be more vulnerable to

this impact, depending on the availability of said habitats within the wider Fish and Shellfish Ecology Study Area. The long term loss and disturbance of seabed habitats due to the Proposed Development will reduce the area of suitable habitat and available food resources within the Site Boundary for the fish and shellfish communities associated with them. However, the total footprint of seabed potentially impacted represents a low percentage of the extensive subtidal habitats present within Site Boundary and within the Fish and Shellfish Ecology Study Area as a whole.

#### Marine fish IEFs

- 9.10.58 The Fish and Shellfish Ecology Study Area coincides with spawning and nursery habitats for a range of species, with several overlapping with the Site Boundary directly (Table 9.10). Sandeel and herring are the most vulnerable teleost fish IEFs to long term seabed habitat loss due to their demersal spawning habitat requirements. As stated in Paragraphs 9.10.14 *et seq.* (for ‘Temporary Habitat Loss and/or Disturbance’), these species lay their eggs on the seabed and require specific sediment composition in order to do so successfully. Some elasmobranchs, such as spotted ray, thornback ray, common skate, and flapper skate, are also demersal spawners, as they lay egg cases in shallow nearshore nurseries. Low intensity nursery grounds for several of these species were identified as overlapping with the Site Boundary and/or being present throughout the Fish and Shellfish Ecology Study Area (Table 9.10). However, given that these habitats are low intensity and extensive throughout the Fish and Shellfish Ecology Study Area, these species are unlikely to be significantly impacted by long term habitat loss and disturbance that may overlap with their nursery grounds.
- 9.10.59 As described in Paragraph 9.10.16 for ‘Temporary habitat loss and/or disturbance’, long term loss and disturbance to seabed habitats could lead to sandeel mortality if individuals cannot colonise their preferred sandy spawning habitats in the immediate vicinity, or where these habitats may be at carrying capacity (Wright *et al.*, 2000). The FeAST tool reports sandeel as having a high sensitivity to ‘physical removal (extraction of substratum)’ and ‘physical change (to another seabed type)’ (NatureScot, 2025). Sandeel may also be particularly vulnerable during their winter hibernation period when they are less mobile and remain buried in the seabed substrates. The Site Boundary is located in an area of low intensity spawning and low intensity nursery grounds for sandeel and a mix of preferred, marginal and unsuitable habitat type (Figure 9.3 and Table 9.10). There is suitable sandeel spawning habitat located throughout the Fish and Shellfish Ecology Study Area as a whole (Figure 9.3), with an MPA designated for sandeel spawning and nursery habitat on the north-west coast of Orkney (far outwith the ZoI for this impact, see Figure 9.4). The maximum footprint of long term habitat loss and disturbance will only make up a small proportion of the Site Boundary as a whole (0.78%). Therefore, it is unlikely that long term habitat loss and

disturbance within the Site Boundary will affect sandeel at a population level. Furthermore, monitoring as the Horns Rev I OWF (Denmark) has indicated that the presence of operational wind farm infrastructure has not caused significant adverse long-term effects on sandeel populations (Stenberg *et al.*, 2011, Van Deurs *et al.*, 2012). Similarly, the initial results of post-construction monitoring at the Beatrice OWF within the Fish and Shellfish Ecology Study Area demonstrated no negative effects on sandeel populations (Beatrice OWF Limited, 2021b).

- 9.10.60 The sandeel IEF is deemed to be of high vulnerability, high recoverability and regional value. The sensitivity of the receptor is therefore considered to be medium.
- 9.10.61 As detailed in Paragraph 9.10.21 for ‘Temporary habitat loss and/or disturbance’, herring also have very particular spawning habitat preferences and could suffer if these habitats are lost or disturbed. However, based on site-specific herring spawning habitat suitability assessment, the habitats present within the Site Boundary are considered to be largely unsuitable for herring spawning (Figure 9.2). Spawning grounds have been recorded in the wider Fish and Shellfish Ecology Study Area (see Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report for more information), however these are outwith the Zol for this impact, which is confined within the Site Boundary. Overall, it is considered unlikely that herring populations will be largely affected by long term habitat loss and disturbance from the Proposed Development.
- 9.10.62 The herring IEF is deemed to be of high vulnerability, medium recoverability, and of national value. The sensitivity of the receptor is therefore considered to be medium.
- 9.10.63 For many of the remaining marine fish IEFs, there are spawning and/or nursery grounds overlapping with the Site Boundary (and thus the Zol of long term habitat loss and disturbance; Table 9.10). However, these are not unique to the Site Boundary and are largely widespread throughout the Fish and Shellfish Ecology Study Area as a whole (see Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report for more information). Further, as the remaining marine fish IEFs are highly mobile species (with many mainly occupying the pelagic zone, such as Atlantic bluefin tuna, mackerel, sprat, and various elasmobranchs), they could easily move away from long term habitat loss and disturbance to the seabed (which does not represent a significant area within the Site Boundary: 0.78%). This rationale has been used by FeAST and MarESA for two of the remaining marine fish IEFs. The common skate IEF and basking shark IEFs both have MarESAs, with the former also included on FeAST (NatureScot, 2025, Neal and Pizzolla, 2006, Wilson *et al.*, 2020). On the FeAST, common skate has been assessed as having low sensitivity to ‘physical change (to another seabed type)’ due to its high mobility (NatureScot, 2025). This species was not assessed against the FeAST

pressure ‘physical removal (extraction of substratum)’ due to insufficient information on potential effects to rocky habitats in which their egg cases are typically laid (NatureScot, 2025). The MarESA for common skate presents a low sensitivity to ‘substratum loss’, again citing this species’ high mobility (Neal and Pizzolla, 2006). However, the MarESA notes concerns about the potential for substratum loss in egg-laying habitats for this species.

- 9.10.64 The spawning (and egg-laying) habitats for flapper skate have been characterised as being rocky, boulder, cobble and mixed substrates in water depths of between -20 m to -50 m (Phillips *et al.*, 2021, Scottish Government, 2021). These were not identified as largely present across the Site Boundary (see Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report). It is likely that these habitat preferences are very similar for common skate, given the close relatedness and life histories of these two species within the common skate complex. Therefore, these species are not likely to be significantly vulnerable to this impact within the Site Boundary.
- 9.10.65 The MarESA for basking shark concludes that this IEF has no sensitivity to ‘physical change (to another seabed type)’, ‘physical change (to another sediment type)’ and ‘habitat structure changes – removal of substratum (extraction)’ (Wilson *et al.*, 2020). These sensitivities can reasonably be applied to the other marine fish IEFs, as they are all highly mobile and many either live and/or spawn in the pelagic zone.
- 9.10.66 Overall, the remaining marine fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

#### Diadromous Fish IEFs

- 9.10.67 As diadromous species are highly mobile and not reliant on demersal offshore habitats for spawning or breeding, they are considered to be less susceptible to the impact of long term habitat loss and disturbance. Diadromous species are only likely to interact within the ZoI while migrating to and from rivers and freshwater habitats. Thus, this impact is unlikely to be of particular relevance for diadromous fish species as it will not present a barrier to migration or affect their ecology during their marine life stages.
- 9.10.68 Diadromous species may be indirectly affected due to impacted prey species, such as sandeel. However, the majority of marine fish species are unlikely to be impacted by any long term habitat loss and disturbance associated with the Proposed Development and population level effects are not likely to occur (see Paragraphs 9.10.57 to 9.10.66).
- 9.10.69 The diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history



of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Shellfish IEFs

- 9.10.70 As most of the shellfish IEFs are less mobile than the fish IEFs, they are potentially more vulnerable to the effects of long term habitat loss and disturbance at the seabed. The installation of infrastructure associated with the Proposed Development has the potential to directly damage the habitats inhabited by these IEFs. The potential for long term habitat loss directly around the Proposed Development infrastructure represents a small proportion of habitat within the Fish and Shellfish Ecology Study Area, and is unlikely to impact on the wider scallop population. This is supported by the MarESA for king scallop, which notes that king scallop tend to have a high potential for recovery from the pressure ‘substratum loss’ (Marshall and Wilson, 2008).
- 9.10.71 There are Norway lobster spawning and nursery habitats within the Fish and Shellfish Ecology Study Area, but these do not overlap with the Site Boundary (Table 9.10). Therefore, the potential for long term habitat loss and disturbance (which is confined within the Site Boundary) will not directly impact their spawning and nursery areas in the wider Fish and Shellfish Ecology Study Area.
- 9.10.72 The spawning and nursery habitats of various other shellfish IEFs identified in this assessment, such as common shore crab and edible crab are not available in the datasets utilised in this assessment (Aires *et al.*, 2014, Coull *et al.*, 1998, Ellis *et al.*, 2012). Given the wide range of available habitat throughout the Fish and Shellfish Ecology Study Area and the low footprint of impact within the Site Boundary (0.78%), it is not likely that this impact will significantly impact these species. As detailed in Paragraph 9.10.33, common shore crab and edible crab are expected to have some recoverability to ‘substratum loss’ (Langhamer *et al.*, 2016, Neal and Pizzolla, 2008, Neal and Wilson, 2008, Van Bernem, 1999).
- 9.10.73 The shellfish IEFs are deemed to be of low to medium vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

*Significance of the effect*

- 9.10.74 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.10.75 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.



*Additional Mitigation and residual effect*

- 9.10.76 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms.

***Decommissioning phase***

*Magnitude of impact*

- 9.10.77 The approach for the decommissioning phase is yet to be determined, however, for the purposes of this assessment, the MDS assumes that all scour protection, cable protection, and cable crossing protection will be left *in situ*. Therefore, up to 3,042,840 m<sup>2</sup> (3.04 km<sup>2</sup>) of long term habitat loss will persist through the decommissioning phase and onwards. This value has been calculated as the total footprint area for all scour protection, cable protection, and cable crossing protection installed during the construction phase. This represents up to 0.78% of the total area of the Site Boundary.
- 9.10.78 It should be noted that the MDS footprint for this impact will be spread out over the Array Area and Export Cable Corridor, within the Site Boundary, and does not represent one continuous area of 3.04 km<sup>2</sup> of long term habitat loss persisting during and after the decommissioning of the Proposed Development.
- 9.10.79 The impact is predicted to be of local spatial extent (0.78% of the total area of the Site Boundary), long term duration, continuous, and of low reversibility (as left *in situ*. It is predicted that the impact will affect the receptor directly. This impact presents some measurable, but minor long term loss of and alteration to areas of seabed within the Site Boundary, but not within the Fish and Shellfish Ecology Study Area. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

- 9.10.80 The sensitivity of the receptor is as already presented for the construction and O&M phases (in Paragraphs 9.10.57 *et seq.*) and is not repeated here.

*Significance of the effect*

- 9.10.81 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.10.82 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.83 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms.

**IMPACT 3 - INTRODUCTION OF ARTIFICIAL HABITAT AND SUBSEQUENT COLONISATION OF HARD STRUCTURES**

- 9.10.84 Introduction of artificial habitat and subsequent colonisation of hard structures is associated with the installation of infrastructure in the construction phase, and ongoing presence of infrastructure through the O&M phase. Whilst some infrastructure will be removed during the decommissioning of the Proposed Development, that left *in situ* represents the MDS for this impact in the decommissioning phase.
- 9.10.85 Hard structures in the marine environment (for example on foundations or scour protection) can attract many marine organisms including benthic and biofouling species. This can lead to the development of artificial reefs with these structures replicating naturally occurring rocky habitats (Karlsson *et al.*, 2022). When hard structures are placed into areas of predominantly soft, sedimentary environments the colonisation of species can alter the naturally occurring habitats and create localised hotspots of prey resources (Inger *et al.*, 2009). Karlsson *et al.* (2022) recorded these effects at the Hywind Floating OWF (Scotland) where colonisation of infrastructure included plumose anemones *Metridium senile* and fan worms *Spirobranchus* sp. which dominated the bottom and mid-section of floating turbines, with kelp *Laminaria* sp., other brown seaweeds, and blue mussels *Mytilus edulis* found in the upper 20 m to surface level. Additionally, anthropogenic structures may also have direct impacts on fish and shellfish communities through their potential to cause fish aggregation effects (Petersen and Malm, 2006). Volume 2, Chapter 8: Benthic Ecology examines this impact from the perspective of benthic colonisation and habitat creation, whereas this assessment looks at the subsequent consequences for fish and shellfish populations (with implications upon the wider marine food web).

**Construction and O&M phase**

*Magnitude of impact*

- 9.10.86 The MDS accounts for up to a total of 3,412,840 m<sup>2</sup> (3.41 km<sup>2</sup>) of artificial hard structures installed during the construction phase, which will persist into the 30 year O&M phase (Table 9.15). This includes footprints of hard structures and also the surface area of Wind Turbine foundations and OSPs. As per Paragraph 9.10.54 for long term habitat loss and disturbance, the MDS includes the installation of the following artificial hard infrastructure on the seabed:
- Wind Turbine moorings and anchors and associated scour protection;
  - OSP foundations and associated scour protection and mud mats;

- Cable protection and cable crossing protection for IACs, interconnector and Offshore Export Cables; and
- Offshore SCs (Table 9.15).

- 9.10.87 In addition, the floating Wind Turbine foundations, OSP jackets, dynamic cables and anchor mooring lines represent additional hard substrate introduced into the water column. Given the complexity of calculating the surface area for these types of infrastructure and the uncertainty around final foundation design, a specific area calculation has not been provided.
- 9.10.88 It should be noted that the MDS footprint and surface areas associated with the Array Area and Export Cable Corridor will be spread out within the Site Boundary, and do not represent one continuous area of 3.41 km<sup>2</sup> of artificial hard structures.
- 9.10.89 Overall, the impact is predicted to be of local spatial extent, long term duration, continuous, and of low reversibility during the construction and O&M phases. It is predicted that the impact will affect the receptor directly. This impact presents some measurable, but minor long term alteration to areas of seabed within the Site Boundary, but not within the Fish and Shellfish Ecology Study Area. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

Marine Fish and Shellfish IEFs

- 9.10.90 Artificial hard structures installed during the construction phase of the Proposed Development can act as artificial reefs and provide habitat for a wide range of species, from lower trophic level biofouling species to higher predators, such as large fish, seabirds, and marine mammals (Degraer *et al.*, 2021, Degraer *et al.*, 2020). This impact has been considered from a benthic ecology perspective in Volume 2, Chapter 8: Benthic Ecology. Three types of species attracted to these artificial hard structures can be discerned:
- Species that predate the biofouling community for a prolonged period such as the cod and pouting *Trisopterus luscus*;
  - Species that occasionally predate the biofouling community such as horse mackerel; and
  - Species such as mackerel that are attracted for non-trophic reasons, for example, to find shelter or to encounter other individuals of their species, which may lead to their creating larger schools and thus increasing their safety and chances of finding food and mates (Degraer *et al.*, 2020).
- 9.10.91 Colonisation of artificial hard structures can occur over a number of years following the initial construction, until a structured recolonised population is formed (Krone *et al.*, 2013). Research on the topic of artificial reef effect of OWFs is beginning to assess population changes and

observations of recolonisation in a more quantitative manner (Bouma and Lengkeek, 2013, Krone *et al.*, 2013).

- 9.10.92 It is uncertain whether artificial reefs facilitate recruitment into the local population, or if these observations are simply a result of concentrating biomass from surrounding areas (Inger *et al.*, 2009). Current evidence suggests that the abundance of fish can be greater in the vicinity of turbine foundations than in the surrounding area, which supports the findings of Linley *et al.* (2007) that finfish species are likely to have a neutral to beneficial likelihood of benefitting from introduction of these structures. Studies of finfish distributions before and after installation of OWFs demonstrate that some species, such as cod, spend at least part of their life cycles closely associated with these artificial structures (Bergström *et al.*, 2013, Reubens *et al.*, 2014). Increased prey availability associated with artificial hard structures may enhance settlement, survival, and/or growth of their predators, such as cod, and allow them to conserve energy (Schwartzbach *et al.*, 2020). Artificial habitats associated with OWF infrastructure have also been recorded to act as refuges for cod (Lindeboom *et al.*, 2011, Winter *et al.*, 2010) and plaice (Buyse *et al.*, 2022) with these effects likely to occur for other species. Key pelagic prey species, such as horse mackerel, mackerel, herring, and sprat, have been shown to utilise artificial hard structures for spawning and/or predation on the newly developed community (Glarou *et al.*, 2020).
- 9.10.93 Some studies have also shown evidence of increased abundance of small demersal fish species in the vicinity of Wind Turbine structures, most likely due to the increase in epifaunal communities and the resulting greater structural complexity of the habitat (e.g. mussel and barnacles *Cirripedia* spp.) (Wilhelmsson *et al.*, 2006a, Wilhelmsson *et al.*, 2006b). Buyse *et al.* (2022) investigated how the distribution of plaice was affected by the introduction of turbines and scour protection at both individual turbine and overall OWF scale in two Belgian OWFs. Plaice abundance was found to be four times higher on sandy patches of scour protection compared to surrounding sand (Buyse *et al.*, 2022). The authors suggest that the configuration of the hard scour protection offers increased food and shelter opportunities, while the sandy patches in between facilitate the natural burrowing behaviour of plaice, resulting in increased abundances at the turbine scale (Buyse *et al.*, 2022).
- 9.10.94 Contrastingly, there have been post-construction studies that found no evidence of fish abundance being beneficially nor adversely affected by the presence of OWFs (Barrow Offshore Windfarm Ltd., 2008, Walker *et al.*, 2010). Therefore, based on this and on the literature described in Paragraphs 9.10.90 *et seq.*, this impact is considered to have some form of a beneficial effect on the fish and shellfish IEFs and the wider ecosystem food web.

- 9.10.95 Crustacean species, such as the crab and lobster IEFs, are likely to benefit from the introduction of hard structures due to the creation of hard structure refuge areas (Linley *et al.*, 2007). Where hard infrastructure is placed within areas of sandy and coarse gravelly sediments (i.e. the majority of the Site Boundary), this presents novel habitat and new potential sources of food in these areas. This could potentially extend the habitat range of shellfish species such as edible crab IEF, which strongly associate with OWF foundations, which may serve as nursery areas (Hooper and Austen, 2014). Evidence from post-construction monitoring surveys at the Horns Rev OWF in the North Sea suggest that hard structures are particularly suitable for hatchery and nursery grounds for the edible crab, as well as several other species (Vattenfall, 2006). These surveys also concluded that crustacean larvae and juveniles can rapidly colonise the hard structures (Vattenfall, 2006).
- 9.10.96 The introduction of hard structures may lead to colonisation from INNS (see Volume 2, Chapter 8: Benthic Ecology for an assessment of this impact, as it was scoped out for fish and shellfish ecology: Table 9.16) which can lead to potential impacts on native shellfish populations through competition or habitat loss. There is currently limited evidence within the literature on the effect of this potential impact on fish and shellfish communities in OWFs and their sensitivity to INNS colonisation. Given this, implementation of precautionary mitigation measures is recommended to reduce or prevent spread of INNS where possible (Baulaz *et al.*, 2023) (see Table 9.22).
- 9.10.97 Overall, the marine fish IEFs and the shellfish IEFs are deemed to be of low vulnerability, low recoverability (due to the persistence of hard structures throughout the lifecycle of the Proposed Development, however these could result in beneficial effects) and local to international value. The sensitivity of the receptor is therefore, considered to be low.

Diadromous Fish IEFs

- 9.10.98 As all of the hard infrastructure will be installed in the offshore waters of the Site Boundary, the diadromous fish IEFs are only likely to interact with these structures during the marine phases of their lifecycles. There will be no hard infrastructure installed in the intertidal zone in Sinclair's Bay associated with the Landfall. Given their typically pelagic migrations, it is expected that diadromous fish IEFs are unlikely to utilise hard structures associated with the Proposed Development for foraging or shelter opportunities as they pass through the Site Boundary in offshore waters. Sea lamprey parasitise a wide range of larger fish species and some cetacean species (Silva *et al.*, 2014), however there is not anticipated to be any potential impact to these host species (as set out in Paragraphs 9.10.90 *et seq.*).
- 9.10.99 There is potential for impacts upon diadromous fish IEFs due to increased predation by marine mammals which are attracted to the fish aggregation

around the hard infrastructure. Tagging of harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus* around OWFs in Dutch and UK waters presented evidence that seals were utilising wind farm sites as foraging habitats, specifically targeting structures such as foundations (Russell *et al.*, 2014). However, other studies have shown there to be no change in seal behaviour (McConnell *et al.*, 2012), and the effects may be site-specific. It is possible that if seals do utilise OWFs as foraging areas, diadromous fish species may be impacted by the increased predation in an area where predation was lower prior to development. It is, however, unlikely that this would result in significantly increased predation on solely diadromous species. Research (with some studies focussing on the Moray Firth) has shown that Atlantic salmon smolts spend little time in coastal waters, and actively swim away from natal rivers making their way to feeding grounds soon after maturation (Gardiner *et al.*, 2018a, Gardiner *et al.*, 2018b, Newton *et al.*, 2021, Newton *et al.*, 2019, Newton *et al.*, 2017). Due to the evidence that Atlantic salmon tend not to forage in the coastal waters of Scotland, they are therefore at low risk of potential impact from increased predation from seals and other predators in the Site Boundary as their presence within it is likely to be transitory.

- 9.10.100 Sea trout may be at higher risk of increased seal predation than Atlantic salmon due to their higher usage of coastal environments. Given that sea trout are typically more coastal than Atlantic salmon, greater abundance would be expected inshore (near the Export Cable Corridor) than compared with the largely offshore waters of the rest of the Site Boundary. Sea trout are generalist, opportunistic feeders, with a diet comprising mainly of fish, crustaceans, polychaetes and surface insects with seasonal variations (Knutsen *et al.*, 2001, Rikardsen *et al.*, 2006). As this impact presents the potential for increased juvenile crustaceans and other shellfish species, which are possible prey items from sea trout, it is possible that foraging sea trout may be attracted to the hard structures introduced by installation of the Proposed Development. This attraction could in turn lead to increased predation of seal species upon sea trout. However, there is little evidence at present to show an increased abundance of sea trout around foundations, (as increases in fish abundance tend to be hard bottom dwelling fish species), therefore the effect of increased prey items attracting sea trout has not been recorded, to date. Given that it is unlikely that sea trout will spend time foraging around the foundations, there is a low risk of impact from increased predation from higher abundances of marine predators within the Site Boundary.
- 9.10.101 The diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.



*Significance of the effect*

- 9.10.102 Overall, for all fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.103 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms.

***Decommissioning phase***

*Magnitude of impact*

- 9.10.104 The approach for decommissioning phase is yet to be determined, however, for the purposes of this assessment, the MDS assumes that all scour protection, cable protection, and cable crossing protection will be left *in situ*, and that Wind Turbine and OSP foundations (including their moorings, anchors and dynamic cables) will be removed. Therefore, up to 3,042,840 m<sup>2</sup> (3.04 km<sup>2</sup>) of artificial hard structures will be present into, and following, the decommissioning phase. This value has been calculated as the total footprint area for all scour protection, cable protection, and cable crossing protection installed during the construction phase. This represents up to 0.78% of the total area of the Site Boundary. It should be noted that the MDS footprint for this impact will be spread out over the Array Area and Export Cable Corridor, within the Site Boundary, and does not represent one continuous area of 3.04 km<sup>2</sup> of hard structure during and after the decommissioning of the Proposed Development.
- 9.10.105 The potential impact is predicted to be of local spatial extent (0.78% of the total area of the Site Boundary), long term duration, continuous, and of low reversibility (as left *in situ*). It is predicted that the impact will affect the receptor directly. This impact presents some measurable, but minor long term alteration to areas of seabed within the Site Boundary, but not within the Fish and Shellfish Ecology Study Area. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

- 9.10.106 The sensitivity of the receptor is as presented in Paragraphs 9.10.90 to 9.10.101 and is not repeated here.

*Significance of the effect*

- 9.10.107 Overall, for all fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.



*Additional Mitigation and residual effect*

- 9.10.108 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms

**IMPACT 4 - INCREASED SSCs AND ASSOCIATED DEPOSITION**

- 9.10.109 Increased SSCs and associated deposition may arise due to the activities associated with the construction, O&M, and decommissioning phases of the Proposed Development.
- 9.10.110 The assessment of this impact was informed by modelling undertaken for the Physical Processes assessment, related to the MDS as outlined in Table 9.15, with the detail of the assessment provided in Volume 2: Chapter 7: Physical Processes and Volume 3, Technical Appendix 7.1: Physical Processes Technical Report.

**Construction phase**

*Magnitude of impact*

- 9.10.111 The site preparation activities and installation of infrastructure associated with the Proposed Development may lead to increased SSCs and associated deposition. During the construction phase, these activities will include drilling for anchor installation, cable installation, sandwave levelling, HDD exit pit excavation and drilling fluid release (Table 9.15).
- 9.10.112 Meta-analyses were conducted by Newcombe and Macdonald (1991) and Newcombe and Jensen (1996) in order to help quantify the response of fish species to increased SSCs. These analyses concluded that concentration alone is a relatively poor indicator of the effects of suspended sediments, and the product of sediment concentration (mg/l) combined with the duration of exposure is a better indicator of the severity of effects (Newcombe and Jensen, 1996, Newcombe and Macdonald, 1991). Therefore, the results of the physical processes modelling provide both sediment concentrations (in mg/l) and duration of exposure (in tidal cycles and/or days, where appropriate).
- 9.10.113 Drilling action for anchor installation may result in up to 692,701 m<sup>3</sup> of drill arisings, from up to 360 drilled piles. This will result in a localised and temporary plume of elevated SSC, which will be advected in the direction of the ambient tidal currents, broadly aligned to the coast. It is expected to be dispersed to relatively low concentrations within hours of release, and to background concentrations within a few tidal cycles (Volume 2: Chapter 7: Physical Processes and Volume 3, Technical Appendix 7.1: Physical Processes Technical Report).
- 9.10.114 Cable installation will involve installations in trenches of up to 6 m width with an average depth of 1.5 m, and a v-shaped profile. Installation may occur using a MFE, with a pre-lay trenching rate of 400 m per hour (Table 9.15). Sandwave levelling for cable installation may cover areas presented in Volume 3, Technical Appendix 7.1: Physical Processes Technical Report,

with associated volumes of displaced sediment. Levelling will be undertaken using a MFE and/or a dredger. The physical processes modelling was undertaken for a MFE for both sandwave levelling and cable installation. This modelling found that increased SSCs associated with this could lead to there being more sediment than water for a very short period of time within 5 m of the excavator activity. However, the plumes were expected to be vertically and horizontally dispersed to less than 1,000 mg/l within tens of metres. The modelling suggested that the SSCs were expected to reach less than 5 mg/l in all locations within three days of the cessation of excavation (Volume 3, Technical Appendix 7.1: Physical Processes Technical Report).

9.10.115 Finally, HDD exit pit extraction and HDD drilling fluid release (at the Landfall at Sinclair's Bay) may occur at four exit pits. These will affect the intertidal zone at Sinclair's Bay, so are not relevant for most fish and shellfish ecology receptors. However, consultation received in the Scoping Opinion emphasised the importance of the River Wester for diadromous fish (notably sea trout), which flows into Sinclair's Bay (Table 9.7). In order to ensure works associated with the Landfall are fully assessed with respect to the diadromous fish, physical processes modelling for the HDD exit pit extraction and drilling fluid release have been included in the assessment. The exit pit extraction may result in a volume of up to 880 m<sup>3</sup> of excavated material per pit, for a total of 3,520 m<sup>3</sup> of excavated material. The drilling fluid release may result in the release of up to 1,030 m<sup>3</sup> drilling mud per pit, for a total of up to 4,120 m<sup>3</sup> of drilling mud, with an assumed conservative maximum bentonite concentration of 100,000 mg/l. The drilling fluid may remain in suspension for several hours to days and will disperse to very low, non-measurable concentrations over time by wave and tidal action. The drilling fluid lubricating clay may accumulate in the HDD exit pit if it is slightly denser than surrounding seawater or may move over the adjacent seabed downslope under gravity in an offshore direction (Volume 3, Technical Appendix 7.1: Physical Processes Technical Report).

9.10.116 Overall, the impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

9.10.117 Increased SSCs and associated deposition could impact fish and shellfish IEFs within the Zol.

9.10.118 A review by Wenger *et al.* (2017) on the effects of dredging on fish considered the impact of increased SSCs at great length, with a wide range of responses presented in the studies reviewed:

- 14 studies showed no effect of suspended sediment (although only 11 of these recorded an exposure time);

- 12 studies observed behavioural changes;
- 34 studies recorded physical damage and substantial behavioural changes;
- 37 studies measured physiological stress and sublethal responses; and
- 49 studies recorded some level of mortality (Wenger *et al.*, 2017).

9.10.119 The fish species reviewed had markedly different tolerances to suspended sediments, with some species able to withstand concentrations up to 28,000 mg/l, while others experience mortality starting at 25 mg/l (Wenger *et al.*, 2017). As per Newcombe and Macdonald (1991) and Newcombe and Jensen (1996) (Paragraph 9.10.111), the linear discriminant analysis indicated that increasing both the concentration and exposure time to suspended sediment increased the severity of fish response (Wenger *et al.*, 2017).

Marine Fish IEFs

9.10.120 In general, eggs and larvae are the most susceptible life stage to increased SSCs and associated deposition (Engell-Sørensen and Skyt, 2001, Yang *et al.*, 2019). Adult fish are highly mobile and able to avoid areas with high sediment loads (Robertson *et al.*, 2006). For example, SSCs on the scale of mg/l can be lethal to eggs and larvae but only lethal to juveniles and adults on the scale of g/l, however, this does not apply to clupeid fish (such as herring), which are more sensitive to suspended sediment (Engell-Sørensen and Skyt, 2001). Eggs and larvae of species which are demersal spawners (such as herring and sandeel) are most likely to be affected by SSCs and associated deposition, given their proximity to the seabed wherein this impact will arise. This is evidenced by the medium and high sensitivities of sandeel to light and heavy siltation rate changes, respectively, on FeAST (NatureScot, 2025). Sandeel spawning grounds were identified within the Fish and Shellfish Ecology Study Area and areas of suitable spawning habitat within the Site Boundary were identified from the PSA results (Figure 9.3). Therefore, increased SSCs in the areas of suitable spawning habitat within the Site Boundary and wider Zol (one tidal excursion) may impact on sandeel leading to avoidance behaviour until the fine sediments are dissipated by the current. However, modelled deposition levels are expected to be highly localised (i.e. dispersed within tens of metres) and reduce to background concentrations (>5 mg/l) within a few tidal cycles for drilling and within three days for cable installation (see Paragraphs 9.10.113 and 9.10.114 and Volume 3, Technical Appendix 7.1: Physical Processes Technical Report for further information). Therefore, overall the potential impact on sandeel spawning populations due to this impact are predicted to be limited.

9.10.121 Furthermore, the results of the PSA conducted on the sediment samples collected within the Site Boundary demonstrated that the area is largely unsuitable spawning habitat for herring (Figure 9.2). Therefore, it is

unlikely that herring populations (including their eggs and larvae) will be largely affected by this impact.

- 9.10.122 The impact of suspended sediment on fish eggs is also important for pelagic eggs (which the majority of the teleost fish IEFs produce), as their survival is dependent on their ability to remain in the level of the water column where the abiotic parameters are ideal for survival and development. Suspended sediments can stick to eggs, causing them to become heavier and sink. A high risk of mortality can be expected if eggs sink, primarily due to reduced oxygen levels, benthic predation, and mechanical or physiological stress (Engell-Sørensen and Skyt, 2001). Studies have demonstrated that the development of fish eggs and larvae can be impacted by SSCs of thousands of mg/l (Appleby and Scarratt, 1989, Auld and Schubel, 1978). A study by Westerberg *et al.* (1996) on the effect of sedimentation on cod eggs showed that adhering particles resulted in a loss of egg buoyancy proportional to the SSC and the exposure time. Therefore, even relatively low SSCs over a longer exposure time could make eggs sink to the seabed (Westerberg *et al.*, 1996). The authors also reported increased mortality of cod yolk-sac larvae after exposure to SSCs of 10 mg/l (Westerberg *et al.*, 1996). Modelling undertaken of SSCs associated with the Proposed Development identified isolated sediment plumes, which would be vertically and horizontally dispersed to less than 1,000 mg/l within tens of metres and reach less than 5 mg/l within three days (see Paragraph 9.10.114 and Volume 3, Technical Appendix 7.1: Physical Processes Technical Report for further information). Therefore, it is unlikely that these SSCs will affect the development of eggs and larvae and they are only expected to be present in the immediate vicinity of the activity, with dispersion continuing over successive tides.
- 9.10.123 The eggs of pelagic spawning IEFs may be less vulnerable to the impact of increased SSCs as they may be high enough in the water column to avoid the ZOI associated with sedimentation at the seabed. Sinking and suffocating of eggs (as detailed in Paragraph 9.10.122) may then only effect eggs or larvae in close proximity to the construction works. Sediments are also expected to be rapidly dispersed by the strong tidal currents present in the Pentland Firth. Given that the IEFs are characteristic of the northern North Sea and Moray Firth, they are expected to be tolerant to temporary increases in SSCs as a result of the strong currents naturally present within the region.
- 9.10.124 Adult fish are more mobile than eggs and larvae and therefore may show greater avoidance behaviour within areas affected by increased SSCs. For example, avoidance of turbid water is a common response behaviour to elevated SSCs (Collin and Hart, 2015). In a study by Westerberg *et al.* (1996), avoidance behaviour was observed in adult herring and cod exposed to sediment plumes as low as 2 mg/l. It is therefore proposed that this increased mobility makes adults of these species less

susceptible to physiological effects of this impact. Conversely, due to the reduced mobility and higher dependence on specific nursery habitats, juvenile fish are likely to be less able to avoid habitat disturbances due to increased SSCs and associated deposition. For example, short-term exposure to turbidity in a laboratory setting reduced foraging success of juvenile Australasian snapper *Pagrus auratus*, while month-long exposure caused higher rates of gill ventilation, gill deformation, weight loss and mortality (Lowe *et al.*, 2015). Field experiments in New Zealand estuaries demonstrated that total suspended sediments were negatively correlated with capture rates of juvenile Australasian snapper and the condition of individuals, and were positively correlated with rates of gill deformation and gill parasite loads (Lowe *et al.*, 2015). Further, a study on juvenile coral reef damselfish *Acanthochromis polyacanthus* demonstrated reduced food acquisition, and subsequent reduced growth rate and body condition, associated with suspended sediments levels measured up to 180 mg/l (Wenger *et al.*, 2012). While there are limited studies on the effect of SSCs on juveniles of the marine fish IEFs in this assessment, the results observed on the Australasian snapper and coral reef damselfish highlighted above may still be relevant. Although it should be noted that these were laboratory studies, with artificially manipulated SSC levels that are outwith those predicted to occur due to construction of the Proposed Development (which are predicted to reduce to background levels within a few tidal cycles/days; see Paragraphs 9.10.113 and 9.10.114 and Volume 3, Technical Appendix 7.1: Physical Processes Technical Report for further information).

- 9.10.125 Juveniles of the marine fish IEFs are likely to occur throughout the Fish and Shellfish Ecology Study Area, with nursery habitats present inshore and offshore depending for a range of species (see Table 9.10 and Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report for a full account). As the marine fish IEFs are characteristic of the Moray Firth and northern North Sea, it is likely that juveniles are acclimatised to any natural fluctuations in SSCs that may occur within their nursery habitats. Therefore, it is proposed that most juveniles will be largely unaffected by the relatively low-level temporary increases in SSCs resulting from the construction phase, which are likely to be within the range of natural variability (generally at background levels of 30 mg/l) and occur intermittently and be dispersed on succeeding tides. Recoverability, in terms of fish returning to the area affected by this impact, is highly dependent on the recovery of the area to pre-disturbance conditions, the availability of alternative suitable habitat, and the ecological plasticity of that species (Wenger *et al.*, 2017). Due to the limited duration of SSCs associated with construction activities, with rapid succession on the following tides, juvenile habitats are expected to recover quickly from this impact. As a result, it is likely that there will be little impact upon juvenile marine fish IEFs.

- 9.10.126 Where available, formal sensitivity assessments, such as MarESA and FeAST for the marine fish IEFs have been consulted in relation to this impact. For example, the MarESA for basking shark lists that this species is not sensitive to ‘changes in suspended solids (water clarity)’ and that ‘smothering and siltation rate changes (light and heavy)’ are not relevant pressures for this species (Wilson *et al.*, 2020). This is because this species is restricted to the pelagic zone in open water and will therefore be outwith the Zol for increased SSCs and associated deposition, which will occur close to the seabed. Basking sharks have been recorded in turbid regions (such as in the Amazon river mouth: Skomal *et al.* (2009)), which previously have been thought to pose a risk of gill-raker clogging. However, there were no reports in the literature of basking sharks suffering from this problem (Wilson *et al.*, 2020). In addition, Sanderson *et al.* (2016) presented a model showing how the basking shark might avoid gill-raker clogging by a particular filter-feeding method: vortical cross-step filtration. Therefore, basking shark, and adult fish with similar pelagic life histories (such as some other elasmobranch IEFs, and the Atlantic bluefin tuna, horse mackerel, mackerel, and sprat IEFs) are considered to have low sensitivity to this impact.
- 9.10.127 It is also considered that adults of demersal species, such as the critically endangered common skate IEF and flapper skate IEF may have low sensitivity to this impact. For example, the MarESA for common skate presents a low sensitivity to ‘smothering’ and that the pressure of ‘increase in suspended sediment’ is not relevant for this species (Neal and Pizzolla, 2006). The reasoning behind this is that individuals will be mobile enough to move to unaffected areas, however it is noted that egg cases may be more sensitive to this impact (Neal and Pizzolla, 2006). Similarly, no sensitivity to ‘siltation rate changes (light)’ and ‘water clarity changes’ is presented for common skate on FeAST (NatureScot, 2025), citing high mobility as the reasoning. However, a medium sensitivity to ‘siltation rate changes (heavy)’ is presented on FeAST for common skate egg cases, as large levels of siltation (between 12 cm to 18 cm) would bury egg cases and block their respiratory channels (NatureScot, 2025), however, spawning grounds for this species are not likely to be present within the Fish and Shellfish Ecology Study Area (Table 9.10). The spawning (and egg-laying) habitats for the closely related flapper skate IEF have been characterised as being rocky, boulder, cobble, and mixed substrates in water depths of between -20 m to -50 m (Phillips *et al.*, 2021, Scottish Government, 2021). These were not identified as largely present across the Site Boundary (see Volume 3, Technical Appendix 9.1: Fish and Shellfish Ecology Technical Report). It is likely that these habitat preferences are very similar for common skate, given the close relatedness and life histories of these two species within the common skate complex.



- 9.10.128 Based on the above findings, it is considered that all marine fish IEFs (except herring and sandeel) are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.
- 9.10.129 As a precaution, the herring and sandeel IEFs are deemed to be of medium vulnerability, medium recoverability, and national value. The sensitivity of the receptor is therefore, considered to be medium.

Diadromous Fish IEFs

- 9.10.130 The diadromous fish IEFs are expected to have some tolerance to high SSCs as their migration routes typically require them to travel through estuarine habitats, which naturally have considerably higher background SSCs than in the marine environment (Bash *et al.*, 2001). As the activities associated with the Proposed Development will produce temporary increases in SSCs, with levels lower than those naturally present in estuarine environments, it is predicted that diadromous fish IEFs will be temporarily affected at most. It may be that certain species are not affected at all if the timing of their migration does not overlap with the timing of activities associated with the Proposed Development. As detailed in paragraph 9.10.111, the duration of exposure is important when assessing the severity of effect (Newcombe and Jensen, 1996, Newcombe and Macdonald, 1991).
- 9.10.131 Any potential effects on these species are likely to be short term behavioural effects, such as temporary changes swimming behaviour. For example, the swimming behaviour of rainbow smelt *Osmerus mordax* (a diadromous species) was evaluated at various SSCs from 0 mg/l to 40 mg/l (Chiasson, 1993). Individuals were significantly more active at SSCs equal to and greater than 10 mg/l, which was interpreted as an alarm response (Chiasson, 1993). In addition, repeated exposure of rainbow smelt to SSCs at 24 hour intervals produced significantly more active fish upon the third exposure (Chiasson, 1993). In addition, the effects of increased SSCs on swimming ability of juvenile sea trout and rainbow trout *Oncorhynchus mykiss* were investigated by Berli *et al.* (2014). Both species experienced a decrease in swimming performance as turbidity increased, but rainbow trout were impaired to a greater extent. This was attributed to impairment of the ability of the fish to utilise anaerobic metabolic pathways in high sediment environments (Berli *et al.*, 2014).
- 9.10.132 Avoidance response is another temporary behavioural effect that may occur due to increased SSCs. A laboratory study by Robertson *et al.* (2007) demonstrated that short-term increases in suspended sediment levels influenced the behaviour of juvenile Atlantic salmon. The initial introduction of SSCs of 20 mg/l increased foraging activity, which subsequently declined at sediment levels greater than 180 mg/l (Robertson *et al.*, 2007). Avoidance responses were demonstrated in early laboratory studies on juvenile Coho salmon *Oncorhynchus kisutch* (Bisson



and Bilby, 1982). Other studies on Coho salmon (which shares life history traits with the diadromous fish IEFs) have illustrated that avoidance behaviour ceases post-disturbance or if the fish becomes acclimated (Berg, 1979, Berg and Northcote, 1985). Avoidance behaviour may occur at very low SSC levels (Wenger *et al.*, 2017), but may vary between species. For example, avoidance responses of the migrating juveniles of six species of diadromous fish in New Zealand were investigated at different levels of suspended solids using a two-choice avoidance tank (Boubée *et al.*, 1997). Avoidance responses varied between species and suspended solid levels with three species showing no avoidance behaviour, even at the highest turbidity levels tested (Boubée *et al.*, 1997). Various other salmonid species have been demonstrated to exhibit avoidance reactions and move away from the vicinity of adverse sediment conditions, if refuge conditions are present (Bash *et al.*, 2001, Sigler *et al.*, 1984).

9.10.133 The studies presented in the preceding paragraphs were laboratory based, and some do not cover the exact diadromous IEFs identified for this assessment, thus the potential for other responses does exist. However, the slight temporary behavioural responses detailed are likely to be similar for the diadromous fish IEFs, due to similar life histories, and natural turbidity of the estuarine environments within the Fish and Shellfish Ecology Study Area. Investigations into the impacts of increased SSCs on diadromous species in the offshore environment are limited (Kjelland *et al.*, 2015), although there is the potential for increased turbidity to improve the survival rates of Pacific salmon species *Oncorhynchus* spp. during migrations due to lower predation associated with reduced visibility (Gregory and Levings, 1998).

9.10.134 Overall, this impact is not expected to create a significant barrier to migration for the diadromous fish IEFs. The diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel IEF with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

#### Shellfish IEFs

9.10.135 Many shellfish species have high tolerances to increased SSCs and are reported to be insensitive to increases in turbidity (Wilber and Clarke, 2001). This includes crustacean IEFs, such as common shore crab, edible crab, and Norway lobster which have all been assessed as having low or no sensitivity to the pressure: 'increase in suspended sediment' on their respective MarESAs (Hill and Sabatini, 2008, Neal and Pizzolla, 2008, Neal and Wilson, 2008). These species also have very low to no sensitivity to the pressures 'smothering' and 'increase in turbidity', which can be associated with this impact (Hill and Sabatini, 2008, Neal and Pizzolla, 2008, Neal and Wilson, 2008). The low to no sensitivity of these IEFs to

pressures associated with increased SSCs is largely due to their high mobility levels and therefore their ability to relocate to unaffected areas (Hill and Sabatini, 2008, Neal and Pizzolla, 2008, Neal and Wilson, 2008). Egg bearing (e.g., 'berried') Norway lobster and European lobster could potentially be more vulnerable to increased SSCs as the eggs they carry attached to their bodies required regular aeration. However, Norway lobster inhabit large burrows, which can penetrate 20 cm to 30 cm into the sediment and be over a metre long (Rice and Chapman, 1971), and are therefore considered unlikely to be affected by this impact. As lobsters are mobile species, they are able to move to more suitable conditions if necessary, during periods of increased SSCs in the construction phase, which are not expected to be continuous and will only affect a small area at any one time (see 'magnitude of impact' in paragraphs 9.10.111 to 9.10.116 above). Further, spawning and nursery grounds for Norway lobster are located within the Fish and Shellfish Ecology Study Area but do not overlap with the Site Boundary (and main ZOI). Therefore, the Norway lobster IEF is unlikely to be impacted by increased SSCs and associated deposition. There is no MarESA available for European lobster, however this species inhabits unsheltered seabeds, rocky crevices, and in excavated burrows (Dybern, 1973), and is also highly mobile. Therefore, it is likely that any potential impact to this species will be low.

- 9.10.136 Although far less mobile than the crustacean IEFs, the king scallop IEF was also assessed as having low sensitivity to increased suspended sediment and no sensitivity to increased turbidity in its MarESA (Marshall and Wilson, 2008). Whilst both king and queen scallop could potentially be buried due to sediment deposition, the sensitivity to smothering was still considered to be low on the king scallop MarESA (Marshall and Wilson, 2008). For example, a study by Hendrick *et al.* (2016) demonstrated that queen scallop had some ability to emerge after being buried under 2 cm of sediment, but mortality occurred after several days of burial and under sediments over 5 cm. The modelling of sediment plume movement and deposition have shown this is unlikely to occur in this case due to activities associated with the construction of the Proposed Development (see Paragraphs 9.10.113 and 9.10.114 and Volume 3, Technical Appendix 7.1: Physical Processes Technical Report for further information). The king scallop IEF appears to be more tolerant to burial than queen scallop, with high levels of emergence and low mortality recorded in coarse to medium grain sizes and depths of <3 cm (Szostek *et al.*, 2013). However, similar to the study on queen scallop, emergence decreased and mortality increased in king scallops buried under fine sediment of increasing depths, up to 5 cm (Szostek *et al.*, 2013). Within this study, king scallop also demonstrated increased clapping rate (e.g. quickly opening and closing their shell to clear unwanted particles) at SSCs of <100 mg/l and up to 700 mg/l, suggesting self-preservation behaviour in response (Szostek *et al.*, 2013). Scallop species may be able to visually detect the

size and speed of moving particles to identify preferable feeding conditions (Speiser and Johnsen, 2008), and may therefore be able to avoid areas of increased SSCs. Further, both species have some mobility, with queen scallops believed to be more mobile than king scallop, although this is yet to be quantified (Howarth and Stewart, 2014). Given the relatively low level of SSCs and deposition modelled (generally within background levels and being diminished on successive tides), the potential for avoidance behaviour and re-emergence from light deposition, king and queen scallop populations are not considered to be sensitive to this potential impact in the short or long term. The low to no sensitivity to the pressures associated with this impact on the king scallop MarESA (Marshall and Wilson, 2008) can reasonably be applied to queen scallop, given the similarity between the two species.

- 9.10.137 Overall, all shellfish IEFS are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

*Significance of the effect*

- 9.10.138 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.10.139 For all other fish and shellfish IEFS, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.140 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms

**O&M phase**

*Magnitude of impact*

- 9.10.141 Operations and maintenance activities associated with cable repair events may cause increased SSCs and associated depositions, from up to one annual IAC repair over a maximum distance of 1,170 m, and one annual export cable repair, again over a maximum distance of 1,170 m (Table 9.15). The adherence to the CaP and EMP as outlined in Section 9.9 are likely to mitigate any large increases in SSCs and associated deposition and would not be greater than those modelled during the construction phase. Specifically, the repair activities will be undertaken using similar methods as during the construction phase, but over a much reduced area and timescale, and therefore the sediment plumes and associated deposition will be smaller and will return to baseline conditions more quickly than

those assessed during the construction phase (see Paragraphs 9.10.111 to 9.10.116).

- 9.10.142 Therefore, the impact is predicted to be of local spatial extent, short term duration (for each individual repair event), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

- 9.10.143 The sensitivity of the receptor is as already presented for the construction phase (in Paragraphs 9.10.117 et seq.) and is not repeated here.

*Significance of the effect*

- 9.10.144 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.10.145 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.146 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms

***Decommissioning phase***

*Magnitude of impact*

- 9.10.147 The MDS for decommissioning phase assumes the total removal of infrastructure including buried cables and cable protection, with the exact programme to be submitted to MD-LOT for consultation and approval (Table 9.15). The decommissioning methods are assumed to be similar to those used during construction, with the magnitude of increased SSCs and associated deposition not being greater than that set out for the assessment in the construction phase of the Proposed Development (see Paragraphs 9.10.111 to 9.10.116).

- 9.10.148 Therefore, the impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

- 9.10.149 The sensitivity of the receptor is as already presented for the construction phase (in Paragraphs 9.10.117 et seq.) and is not repeated here.

*Significance of the effect*

- 9.10.150 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.10.151 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.152 No Additional Mitigation is considered necessary because the likely effect, in the absence of mitigation, is not significant in EIA terms

**IMPACT 5 - SUBSEA NOISE IMPACTING FISH AND SHELLFISH RECEPTORS**

- 9.10.153 Subsea noise may arise due to activities associated with the construction, O&M, and decommissioning phases of the Proposed Development.
- 9.10.154 The assessment of this impact was informed by subsea noise modelling undertaken, related to the MDS as outlined in Table 9.15, with full detail of the modelling provided in Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report.

***Construction phase***

- 9.10.155 In the construction phase, subsea noise may arise from the following activities:
- Piling of Wind Turbine and OSP foundations;
  - UXO clearance;
  - Site investigation surveys; and
  - Other construction activities.

*Magnitude of impact - piling*

- 9.10.156 Piling of Wind Turbine foundations and OSP foundations could lead to injury and disturbance for fish and shellfish IEFs during the construction phase of the Proposed Development. For piling, the subsea noise modelling considered three potential foundation options and a concurrent piling scenario (Table 9.15):
- Floating foundations – 25 MW semi-submersible option;
    - 40 foundations;
    - 360 piles;
    - maximum pile diameter of 5 m;

- maximum pile length of 100 m, with final pile penetration of 98 m;
- maximum hammer energy of 4,500 kJ; and
- maximum piling duration of 20 hours.
- Fixed foundations – 25 MW 3-legged jacket:
  - 40 foundations;
  - 120 piles;
  - maximum pile diameter of 4.8 m;
  - maximum pile length of 75 m, with final pile penetration of 70 m;
  - maximum hammer energy of 4,500 kJ; and
  - maximum piling duration of 14 hours.
- Realistic scenario – 25 MW semi-submersible with the average hammer energy and average piling duration, instead of the maximums modelled for the scenarios above:
  - 40 foundations;
  - 360 piles;
  - maximum pile diameter of 5 m;
  - maximum pile length of 100 m, with final pile penetration of 98 m;
  - maximum hammer energy of 4,275 kJ; and
  - maximum piling duration of 10 hours.
- Concurrent piling – all three scenarios:
  - up to two vessels piling concurrently; and
  - minimum of 1 km and maximum of 15 km distance between concurrent piling events.

9.10.157 The subsea noise modelling and the MDS, therefore considers the greatest potential impact from subsea noise on fish and shellfish IEFs, based on the greatest hammer energy, alongside a realistic scenario (using the average hammer energies and piling durations). The subsea noise modelling of concurrent piling (i.e. piling at more than one location simultaneously) ensures a precautionary assessment has been undertaken, alongside the single piling scenarios. The results of the subsea noise modelling are discussed in Paragraphs 9.10.179 to 9.10.193 to define the ‘sensitivity of the receptor’ in relation to injury and behavioural impacts upon the fish and shellfish IEFs.



- 9.10.158 The impact is predicted to be of local spatial extent, short term duration (in terms of piling hours), intermittent over the construction phase and high reversibility, with the soundscape returning to near baseline conditions upon completion of piling. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Magnitude of impact – UXO clearance*

- 9.10.159 UXO clearance (including detonation) has the potential to cause injury and disturbance to the fish and shellfish IEFs. UXO clearance will be completed prior to the construction activities, as part of the site preparation activities. The MDS assumes clearance of up to 20 UXOs within the Site Boundary, with a maximum realistic charge weight of 720 kg NEQ (Table 9.15). The total duration of UXO clearance is estimated at up to twenty days, with up to two detonations within 24 hours.
- 9.10.160 As detailed in Table 9.22, the use of low order disposal of UXOs (e.g. deflagration and clearance shots) where possible is an Embedded Mitigation measure. This will reduce subsea noise levels and thereby injury and disturbance to fish and shellfish IEFs during UXO clearance. The low order UXO clearance campaign will involve subsonic combustion with a donor charge of up to 0.08 kg NEQ for each clearance event, and a clearing shot of up to 0.5 kg NEQ to neutralise residual explosive material at each location. There is a small risk that low order disposal could unintentionally arise in a high order detonation and therefore this scenario has also been considered in the assessment.
- 9.10.161 To understand the magnitude of noise emissions from UXO clearance, subsea noise modelling has been undertaken considering the key parameters summarised above. In addition, the implications of UXO clearance on fish (in terms of injury and disturbance) are discussed in Paragraphs 9.10.213 to 9.10.216. Compared to piling, UXO clearance will consist of single, isolated events of very short duration.
- 9.10.162 The impact is predicted to be of local spatial extent (up to 20 clearances isolated within the Site Boundary), short term duration during the site preparation activities, intermittent and high reversibility, with the soundscape returning to near baseline conditions upon completion of UXO clearance. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Magnitude of impact – Site Investigation Surveys*

- 9.10.163 Site investigation surveys will be conducted prior to construction, although details on the specific equipment to be used are not currently available. There are no thresholds in Popper *et al.* (2014) in relation to subsea noise from high frequency sonar (>10 kHz) for fish. This is because the hearing range of fish species falls well below the frequency range of high frequency sonar systems (such as geophysical site investigation



survey equipment). Consequently, the effects of high frequency sonar-like seabed imaging surveys on fish have not been conducted as part of the noise modelling study, due to the frequency of the source being beyond the range of hearing and also due to the lack of any suitable thresholds. Therefore, the subsea noise modelling and MDS considered the following geotechnical survey equipment: borehole drilling and vibro-coring (Table 9.15).

9.10.164 The site investigation surveys will be short term and spatially limited, reducing the magnitude of their likely impact on the fish and shellfish IEFs. They will also operate largely outside of the hearing frequencies of most fish and shellfish, thereby reducing the potential for injury and behavioural impacts to low or negligible levels (see Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report).

9.10.165 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility, with the soundscape returning to near baseline conditions upon completion of the surveys. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Magnitude of impact – Other construction activities*

9.10.166 All other subsea noise sources in the construction phase, including jack-up usage, cable laying, cable trenching and drilling are non-percussive and will result in much lower sound levels and therefore much smaller injury ranges (in all cases no injury was predicted) than those modelled for piling operations.

9.10.167 Therefore, the impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility, with the soundscape returning to near baseline conditions upon completion of the construction activity. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor – piling*

9.10.168 Subsea noise can potentially have an adverse impact on marine and diadromous fish species ranging from physical injury and mortality to behavioural effects. Peer reviewed guidelines have been published by the Acoustical Society of America (ASA) and provide directions and recommendations for setting criteria (including injury and behavioural criteria) for fish (Popper *et al.*, 2014). These are the most relevant and best available guidelines for assessing the impacts of subsea noise on fish species (see Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report for further information).

9.10.169 The Popper *et al.* (2014) guidelines broadly place fish species into the following groups according to the presence or absence of a swim bladder and on the potential for that swim bladder to improve the sound sensitivity and range of hearing:

- Group 1: fish species which lack swim bladders (e.g. lampreys, elasmobranchs and flatfish species). These species are only sensitive to particle motion, not sound pressure and show sensitivity to only a narrow band of frequencies (see Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report for further information on particle motion). These species are less susceptible to barotrauma.
- Group 2: fish species which have a swim bladder, but the swim bladder does not play a role in hearing (e.g. salmonids (such as Atlantic salmon and sea trout)). These species are susceptible to barotrauma, although hearing only involves particle motion, not sound pressure.
- Group 3: fish species with swim bladders that are close, but not connected, to the ear (e.g. gadoid species (such as cod) and European eel). These species are sensitive to both particle motion and sound pressure and have a more extended frequency range than Groups 1 and 2, extending to about 500 Hz.
- Group 4: fish species that have special structures mechanically linking the swim bladder to the ear (e.g. clupeids such as herring, sprat and shads). These species are sensitive primarily to sound pressure, although they can also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than Groups 1, 2 and 3.
- Eggs and larvae: separated due to greater vulnerability and reduced mobility. Very few peer-reviewed studies report on the response of eggs and larvae to anthropogenic subsea noise.

9.10.170 The Popper *et al.* (2014) guidelines set out criteria for injury effects due to different sources of subsea noise. Those relevant to the Proposed Development are considered to be those for impulsive piling sources only, as non-impulsive sources were not considered to be a key potential impact and therefore were screened out of the guidance (Popper *et al.*, 2014). The criteria include a range of indices including Sound Exposure Level (SEL), rms and Peak Sound Pressure Level (SPL<sub>pk</sub>). Where insufficient data exist to determine a quantitative guideline value, the risk is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres). It should be noted that these qualitative criteria cannot differentiate between exposures to different subsea noise levels and therefore all sources of subsea noise, no matter how loud, would theoretically elicit the same assessment result. However, because the qualitative risks are generally qualified as “low”, with the exception of a moderate risk at “near” range (i.e. within tens of metres) for some types of hearing groups and impairment effects, this is not considered to be a

significant issue with respect to determining the potential effect of subsea noise on fish.

- 9.10.171 Few studies have been conducted on impacts of subsea noise on shellfish, including the IEFs defined for this assessment, and little is known about the effects of anthropogenic subsea noise upon them (Hawkins and Popper, 2017, Morley *et al.*, 2014, Williams *et al.*, 2015). There are therefore no injury or disturbance criteria that have been developed for shellfish and could not be applied to the shellfish IEFs. However, the shellfish IEFs are expected to be less sensitive than fish species and therefore injury ranges for fish could be considered conservative estimates for shellfish species.
- 9.10.172 An assessment of the potential for injury/mortality and behavioural effects on the fish and shellfish IEFs with reference to the Popper *et al.* (2014) fish hearing groups is presented in Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report, with the results summarised and used to inform the assessment of this impact throughout.
- 9.10.173 The injury threshold criteria used in the subsea noise modelling for impulsive piling are presented in Table 9.23. This includes parameters for both SEL and  $SPL_{pk}$ , both of which are unweighted. Physiological effects relating to injury criteria are as follows (Popper *et al.*, 2014, Popper and Hawkins, 2016):
- Mortality and potential mortal injury: either immediate mortality or tissue and/or physiological damage that is sufficiently severe (e.g. a barotrauma) that death occurs sometime later due to decreased fitness. Mortality has a direct effect upon animal populations, especially if it affects individuals close to maturity.
  - Recoverable injury: Tissue and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.
  - TTS: Short term changes in hearing sensitivity may, or may not, reduce fitness and survival. Temporary impairment of hearing may affect the ability of animals to capture prey and avoid predators, and also cause deterioration in communication between individuals affecting growth, survival, and reproductive success. After termination of a noise that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of exposure.

**Table 9.23: Criteria for the Onset of Injury and Disturbance to Fish from Impulsive Piling (Popper *et al.*, 2014)**

| Hearing Group                                                                                        | Parameter                                  | Mortality and Potential Mortal Injury | Recoverable Injury                 | TTS                                |
|------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------------|------------------------------------|------------------------------------|
| <b>Group 1 Fish: no swim bladder (particle motion detection)</b>                                     | SEL, dB re 1 $\mu\text{Pa}^2\text{s}$      | >219                                  | >216                               | >186                               |
|                                                                                                      | SPL <sub>pk</sub> , dB re 1 $\mu\text{Pa}$ | >213                                  | >213                               | -                                  |
| <b>Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)</b>       | SEL, dB re 1 $\mu\text{Pa}^2\text{s}$      | 210                                   | 203                                | >186                               |
|                                                                                                      | SPL <sub>pk</sub> , dB re 1 $\mu\text{Pa}$ | >207                                  | >207                               | -                                  |
| <b>Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)</b> | SEL, dB re 1 $\mu\text{Pa}^2\text{s}$      | 207                                   | 203                                | 186                                |
|                                                                                                      | SPL <sub>pk</sub> , dB re 1 $\mu\text{Pa}$ | >207                                  | >207                               | -                                  |
| <b>Eggs and larvae</b>                                                                               | SEL, dB re 1 $\mu\text{Pa}^2\text{s}$      | >210                                  | (Near) Moderate (Intermediate) Low | (Near) Moderate (Intermediate) Low |
|                                                                                                      | SPL <sub>pk</sub> , dB re 1 $\mu\text{Pa}$ | >207                                  | (Far) Low                          | (Far) Low                          |

9.10.174 Behavioural reactions of fish to subsea noise have been found to vary between species based on their hearing sensitivity. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fish's body (see Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report for further details on particle motion). The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders. However, it should be noted that the presence of a swim bladder does not necessarily mean that the fish can detect pressure. Some fish have swim bladders that are not involved in the hearing mechanism and can only detect particle motion.

9.10.175 Highly sensitive species, such as herring, have elaborate specialisations of their auditory apparatus, known as an otic bulla, which is a gas filled sphere, connected to the swim bladder, which enhances hearing ability. The gas filled swim bladder in species such as cod and Atlantic salmon may be involved in their hearing capabilities, so although there is no direct link to the inner ear, these species are able to detect lower sound frequencies and as such are considered to be of medium sensitivity to

sound. All flatfish, lampreys, and elasmobranch species have no swim bladders and as such are considered to be relatively less sensitive to sound pressure.

- 9.10.176 The most recent criteria for disturbance are considered to be those contained in Popper *et al.* (2014) which set out qualitative criteria for disturbance due to different sources of sound. The risk of behavioural effects is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres), as shown in Table 9.24.

**Table 9.24: Criteria for the Onset of Behavioural Effects in Fish (Popper *et al.*, 2014)**

| Hearing Group                                                                                        | Relative Risk of Behavioural Effects                   |                                                        |                                                            |
|------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|------------------------------------------------------------|
|                                                                                                      | Impulsive piling                                       | Explosives                                             | Non-impulsive sound                                        |
| <b>Group 1 Fish: no swim bladder (particle motion detection)</b>                                     | (Near) High<br>(Intermediate)<br>Moderate<br>(Far) Low | (Near) High<br>(Intermediate)<br>Moderate<br>(Far) Low | (Near) Moderate<br>(Intermediate)<br>Moderate<br>(Far) Low |
| <b>Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)</b>       | (Near) High<br>(Intermediate)<br>Moderate<br>(Far) Low | (Near) High<br>(Intermediate) High<br>(Far) Low        | (Near) Moderate<br>(Intermediate)<br>Moderate<br>(Far) Low |
| <b>Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)</b> | (Near) High<br>(Intermediate) High<br>(Far) Moderate   | (Near) High<br>(Intermediate) High<br>(Far) Low        | (Near) High<br>(Intermediate)<br>Moderate<br>(Far) Low     |
| <b>Eggs and larvae</b>                                                                               | (Near) Moderate<br>(Intermediate) Low<br>(Far) Low     | (Near) High<br>(Intermediate) Low<br>(Far) Low         | (Near) Moderate<br>(Intermediate)<br>Moderate<br>(Far) Low |

- 9.10.177 It is important to note that the Popper *et al.* (2014) criteria for behavioural disturbance (Table 9.24) due to subsea noise are qualitative rather than quantitative. Consequently, a subsea noise source a particular type (e.g. piling) would be predicted to result in the same potential impact, no matter the level of subsea noise produced or the propagation characteristics.
- 9.10.178 Therefore, the criteria presented in the Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2011) have been used in this assessment for predicting the distances at which behavioural effects may occur due to subsea noise from impulsive piling. This manual suggests an

unweighted SPL of 150 dB re 1  $\mu$ Pa (rms) as the criterion for onset of behavioural effects, based on work by Hastings (2002). SPL in excess of 150 dB re 1  $\mu$ Pa (rms) are expected to cause temporary behavioural changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area. The document notes that levels exceeding this threshold are not expected to cause direct permanent injury but may indirectly affect the individual fish (such as by impairing predator detection). It is important to note that this threshold is for onset of potential effects, and not necessarily an 'adverse effect' threshold.

Marine and Diadromous Fish IEFs

- 9.10.179 For the different piling scenarios, the modelling using the SEL metric considers fish as both moving and static receptors. As illustrated in the Scoping Opinion from MD-LOT (see Table 9.7), presenting results of fish modelled as static receptors allows for the most precautionary approach to assessment. To model moving receptors, a swim speed of 1 m/s was used for basking shark (Sims *et al.*, 2000), and 0.5 m/s for all other fish species (Popper *et al.*, 2014). Due to the difference in swim speeds, the modelling results for the basking shark IEF have been presented in their own row in the results tables from the other Group 1 fish species.
- 9.10.180 The MDS considers both single and concurrent piling of the three different foundation scenarios: floating, fixed, and realistic (see Table 9.15). For the floating Wind Turbine foundations, the piling schedule modelled included a maximum hammer energy of 4,500 kJ and a total piling duration of 20 hours.
- 9.10.181 The potential injury and disturbance ranges for single piling of the floating Wind Turbine foundation scenario are presented in Table 9.25 for fish modelled as moving receptors using the cumulative SEL metric. For Group 1 fish (including basking shark), the modelling results suggest that the thresholds for mortality and recoverable injury will not be exceeded (N/E), with higher ranges modelled for Groups 2, 3 and 4 fish (Table 9.25). Recoverable injury and TTS ranges were higher for all hearing groups; however, these are reversible. For eggs and larvae, mortality was modelled out to 4,060 m, and disturbance (for all hearing groups) was modelled out to 40,700 m (Table 9.25).

**Table 9.25: Potential Injury and Disturbance Ranges for Single Floating Wind Turbine Anchor Pile Installation, based on the Cumulative SEL Metric for Moving Fish**

| Hearing Group             | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|---------------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 1</b>            | Mortality          | 219                                                | N/E       |
|                           | Recoverable injury | 216                                                | N/E       |
|                           | TTS                | 186                                                | 14,700    |
| <b>Basking shark</b>      | Mortality          | 219                                                | N/E       |
|                           | Recoverable injury | 216                                                | N/E       |
|                           | TTS                | 186                                                | 11,700    |
| <b>Group 2</b>            | Mortality          | 210                                                | 48        |
|                           | Recoverable injury | 203                                                | 1,870     |
|                           | TTS                | 186                                                | 14,700    |
| <b>Groups 3 and 4</b>     | Mortality          | 207                                                | 476       |
|                           | Recoverable injury | 203                                                | 1,870     |
|                           | TTS                | 186                                                | 14,700    |
| <b>Eggs and larvae</b>    | Mortality          | 210                                                | 4,060     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                   | 40,700    |

9.10.182 The potential injury and disturbance ranges for single piling of the floating Wind Turbine foundation scenario are presented in Table 9.26 for fish modelled as static receptors using the cumulative SEL metric. The modelling results suggest that the thresholds for mortality will be exceeded for all hearing groups, with a maximum of 5,700 m for Groups 3 and 4 (Table 9.26). Recoverable injury and TTS ranges were higher; however, these are reversible. For eggs and larvae, mortality was modelled out to 4,060 m, and disturbance (for all hearing groups) was modelled out to 40,700 m (Table 9.26).



**Table 9.26: Potential Injury and Disturbance Ranges for Single Floating Wind Turbine Anchor Pile Installation, based on the Cumulative SEL Metric for Static Fish**

| Hearing Group             | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|---------------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 1</b>            | Mortality          | 219                                                | 1,390     |
|                           | Recoverable injury | 216                                                | 2,000     |
|                           | TTS                | 186                                                | 40,600    |
| <b>Basking shark</b>      | Mortality          | 219                                                | 1,390     |
|                           | Recoverable injury | 216                                                | 2,000     |
|                           | TTS                | 186                                                | 40,600    |
| <b>Group 2</b>            | Mortality          | 210                                                | 4,060     |
|                           | Recoverable injury | 203                                                | 8,860     |
|                           | TTS                | 186                                                | 40,600    |
| <b>Groups 3 and 4</b>     | Mortality          | 207                                                | 5,700     |
|                           | Recoverable injury | 203                                                | 8,860     |
|                           | TTS                | 186                                                | 40,600    |
| <b>Eggs and larvae</b>    | Mortality          | 210                                                | 4,060     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                   | 40,700    |

9.10.183 Finally, the potential injury and disturbance ranges for single piling of the floating Wind Turbine foundation scenario are presented in Table 9.27 using the  $\text{SPL}_{\text{pk}}$  metric. For all hearing groups, the mortality and recoverable injury ranges were modelled as within the low hundreds of meters for the first hammer strike, and out to between 502 m to 853 m for the highest hammer energy (Table 9.27).

**Table 9.27: Potential Injury Ranges for Single Floating Wind Turbine Anchor Pile Installation, based on the  $\text{SPL}_{\text{pk}}$  Metric**

| Hearing Group         | Response           | Threshold ( $\text{SPL}_{\text{pk}}$ db re 1 $\mu\text{Pa}$ ) | Range (m)    |                |
|-----------------------|--------------------|---------------------------------------------------------------|--------------|----------------|
|                       |                    |                                                               | First Strike | Highest Energy |
| <b>Group 1</b>        | Mortality          | 213                                                           | 170          | 502            |
|                       | Recoverable injury | 213                                                           | 170          | 502            |
| <b>Basking shark</b>  | Mortality          | 213                                                           | 170          | 502            |
|                       | Recoverable injury | 213                                                           | 170          | 502            |
| <b>Group 2</b>        | Mortality          | 207                                                           | 290          | 853            |
|                       | Recoverable injury | 207                                                           | 290          | 853            |
| <b>Groups 3 and 4</b> | Mortality          | 207                                                           | 290          | 853            |

| Hearing Group          | Response           | Threshold<br>(SPL <sub>pk</sub><br>db re 1 µPa) | Range (m)    |                |
|------------------------|--------------------|-------------------------------------------------|--------------|----------------|
|                        |                    |                                                 | First Strike | Highest Energy |
|                        | Recoverable injury | 207                                             | 290          | 853            |
| <b>Eggs and larvae</b> | Mortality          | 207                                             | 290          | 853            |

9.10.184 The MDS considers single piling of three different foundation scenarios: floating, fixed, and realistic (see Table 9.15). For the fixed jacket Wind Turbine foundations, the piling schedule modelled included a maximum hammer energy of 4,500 kJ and a total piling duration of 14 hours.

9.10.185 The potential injury and disturbance ranges for single piling of the fixed jacket Wind Turbine foundation scenario are presented in Table 9.28 for fish modelled as moving receptors using the cumulative SEL metric. For Group 1 (including basking shark) and 2 fish, the modelling results suggest that the thresholds for mortality will not be exceeded, with a range of up to 30 m modelled for Groups 3 and 4 fish (Table 9.28). Recoverable injury and TTS ranges were higher; however, these are reversible. For eggs and larvae, mortality was modelled out to 2,190 m, and disturbance (for all hearing groups) was modelled out to 30,700 m (Table 9.28).

**Table 9.28: Potential Injury and Disturbance Ranges for Single Fixed Jacket Pile Installation, based on the Cumulative SEL Metric for Moving Fish**

| Hearing Group             | Response           | Threshold (SEL:<br>db re 1 µPa <sup>2</sup> s) | Range (m) |
|---------------------------|--------------------|------------------------------------------------|-----------|
| <b>Group 1</b>            | Mortality          | 219                                            | N/E       |
|                           | Recoverable injury | 216                                            | N/E       |
|                           | TTS                | 186                                            | 9,060     |
| <b>Basking shark</b>      | Mortality          | 219                                            | N/E       |
|                           | Recoverable injury | 216                                            | N/E       |
|                           | TTS                | 186                                            | 6,920     |
| <b>Group 2</b>            | Mortality          | 210                                            | N/E       |
|                           | Recoverable injury | 203                                            | 540       |
|                           | TTS                | 186                                            | 9,060     |
| <b>Groups 3 and 4</b>     | Mortality          | 207                                            | 30        |
|                           | Recoverable injury | 203                                            | 540       |
|                           | TTS                | 186                                            | 9,060     |
| <b>Eggs and larvae</b>    | Mortality          | 210                                            | 2,190     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1µPa (rms)                           | 30,700    |

9.10.186 The potential injury and disturbance ranges for single piling of the fixed jacket Wind Turbine foundation scenario are presented in Table 9.29 for fish modelled as static receptors using the cumulative SEL metric. Thresholds were exceeded for all responses and hearing groups, with the highest mortality range of 3,140 m modelled for Groups 3 and 4 fish (Table 9.29). Recoverable injury and TTS ranges were higher; however, these are reversible. For eggs and larvae, mortality was modelled out to 2,190 m, and disturbance (for all hearing groups) was modelled out to 30,700 m (Table 9.29).

**Table 9.29: Potential Injury and Disturbance Ranges for Single Fixed Jacket Pile Installation, based on the Cumulative SEL Metric for Static Fish**

| Hearing Group             | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|---------------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 1</b>            | Mortality          | 219                                                | 735       |
|                           | Recoverable injury | 216                                                | 1,055     |
|                           | TTS                | 186                                                | 27,320    |
| <b>Basking shark</b>      | Mortality          | 219                                                | 735       |
|                           | Recoverable injury | 216                                                | 1,055     |
|                           | TTS                | 186                                                | 27,320    |
| <b>Group 2</b>            | Mortality          | 210                                                | 2,190     |
|                           | Recoverable injury | 203                                                | 4,960     |
|                           | TTS                | 186                                                | 27,320    |
| <b>Groups 3 and 4</b>     | Mortality          | 207                                                | 3,140     |
|                           | Recoverable injury | 203                                                | 4,960     |
|                           | TTS                | 186                                                | 27,320    |
| <b>Eggs and larvae</b>    | Mortality          | 210                                                | 2,190     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                   | 30,700    |

9.10.187 Finally, the potential injury and disturbance ranges for single piling of the fixed jacket Wind Turbine foundation scenario are presented in Table 9.30 using the  $\text{SPL}_{\text{pk}}$  metric. For all hearing groups, the mortality and recoverable injury ranges were modelled as within 200 m for the first hammer strike, and out to between 313 m to 532 m for the highest hammer energy (Table 9.30).

**Table 9.30: Potential Injury Ranges for Single Fixed Jacket Pile Installation, based on the  $\text{SPL}_{\text{pk}}$  Metric**

| Hearing Group  | Response  | Threshold ( $\text{SPL}_{\text{pk}}$ db re 1 $\mu\text{Pa}$ ) | Range (m)    |                |
|----------------|-----------|---------------------------------------------------------------|--------------|----------------|
|                |           |                                                               | First Strike | Highest Energy |
| <b>Group 1</b> | Mortality | 213                                                           | 115          | 313            |

| Hearing Group   | Response           | Threshold<br>(SPL <sub>pk</sub><br>db re 1 µPa) | Range (m)    |                |
|-----------------|--------------------|-------------------------------------------------|--------------|----------------|
|                 |                    |                                                 | First Strike | Highest Energy |
|                 | Recoverable injury | 213                                             | 115          | 313            |
| Basking shark   | Mortality          | 213                                             | 115          | 313            |
|                 | Recoverable injury | 213                                             | 115          | 313            |
| Group 2         | Mortality          | 207                                             | 196          | 532            |
|                 | Recoverable injury | 207                                             | 196          | 532            |
| Groups 3 and 4  | Mortality          | 207                                             | 196          | 532            |
|                 | Recoverable injury | 207                                             | 196          | 532            |
| Eggs and larvae | Mortality          | 207                                             | 196          | 532            |

9.10.188 The MDS considers single piling of three different foundation scenarios: floating, fixed, and realistic (see Table 9.15). For the realistic piling schedule (based the 25 MW semi-submersible option, using the average hammer energy and average piling duration instead of maximums), the piling schedule modelled included a full power hammer energy of 4,275 kJ and a total piling duration of 10 hours.

9.10.189 The potential injury and disturbance ranges for single piling of the realistic piling scenario are presented in Table 9.31 for fish modelled as moving receptors using the cumulative SEL metric. For Group 1 (including basking shark) and Group 2 fish, the modelling results suggest that the thresholds for mortality will not be exceeded, with a range of 47 m modelled for Groups 3 and 4 fish (Table 9.31). Recoverable injury and TTS ranges were higher; however, these are reversible. For eggs and larvae, mortality was modelled out to 1,970 m, and disturbance (for all hearing groups) was modelled out to 32,620 m (Table 9.31).

**Table 9.31: Potential Injury and Disturbance Ranges for the Realistic Scenario (Single Floating Wind Turbine Anchor Piling), based on the Cumulative SEL Metric for Moving Fish**

| Hearing Group | Response           | Threshold (SEL:<br>db re 1 µPa <sup>2</sup> s) | Range (m) |
|---------------|--------------------|------------------------------------------------|-----------|
| Group 1       | Mortality          | 219                                            | N/E       |
|               | Recoverable injury | 216                                            | N/E       |
|               | TTS                | 186                                            | 9,840     |
| Basking shark | Mortality          | 219                                            | N/E       |
|               | Recoverable injury | 216                                            | N/E       |
|               | TTS                | 186                                            | 7,600     |

| Hearing Group             | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|---------------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 2</b>            | Mortality          | 210                                                | N/E       |
|                           | Recoverable injury | 203                                                | 670       |
|                           | TTS                | 186                                                | 9,840     |
| <b>Groups 3 and 4</b>     | Mortality          | 207                                                | 47        |
|                           | Recoverable injury | 203                                                | 670       |
|                           | TTS                | 186                                                | 9,840     |
| <b>Eggs and larvae</b>    | Mortality          | 210                                                | 1,970     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                   | 32,620    |

9.10.190 The potential injury and disturbance ranges for single piling of the realistic piling scenario are presented in Table 9.32 for fish modelled as static receptors using the cumulative SEL metric. Thresholds were exceeded for all responses and hearing groups, with the highest mortality range of 2,800 m modelled for Groups 3 and 4 fish (Table 9.32). Recoverable injury and TTS ranges were higher; however, these are reversible. For eggs and larvae, mortality was modelled out to 1,970 m, and disturbance (for all hearing groups) was modelled out to 32,620 m (Table 9.32).

**Table 9.32: Potential Injury and Disturbance Ranges for the Realistic Scenario (Single Floating Wind Turbine Anchor Piling), based on the Cumulative SEL Metric for Static Fish**

| Hearing Group             | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|---------------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 1</b>            | Mortality          | 219                                                | 655       |
|                           | Recoverable injury | 216                                                | 950       |
|                           | TTS                | 186                                                | 25,280    |
| <b>Basking shark</b>      | Mortality          | 219                                                | 655       |
|                           | Recoverable injury | 216                                                | 950       |
|                           | TTS                | 186                                                | 25,280    |
| <b>Group 2</b>            | Mortality          | 210                                                | 1,970     |
|                           | Recoverable injury | 203                                                | 4,460     |
|                           | TTS                | 186                                                | 25,280    |
| <b>Groups 3 and 4</b>     | Mortality          | 207                                                | 2,800     |
|                           | Recoverable injury | 203                                                | 4,460     |
|                           | TTS                | 186                                                | 25,280    |
| <b>Eggs and larvae</b>    | Mortality          | 219                                                | 1,970     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                   | 32,620    |

9.10.191 Finally, the potential injury and disturbance ranges for single piling of the realistic piling scenario are presented in Table 9.33 using the  $\text{SPL}_{\text{pk}}$  metric.

For all hearing groups, the mortality and recoverable injury ranges were modelled as within 122 m to 207 m for the first hammer strike, and out to between 342 m to 582 m for the highest hammer energy (Table 9.33).

**Table 9.33: Potential Injury Ranges for the Realistic Scenario (Single Floating Wind Turbine Anchor Piling), based on the SPL<sub>pk</sub> Metric**

| Hearing Group   | Response           | Threshold<br>(SPL <sub>pk</sub><br>db re 1 µPa) | Range (m)    |                |
|-----------------|--------------------|-------------------------------------------------|--------------|----------------|
|                 |                    |                                                 | First Strike | Highest Energy |
| Group 1         | Mortality          | 213                                             | 122          | 342            |
|                 | Recoverable injury | 213                                             | 122          | 342            |
| Basking shark   | Mortality          | 213                                             | 122          | 342            |
|                 | Recoverable injury | 213                                             | 122          | 342            |
| Group 2         | Mortality          | 207                                             | 207          | 582            |
|                 | Recoverable injury | 207                                             | 207          | 582            |
| Groups 3 and 4  | Mortality          | 207                                             | 207          | 582            |
|                 | Recoverable injury | 207                                             | 207          | 582            |
| Eggs and larvae | Mortality          | 207                                             | 207          | 582            |

9.10.192 The subsea noise modelling also considered concurrent piling, using two pile installation vessels at once, with a minimum of 1 km and maximum of 15 km between concurrent piling events. Potential injury and disturbance ranges for concurrent piling of the three different piling scenarios (floating, fixed jackets and realistic) are presented in Table 9.34 to Table 9.39. These are all based on the cumulative SEL metric, as ranges calculated using the SPL<sub>pk</sub> metric will remain the same as those detailed in Table 9.27, Table 9.30, and Table 9.33, for single piling.

9.10.193 The results of the concurrent piling modelling illustrate that mortality, recoverable injury, and TTS ranges are similar or slightly larger than the single piling scenarios for all hearing groups when modelled as moving fish, but considerably larger for fish modelled as static receptors (Table 9.34 to Table 9.39). The behavioural disturbance ranges remain the same for the concurrent and single piling scenarios. It should be noted that, in reality, most fish species are not likely to remain static for the duration of piling, and therefore being modelled as static receptors is highly precautionary.

9.10.194 Therefore, as per Table 9.39, mortality may occur for all hearing groups in the hundreds of metres (705 m) for Group 1 species, and several kilometres for Group 2, Groups 3 and 4, and eggs and larvae (2,110 m, 3,020 m and 2,110 m, respectively). Recoverable injury and TTS ranges

increase to the thousands of metres, with TTS ranges of 25,580 m for all hearing groups (Table 9.39).

**Table 9.34: Potential Injury and Disturbance Ranges for Concurrent Floating Wind Turbine Anchor Pile Installation, with a separation of 1.9 km, based on the Cumulative SEL Metric for Moving Fish**

| Hearing Group             | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|---------------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 1</b>            | Mortality          | 219                                                | N/E       |
|                           | Recoverable injury | 216                                                | N/E       |
|                           | TTS                | 186                                                | 14,700    |
| <b>Basking shark</b>      | Mortality          | 219                                                | N/E       |
|                           | Recoverable injury | 216                                                | N/E       |
|                           | TTS                | 186                                                | 12,200    |
| <b>Group 2</b>            | Mortality          | 210                                                | 78        |
|                           | Recoverable injury | 203                                                | 2,030     |
|                           | TTS                | 186                                                | 14,700    |
| <b>Groups 3 and 4</b>     | Mortality          | 207                                                | 585       |
|                           | Recoverable injury | 203                                                | 2,030     |
|                           | TTS                | 186                                                | 14,700    |
| <b>Eggs and larvae</b>    | Mortality          | 210                                                | 3,040     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                   | 40,700    |

**Table 9.35: Potential Injury and Disturbance Ranges for Concurrent Floating Wind Turbine Anchor Pile Installation, with a separation of 1.9 km, based on the Cumulative SEL Metric for Static Fish**

| Hearing Group         | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|-----------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 1</b>        | Mortality          | 219                                                | 1,025     |
|                       | Recoverable injury | 216                                                | 1,480     |
|                       | TTS                | 186                                                | 33,700    |
| <b>Basking shark</b>  | Mortality          | 219                                                | 1,025     |
|                       | Recoverable injury | 216                                                | 1,480     |
|                       | TTS                | 186                                                | 33,700    |
| <b>Group 2</b>        | Mortality          | 210                                                | 3,040     |
|                       | Recoverable injury | 203                                                | 6,780     |
|                       | TTS                | 186                                                | 33,700    |
| <b>Groups 3 and 4</b> | Mortality          | 207                                                | 4,280     |
|                       | Recoverable injury | 203                                                | 6,780     |
|                       | TTS                | 186                                                | 33,700    |



| Hearing Group      | Response    | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|--------------------|-------------|----------------------------------------------------|-----------|
| Eggs and larvae    | Mortality   | 219                                                | 3,040     |
| All hearing groups | Disturbance | 150 dB re 1 $\mu\text{Pa}$ (rms)                   | 40,700    |

**Table 9.36: Potential Injury and Disturbance Ranges for Concurrent Fixed Jacket Pile Installation, with a separation of 1.9 km, based on the Cumulative SEL Metric for Moving Fish**

| Hearing Group             | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|---------------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 1</b>            | Mortality          | 219                                                | N/E       |
|                           | Recoverable injury | 216                                                | N/E       |
|                           | TTS                | 186                                                | 9,200     |
| <b>Basking shark</b>      | Mortality          | 219                                                | N/E       |
|                           | Recoverable injury | 216                                                | N/E       |
|                           | TTS                | 186                                                | 7,160     |
| <b>Group 2</b>            | Mortality          | 210                                                | N/E       |
|                           | Recoverable injury | 203                                                | 700       |
|                           | TTS                | 186                                                | 9,200     |
| <b>Groups 3 and 4</b>     | Mortality          | 207                                                | 53        |
|                           | Recoverable injury | 203                                                | 700       |
|                           | TTS                | 186                                                | 9,200     |
| <b>Eggs and larvae</b>    | Mortality          | 210                                                | 2,340     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                   | 30,700    |

**Table 9.37: Potential Injury and Disturbance Ranges for Concurrent Fixed Jacket Pile Installation, with a separation of 1.9 km, based on the Cumulative SEL Metric for Static Fish**

| Hearing Group         | Response           | Threshold (SEL: db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|-----------------------|--------------------|----------------------------------------------------|-----------|
| <b>Group 1</b>        | Mortality          | 219                                                | 795       |
|                       | Recoverable injury | 216                                                | 1,140     |
|                       | TTS                | 186                                                | 28,680    |
| <b>Basking shark</b>  | Mortality          | 219                                                | 795       |
|                       | Recoverable injury | 216                                                | 1,140     |
|                       | TTS                | 186                                                | 28,680    |
| <b>Group 2</b>        | Mortality          | 210                                                | 2,340     |
|                       | Recoverable injury | 203                                                | 5,300     |
|                       | TTS                | 186                                                | 28,680    |
| <b>Groups 3 and 4</b> | Mortality          | 207                                                | 3,360     |

| Hearing Group      | Response           | Threshold (SEL:<br>db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|--------------------|--------------------|-------------------------------------------------------|-----------|
|                    | Recoverable injury | 203                                                   | 5,300     |
|                    | TTS                | 186                                                   | 28,680    |
| Eggs and larvae    | Mortality          | 219                                                   | 2,340     |
| All hearing groups | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                      | 30,700    |

**Table 9.38: Potential Injury and Disturbance Ranges for Concurrent Piling of the Realistic Scenario, with a separation of 1.9 km, based on the Cumulative SEL Metric for Moving Fish**

| Hearing Group         | Response           | Threshold (SEL:<br>db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|-----------------------|--------------------|-------------------------------------------------------|-----------|
| <b>Group 1</b>        | Mortality          | 219                                                   | N/E       |
|                       | Recoverable injury | 216                                                   | N/E       |
|                       | TTS                | 186                                                   | 10,520    |
| <b>Basking shark</b>  | Mortality          | 219                                                   | N/E       |
|                       | Recoverable injury | 216                                                   | N/E       |
|                       | TTS                | 186                                                   | 7,840     |
| <b>Group 2</b>        | Mortality          | 210                                                   | N/E       |
|                       | Recoverable injury | 203                                                   | 845       |
|                       | TTS                | 186                                                   | 10,520    |
| <b>Groups 3 and 4</b> | Mortality          | 207                                                   | 81        |
|                       | Recoverable injury | 203                                                   | 845       |
|                       | TTS                | 186                                                   | 10,520    |
| Eggs and larvae       | Mortality          | 210                                                   | 2,110     |
| All hearing groups    | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                      | 32,620    |

**Table 9.39: Potential Injury and Disturbance Ranges for Concurrent Piling of the Realistic Scenario, with a separation of 1.9 km, based on the Cumulative SEL Metric for Static Fish**

| Hearing Group        | Response           | Threshold (SEL:<br>db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|----------------------|--------------------|-------------------------------------------------------|-----------|
| <b>Group 1</b>       | Mortality          | 219                                                   | 705       |
|                      | Recoverable injury | 216                                                   | 1,015     |
|                      | TTS                | 186                                                   | 26,580    |
| <b>Basking shark</b> | Mortality          | 219                                                   | 705       |
|                      | Recoverable injury | 216                                                   | 1,015     |
|                      | TTS                | 186                                                   | 26,580    |
| <b>Group 2</b>       | Mortality          | 210                                                   | 2,110     |
|                      | Recoverable injury | 203                                                   | 4,760     |
|                      | TTS                | 186                                                   | 26,580    |

| Hearing Group             | Response           | Threshold (SEL:<br>db re 1 $\mu\text{Pa}^2\text{s}$ ) | Range (m) |
|---------------------------|--------------------|-------------------------------------------------------|-----------|
| <b>Groups 3 and 4</b>     | Mortality          | 207                                                   | 3,020     |
|                           | Recoverable injury | 203                                                   | 4,760     |
|                           | TTS                | 186                                                   | 26,580    |
| <b>Eggs and larvae</b>    | Mortality          | 219                                                   | 2,110     |
| <b>All hearing groups</b> | Disturbance        | 150 dB re 1 $\mu\text{Pa}$ (rms)                      | 32,620    |

9.10.195 As detailed in the preceding tables, behavioural disturbance ranges extend to tens of kilometres for the different piling scenarios (between 30,700 m to 40,700 m). This was modelled using a threshold SPL of 150 dB re 1  $\mu\text{Pa}$  (rms) (from WSDOT (2011), see Paragraph 9.10.178 for further details). It should be noted that these ranges are for all hearing groups combined and will be highly conservative for the less sensitive fish IEFs (i.e. those in Groups 1 and 2). Additional information is provided here to further characterise the sensitivity of the receptor with regards to behavioural disturbance.

9.10.196 In some cases (e.g. previous offshore wind projects), TTS has been used as a proxy for behavioural disturbance. The maximum TTS value of 33,700 m was modelled for concurrent piling of the floating Wind Turbines, with fish as static receptors (Table 9.35). It should be noted that, in reality, most fish species are not likely to remain static for the duration of piling, and therefore being modelled as static receptors is highly precautionary. This range is of a similar magnitude to the behavioural disturbance values between 30,700 m to 40,700 m modelled for the different piling scenarios using the threshold SPL of 150 dB re 1  $\mu\text{Pa}$  (rms). Therefore, values in the low tens of kilometres are likely representative of the maximum ranges of behavioural disturbance to all fish species. These results broadly align with qualitative thresholds for behavioural effects on fish as set out in Table 9.24, with moderate risk of behavioural effects in the range of hundreds of metres to thousands of metres from the piling activity, depending on the hearing groups. As previously discussed, these behavioural disturbance thresholds are likely to be highly precautionary for the less sensitive Group 1 and Group 2 fish species.

9.10.197 Behavioural responses to subsea noise have been found to vary between species, based on their hearing sensitivity. There have been several studies on the behavioural effects of the sound pressure component of impulsive noise (which includes piling operations) on fish. For example, Mueller-Blenkle *et al.* (2010) demonstrated behavioural responses in cod and sole to subsea noise similar to that produced during piling, with variation noticed across individuals (i.e. depending on the age, sex, and condition of the fish, as well as the possible increased stress levels due

to confinement in cages). Mueller-Blenkle *et al.* (2010) could not define a clear relationship between the level of exposure and the extent of the behavioural response, although an observable behavioural response was reported at 140 to 161 dB re 1  $\mu$ Pa ( $SPL_{pk}$ ) for cod and 144 dB to 156 dB re 1  $\mu$ Pa ( $SPL_{pk}$ ) for sole. Nonetheless, these thresholds have not been interpreted as the level at which an avoidance reaction will be elicited, as Mueller-Blenkle *et al.* (2010) were not able to show this.

9.10.198 In addition, Pearson *et al.* (1992) examined the effects of geophysical survey noise on caged rockfish *Sebastes* spp. and observed a startle or 'C-turn response' beginning at around 200 dB re 1  $\mu$ Pa ( $SPL_{pk}$ ). However, this behavioural response was less common in larger fish. Similarly, McCauley *et al.* (2000) exposed various caged fish species to seismic airgun noise to assess behavioural, physiological and pathological changes. The study observed that:

- A general behavioural response in many fish was to move to the bottom of the cage during periods of high level exposure (around 156 to 161 dB re 1  $\mu$ Pa (rms); approximately equivalent to around 168 dB to 173 dB re 1  $\mu$ Pa ( $SPL_{pk}$ )).
- A greater startle response was seen in small fish to the above levels than in larger fish.
- A return to normal behavioural patterns occurred between 14 to 30 minutes after airgun operations ceased.
- No significant increases in physiological stress were attributed to airgun exposure.
- Some preliminary evidence of damage to the hair cells was noticed when fish were exposed to the highest subsea noise levels, although it was determined that such damage would only likely occur at short range from the source (McCauley *et al.*, 2000).

9.10.199 Behavioural disturbance due to piling can also be inferred from post-construction monitoring studies of other OWFs. For example, a post-construction monitoring study for cod at the Beatrice OWF (58.57 km from the Array Area) recorded no change in the presence of spawning individuals between pre and post construction (although spawning intensity was found to be low across both surveys) (Beatrice OWF Limited, 2021a). Similarly, a sandeel monitoring study at the Beatrice OWF found no evidence of adverse impacts on sandeel populations between pre and post construction levels over a six year period (Beatrice OWF Limited, 2021b). Based on these results, it can be inferred that behavioural disturbance associated with piling and other construction noise from an OWF are likely to be temporary and that fish communities (specifically cod and sandeel in this case) show a higher degree of recoverability following construction. As cod are a Group 3 fish (with some of the highest sensitivity to subsea noise), these results could be extrapolated to other fish IEFs with similar, or lower, hearing sensitivities.

- 9.10.200 With specific reference to diadromous fish (which are a key consideration for the assessment, based on consultation received in Table 9.7), a study by Harding *et al.* (2016) failed to produce physiological or behavioural responses in Atlantic salmon when subjected to noise similar to piling. However, the noise levels tested were estimated at <160 dB re 1µPa (rms), below the level at which injury or behavioural disturbance would be expected for Atlantic salmon (Harding *et al.*, 2016). Nedwell *et al.* (2006) compared behavioural responses to piling in sea trout and Atlantic salmon. This study found no significant behavioural response in both species (Nedwell *et al.*, 2006). Physical impacts on migrating salmonids exposed to piling noise of 218 dB re 1µPa<sup>2</sup>s (SEL) were recorded by Bagočius (2015), although at these high noise levels, avoidance reactions would be expected, in order to avoid injury.
- 9.10.201 As there are no agreed thresholds for behavioural effects on fish from piling, a risk based approach has been undertaken using published literature summarised in Paragraphs 9.10.197 to 9.10.200. Based on these studies, the 160 dB re 1 µPa (SPL<sub>pk</sub>) noise contour has been mapped to assess behavioural responses in fish species in general. It is unlikely that species will experience behavioural disturbance beyond this noise contour, based on the described studies which demonstrated responses (including avoidance) at levels above this threshold. It's likely that 160 dB re 1 µPa (SPL<sub>pk</sub>) contour is over conservative, given that many fish IEFs (such as flatfish, elasmobranchs, lampreys, and salmonids) are at the lower end of the sensitivity spectrum (i.e. hearing Groups 1 and 2). The 160 dB re 1 µPa (SPL<sub>pk</sub>) contour is presented on Figure 9.5 for single piling of the maximum piling scenarios for both fixed and floating foundations at the North and South of the Array Area (as these represent the worst-case scenario in the MDS). The single piling scenario with the maximum hammer energy of 4,500 kJ has been used as the SPL<sub>pk</sub> metric will remain the same for both single and concurrent piling. Therefore, potential disturbance ranges will not increase the risk of behavioural or barrier effects under concurrent piling scenarios.
- 9.10.202 The extent of the 160 dB re 1 µPa (SPL<sub>pk</sub>) contour should be noted, particularly in terms of its considerable distance offshore, lack of attenuation past the Orkney Islands and its relatively small area of effect in terms of the availability of habitat in the Fish and Shellfish Ecology Study Area. While the 155 and 150 dB re 1 µPa (SPL<sub>pk</sub>) contours do extend closer to the shore of mainland Scotland, behavioural disturbance is unlikely at this level (based on the studies outlined above).
- 9.10.203 Figure 9.6 and Figure 9.7 show the 160 dB re 1 µPa (SPL<sub>pk</sub>) contour in relation to the spawning grounds of the cod and sandeel. These figures illustrate that this behavioural disturbance could occur within the cod and sandeel spawning grounds, although the area of the 160 dB re 1 µPa (SPL<sub>pk</sub>) contour is limited compared to the wider availability of their

spawning grounds, particularly within the Moray Firth, wherein the contour does not extend.

- 9.10.204 Figure 9.8 shows the 160 dB re 1  $\mu$ Pa ( $SPL_{pk}$ ) contour in relation to the spawning grounds for herring alongside cumulative larval densities. This figure illustrates that the 160 dB re 1  $\mu$ Pa ( $SPL_{pk}$ ) contour associated with piling at the south of the Array Area does not extend to the hotspot of herring larval density, while piling at the North does. Therefore, the herring IEF is deemed to be of high vulnerability, medium recoverability, and national importance. The sensitivity of the receptor is, precautionarily, considered to be high.
- 9.10.205 Finally, Figure 9.9 shows the 160 dB re 1  $\mu$ Pa ( $SPL_{pk}$ ) contour in relation to the designated sites identified in Table 9.12. Based on this figure, behavioural disturbance is not likely to impact the sandeel features of the North-West Orkney MPA. Due to the extent of the modelled contours offshore, any potential behavioural impacts are unlikely to cause barrier effects to diadromous species as they migrate along the east and north coasts of Scotland, due to the relatively limited area around piling events where noise levels are high enough to cause behavioural responses in the context of the wider Fish and Shellfish Ecology Study Area.
- 9.10.206 The remaining marine and diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.



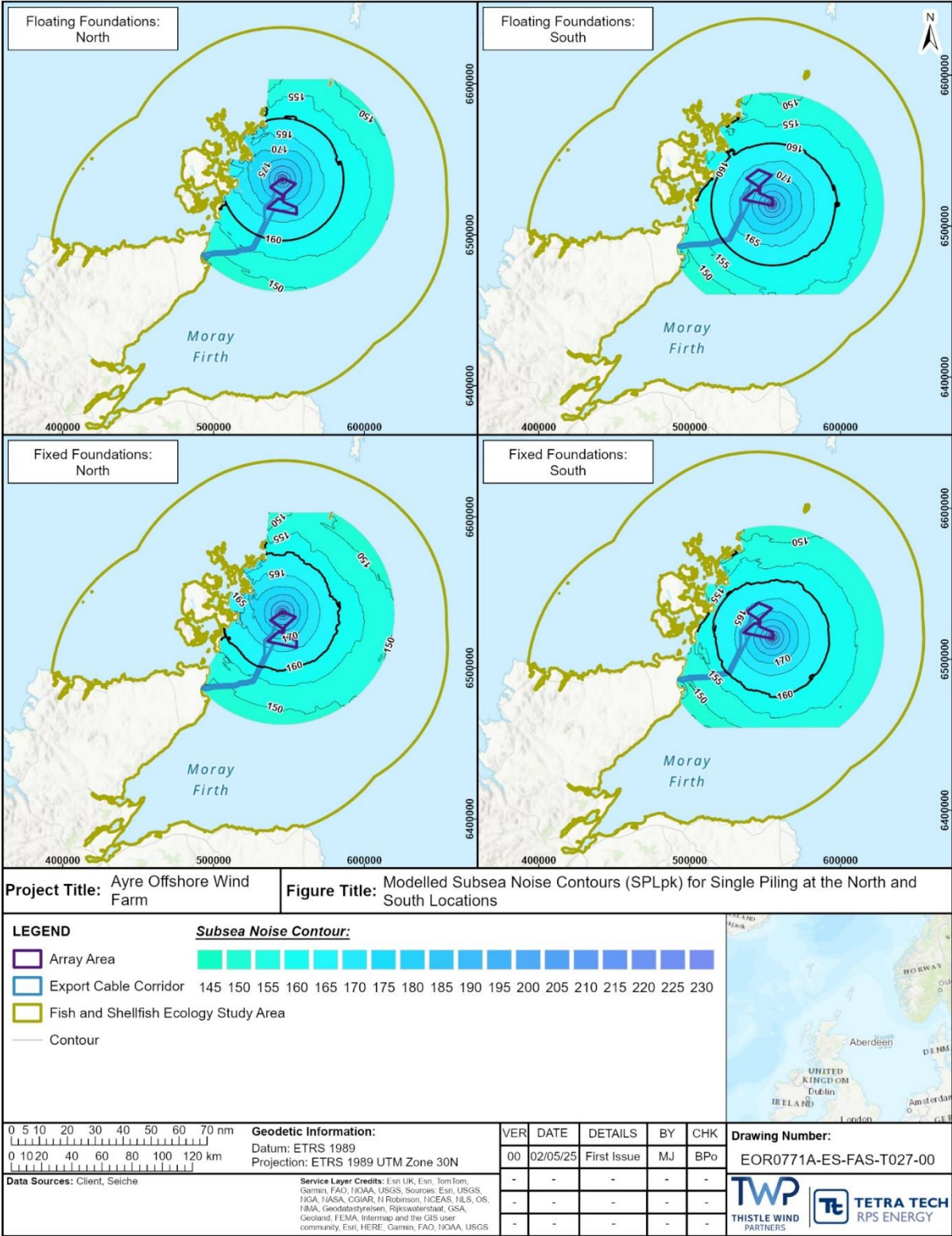


Figure 9.5: Modelled Subsea Noise Contours (SPL<sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations



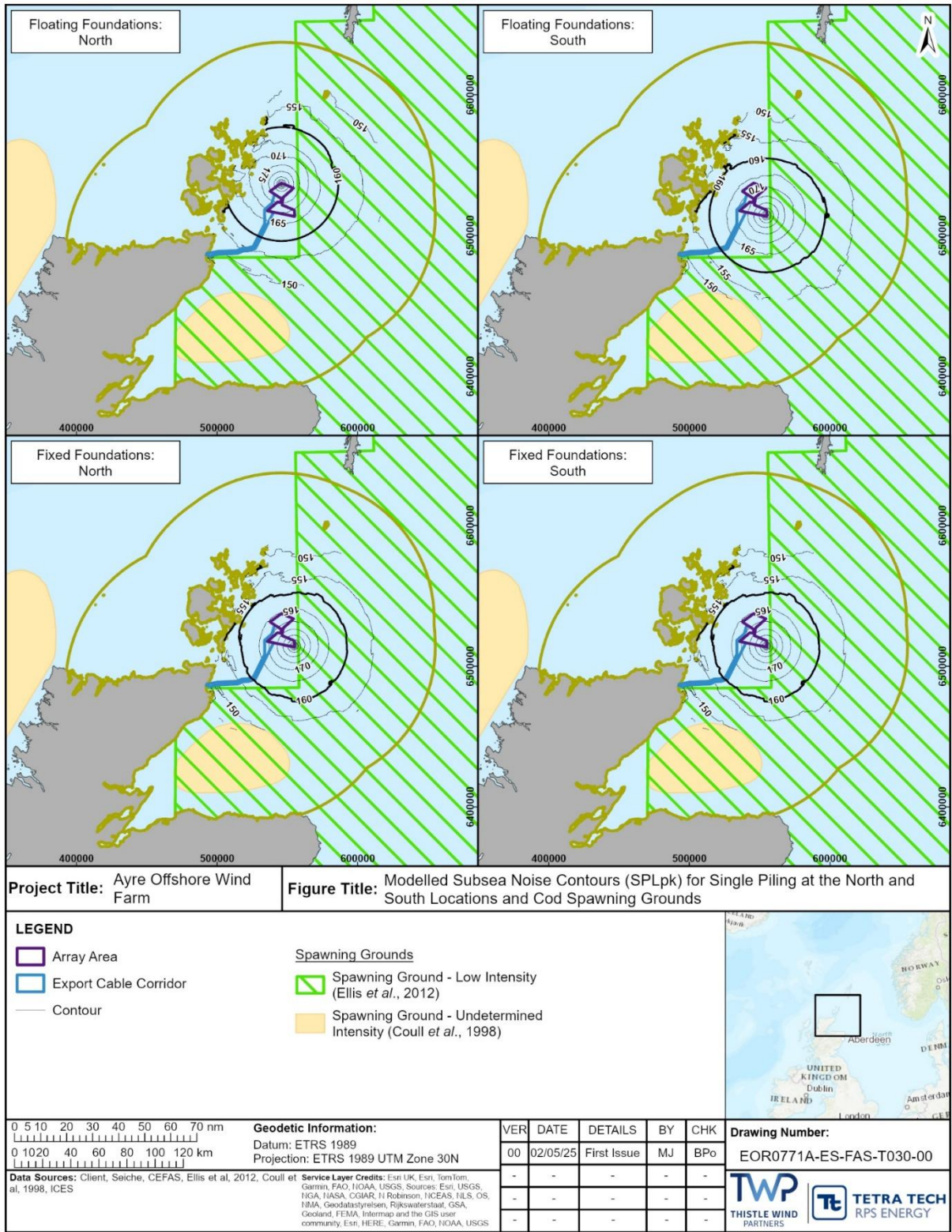


**Figure 9.6: Modelled Subsea Noise Contours (SPL<sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations and Cod Spawning Grounds**



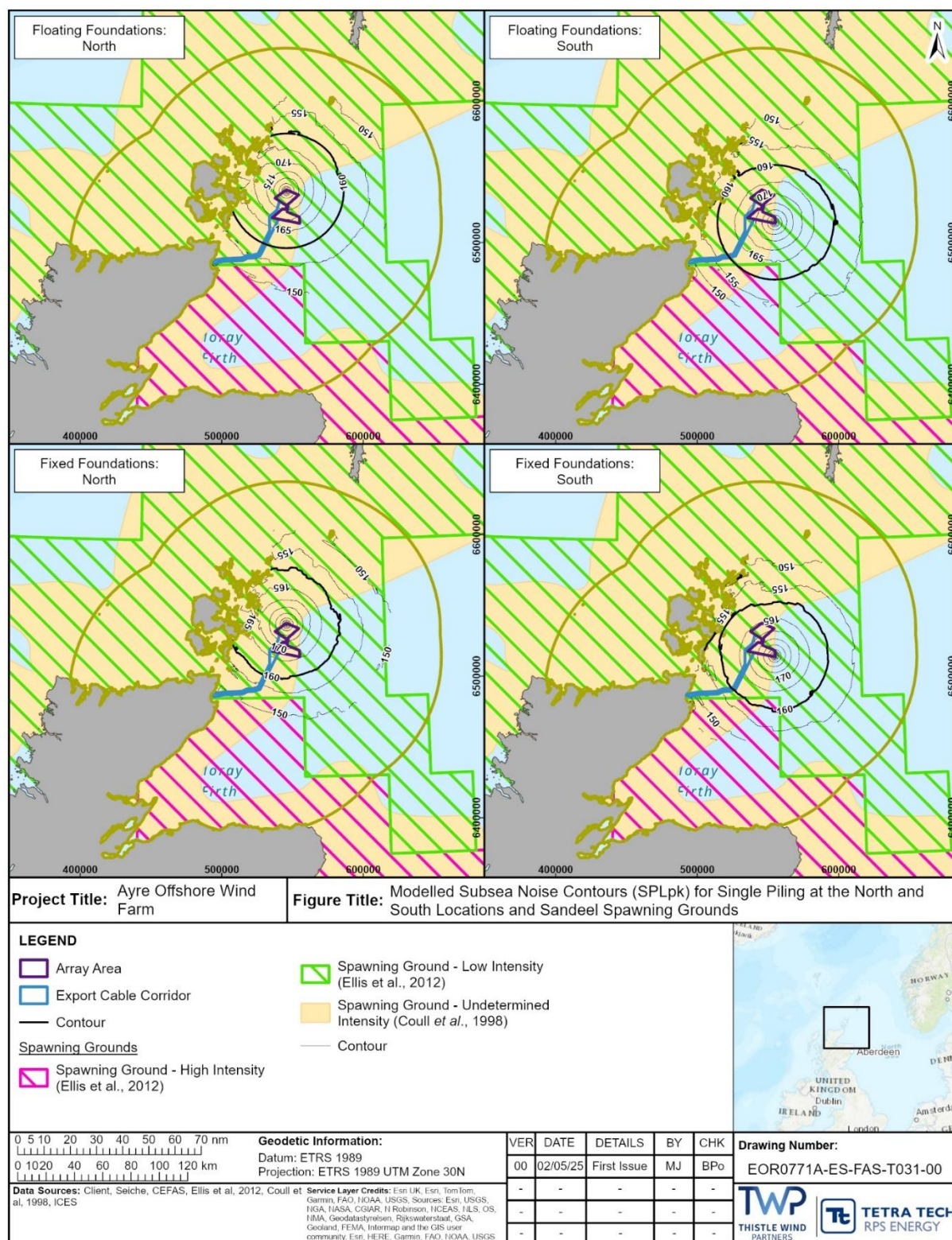


**Figure 9.7: Modelled Subsea Noise Contours (SPL<sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations and Sandeel Spawning Grounds**



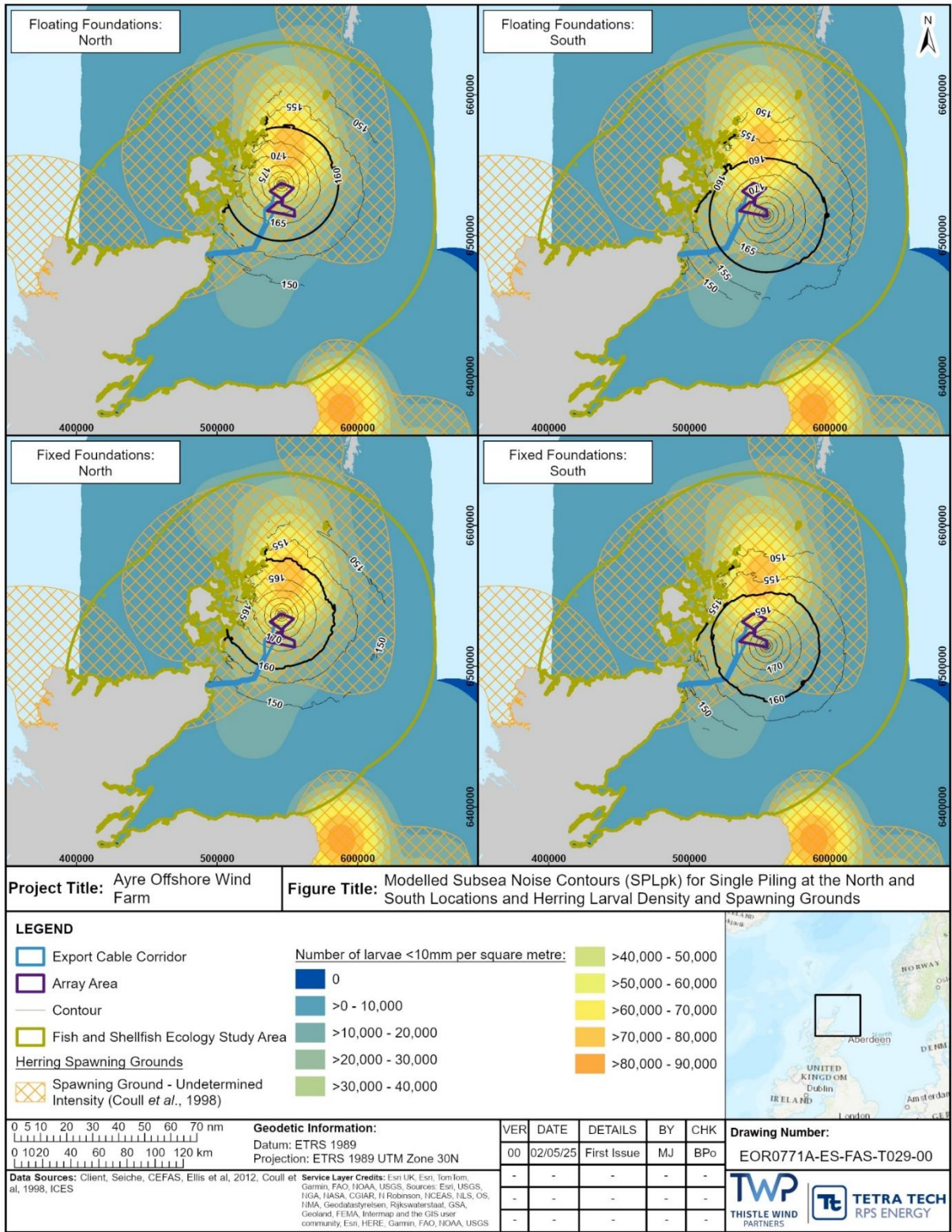


**Figure 9.8: Modelled Subsea Noise Contours (SPL<sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations and Herring Larval Density and Spawning Grounds**

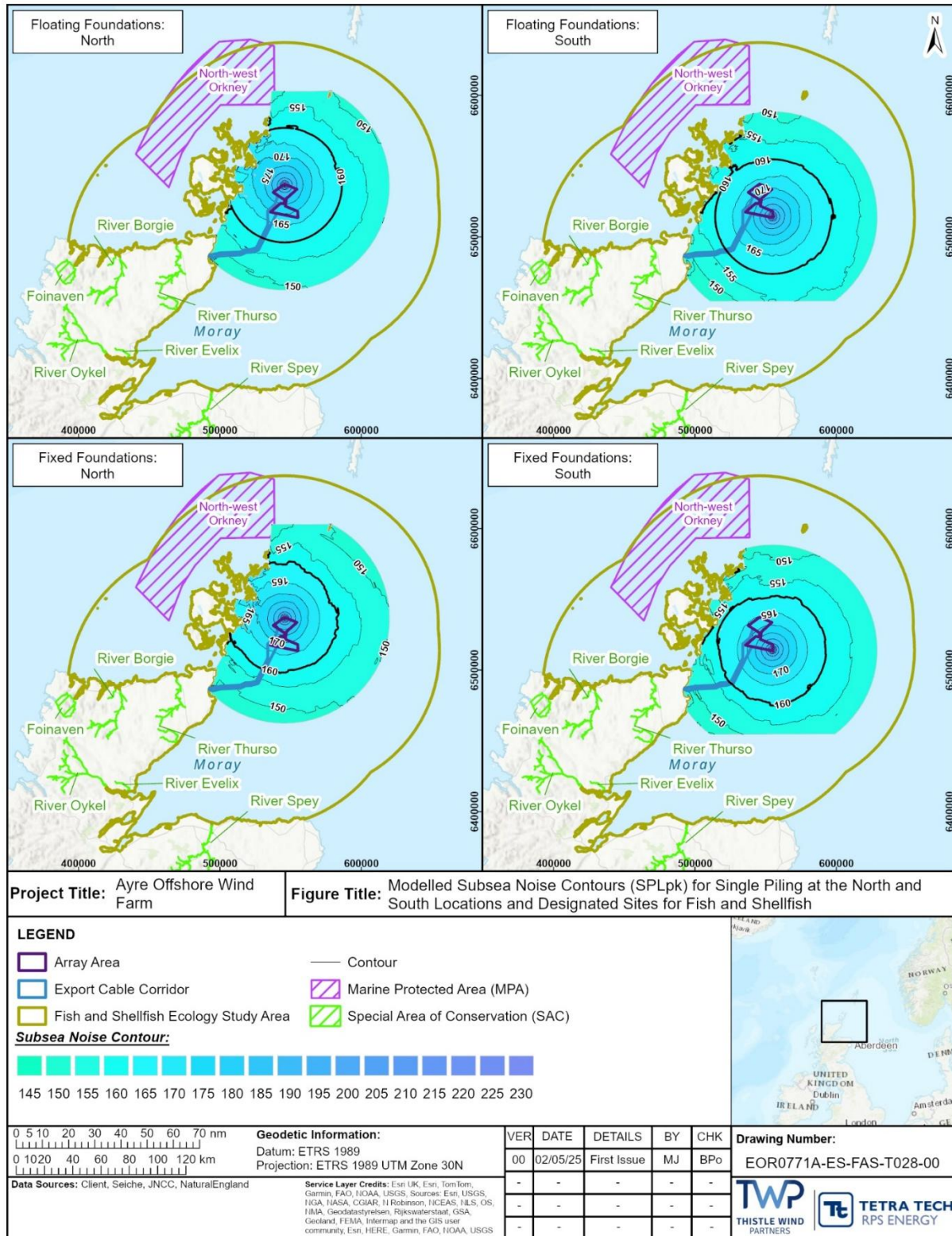


**Figure 9.9: Modelled Subsea Noise Contours (SPL<sub>pk</sub> dB re 1 µPa) for Single Piling at the North and South Locations and Designated Sites for Fish and Shellfish**



Shellfish IEFs

- 9.10.207 Injury and disturbance criteria has not been developed for shellfish and, therefore, modelling could not be conducted for the shellfish IEFs. As the shellfish IEFs are expected to be less sensitive than fish species, the injury and disturbance ranges modelled for fish could be considered conservative overestimates for the shellfish IEFs. Nonetheless, an overview of literature available on shellfish sensitivity to subsea noise has been provided in the following paragraphs.
- 9.10.208 To date, no effect or influence of noise or vibrations has been reported on shellfish mortality rates or fisheries yields. Further, no studies have indicated a direct mortal effect of anthropogenic noise, either immediate or delayed (Scott *et al.*, 2020).
- 9.10.209 Of the shellfish IEFs identified, studies suggest that crustaceans such as European lobster, Norway lobster and various crab species are likely to be physiologically resilient to subsea noise due to the lack of gas within their bodies (Popper *et al.*, 2001). For example, a study by Christian *et al.* (2003) found no significant difference between acute effects of seismic airgun exposure (an impulsive high amplitude noise source similar to piling; >189 dB re 1  $\mu$ Pa (peak–peak) at 1 m) upon adult snow crabs *Chionoecetes opilio*.
- 9.10.210 Sub-lethal physiological effects have been identified from anthropogenic subsea noise sources including bruised internal organs in snow crabs exposed to seismic survey noise emissions (at unspecified SPLs) (Chadwick, 2004), changes in serum biochemistry and hepatopancreatic cells in American lobster *Homarus americanus* (Payne *et al.*, 2007), and metabolic rate changes in green shore crab *Carcinus maenas* exposed to shipping noise (Wale *et al.*, 2013).
- 9.10.211 There is currently no evidence to suggest shellfish eggs and larvae are at risk of direct harm from underwater noise such as piling, although it should be noted that studies are limited (Edmonds *et al.*, 2016). Of the limited studies that have focussed on shellfish eggs and larvae, impaired embryonic development and mortality has been observed after playback of seismic survey noise among gastropods and bivalves (De Soto *et al.*, 2013, Nedelec *et al.*, 2014). There is limited information on the impact of impulsive noise upon crustacean eggs, and no research has been conducted on commercially exploited decapods around the UK. All studies focus on the impact of seismic noise, which has been demonstrated to delay the hatching of snow crab eggs, causing resultant larvae to be smaller than controls (Chadwick, 2004). However, Pearson *et al.* (1994) reported no statistically significant difference between the mortality and development rates of the free-swimming, planktonic larval stage of Dungeness crab *Metacarcinus magister* larvae exposed to single field-based discharges (231 dB re 1  $\mu$ Pa (zero-peak) at 1 m) from a seismic airgun.

- 9.10.212 Therefore, the shellfish IEFs are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

*Sensitivity of the receptor – UXO clearance*

- 9.10.213 The criteria used in the subsea noise modelling assessment for explosives (i.e. UXO clearance activities) are given in Table 9.40. These are not available for eggs and larvae.

**Table 9.40: Criteria for the Onset of Injury to Fish due from Explosives (Popper *et al.*, 2014)**

| Hearing Group                                                                                        | Parameter        | Mortality and Potential Mortal Injury | Recoverable Injury                                 | TTS                                                    |
|------------------------------------------------------------------------------------------------------|------------------|---------------------------------------|----------------------------------------------------|--------------------------------------------------------|
| <b>Group 1 Fish: no swim bladder (particle motion detection)</b>                                     | Peak, dB re 1µPa | 229 - 234                             | (Near) High<br>(Intermediate)<br>Low<br>(Far) Low  | (Near) High<br>(Intermediate)<br>Moderate<br>(Far) Low |
| <b>Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)</b>       | Peak, dB re 1µPa | 229 - 234                             | (Near) High<br>(Intermediate)<br>High<br>(Far) Low | (Near) High<br>(Intermediate)<br>Moderate<br>(Far) Low |
| <b>Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)</b> | Peak, dB re 1µPa | 229 - 234                             | (Near) High<br>(Intermediate)<br>High<br>(Far) Low | (Near) High<br>(Intermediate)<br>High<br>(Far) Low     |

- 9.10.214 As detailed in Paragraphs 9.10.159 to 9.10.161, the use of low order disposal of UXOs (e.g. deflagration and clearance shots) where possible is an Embedded Mitigation measure. There is a small risk that low order disposal could unintentionally arise in a high order detonation and therefore this scenario has also been considered in the assessment. Details and assumptions of the different charge sizes involved in both low and high order disposal are detailed in Table 9.41.

**Table 9.41: Details of High and Low Order UXO Disposal Assumptions and their Relevant Charge Sizes used in the Subsea Noise Modelling**

| Charge Size (kg NEQ)                                        | Notes/Assumptions                                                                                             |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| <b>Low Order and Low- Yield Donor Charge Configurations</b> |                                                                                                               |
| <b>0.25 kg</b>                                              | Maximum size of donor charge used for low-order technique.                                                    |
| <b>0.5 kg</b>                                               | Maximum size of clearing shot to neutralise any residual explosive material.                                  |
| <b>Potential UXOs (High Order Disposal)</b>                 |                                                                                                               |
| <b>227 kg</b>                                               | Realistic worst case UXO charge weight, based on British World War Two (WW2) mine Mk XIV.                     |
| <b>720 kg</b>                                               | Maximum estimated UXO size that is anticipated to be encountered, based on a 1,000 kg German WW2 mine BM1000. |

- 9.10.215 The modelled mortality and potential mortal injury ranges (using the  $SPL_{pk}$  metric) for low order and high order are presented in Table 9.42 and Table 9.43. The criteria used in this underwater noise assessment for explosives are detailed in further detail in Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report, and are derived from Popper *et al.* (2014). There are no thresholds in Popper *et al.* (2014) in relation to eggs and larvae in terms of sound pressure, therefore only results for fish have been presented. As detailed in Table 9.42, the mortality and potential mortal injury ranges for the low order clearance activities were modelled out to tens of metres for all fish hearing groups, with these increasing to multiple hundreds of metres for high order clearance activities (Table 9.43).
- 9.10.216 It should be noted that, due to a combination of dispersion (i.e. where the waveform elongates), multiple reflections from the sea surface and seabed and molecular absorption of high frequency energy, the subsea noise is unlikely to still be impulsive in character once it has propagated more than a few kilometres. Furthermore, the modelling assumes that the UXO acts like a charge suspended in open water whereas in reality it is likely to be partially buried in the sediment. In addition, it is possible that the explosive material will have deteriorated over time meaning that the predicted subsea noise levels are likely to be overestimated. In combination, these factors mean that the results should be treated as precautionary potential impact ranges which are likely to be significantly lower than predicted.



**Table 9.42: Potential Impact Ranges for Low Order and Low Yield UXO Clearance Activities based on the SPL<sub>pk</sub> Metric**

| UXO Clearance Parameter                     | Impact Range (m) |
|---------------------------------------------|------------------|
| <b>0.08 kg Low Order Donor Charge</b>       |                  |
| Fish (lower range: Potential Mortal Injury) | 44               |
| Fish (upper range: Mortality)               | 27               |
| <b>0.5 kg Clearing Shot</b>                 |                  |
| Fish (lower range: Potential Mortal Injury) | 81               |
| Fish (upper range: Mortality)               | 49               |

**Table 9.43: Potential Impact Ranges for High Order UXO Clearance Activities based on the SPL<sub>pk</sub> Metric**

| UXO Clearance Parameter                     | Impact Range (m) |
|---------------------------------------------|------------------|
| <b>227 kg UXO – High Order Explosion</b>    |                  |
| Fish (lower range: Potential Mortal Injury) | 620              |
| Fish (upper range: Mortality)               | 375              |
| <b>720 kg UXO – High Order Explosion</b>    |                  |
| Fish (lower range: Potential Mortal Injury) | 910              |
| Fish (upper range: Mortality)               | 550              |

All Fish and Shellfish IEFs

- 9.10.217 Overall, as a precaution, the herring IEF is deemed to be of medium vulnerability, high recoverability, and national importance. The sensitivity of the receptor is, therefore, considered to be medium.
- 9.10.218 The remaining marine and diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.
- 9.10.219 There are limited data on the sensitivity (if any) of shellfish species to subsea noise generated from UXO clearance. As shellfish species have a lower sensitivity to subsea noise than the fish IEFs, the results presented in Table 9.42 and Table 9.43 for the fish IEFs could be considered highly over precautionary estimates. Therefore, the shellfish IEFs are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

*Sensitivity of the receptor – site investigation surveys*

- 9.10.220 The criteria used in the subsea noise modelling assessment for non-impulsive piling and other continuous sound sources (such as site

investigation surveys, vessels and other construction activities), are given in Table 9.44. The only numerical criteria for these sources are for recoverable injury and TTS for Groups 3 and 4 Fish.

- 9.10.221 It should be noted that there are no thresholds in Popper *et al.* (2014) in relation to subsea noise from high frequency sonar (>10 kHz). This is because the hearing range of fish species falls well below the frequency range of high frequency sonar systems (such as geophysical site investigation survey equipment). Consequently, the effects of high frequency sonar-like seabed imaging surveys on fish have not been conducted as part of the noise modelling study, due to the frequency of the source being beyond the range of hearing and also due to the lack of any suitable thresholds.

**Table 9.44: Criteria for the Onset of Injury to Fish due to Non-Impulsive Sources (Popper *et al.*, 2014)**

| Hearing Group                                                                                        | Mortality and Potential Mortal Injury         | Recoverable Injury                                   | TTS                                                |
|------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------|----------------------------------------------------|
| <b>Group 1 Fish: no swim bladder (particle motion detection)</b>                                     | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Low<br>(Intermediate) Low<br>(Far) Low        | (Near) Moderate<br>(Intermediate) Low<br>(Far) Low |
| <b>Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)</b>       | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Low<br>(Intermediate) Low<br>(Far) Low        | (Near) Moderate<br>(Intermediate) Low<br>(Far) Low |
| <b>Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)</b> | (Near) Low<br>(Intermediate) Low<br>(Far) Low | 170 dB re 1µPa (root mean square (rms)) for 48 hours | 158 dB re 1µPa (rms) for 12 hours                  |
| <b>Eggs and larvae</b>                                                                               | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Low<br>(Intermediate) Low<br>(Far) Low        | (Near) Low<br>(Intermediate) Low<br>(Far) Low      |

- 9.10.222 Modelled impact ranges for recoverable injury and TTS are illustrated in Table 9.45. These ranges were very low, with thresholds not exceeded borehole drilling.

**Table 9.45: Estimated Recoverable Injury and TTS Ranges for Site Investigation activities for Groups 3 and 4 Fish**

| Site Investigation Survey Equipment | Impact Range (m)                                                 |                                                   |
|-------------------------------------|------------------------------------------------------------------|---------------------------------------------------|
|                                     | Recoverable injury<br>170 dB re 1 $\mu$ Pa (rms) for<br>48 hours | TTS<br>158 dB re 1 $\mu$ Pa (rms) for<br>12 hours |
| Borehole drilling                   | N/E                                                              | N/E                                               |
| Vibro-coring                        | 10                                                               | 53                                                |

9.10.223 As Group 3 and 4 fish are the most sensitive to subsea noise, and the impact ranges modelled for site investigation surveys were very low, it can reasonably be assumed that injury ranges for the other hearing groups (and the shellfish IEFs, by proxy) will be similar or lower. Therefore, all fish and shellfish IEFs are deemed to be of low vulnerability, high recoverability (upon cessation of site investigation surveys and due to recoverable injury thresholds largely not being exceeded) and local to international value. The sensitivity of the receptor is therefore, considered to be low.

*Sensitivity of the receptor –other construction activities*

9.10.224 A range of construction activities were considered in the MDS for this impact (Table 9.15 and see Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report for full detail). As illustrated in Table 9.44, the only numerical criteria for these sources are for recoverable injury and TTS for Groups 3 and 4 Fish, which are the most sensitive to subsea noise. Modelled impact ranges for recoverable injury and TTS are, therefore, illustrated in Table 9.46. These results suggest very low TTS ranges (maximum of 19 m) with recoverable injury thresholds not exceeded at all.

**Table 9.46: Estimated Recoverable Injury and TTS Ranges for Other Construction Activities for Group 3 and 4 Fish**

| Subsea Noise Source            | Impact Range (m)                                                 |                                                   |
|--------------------------------|------------------------------------------------------------------|---------------------------------------------------|
|                                | Recoverable injury<br>170 dB re 1 $\mu$ Pa (rms) for<br>48 hours | TTS<br>158 dB re 1 $\mu$ Pa (rms) for<br>12 hours |
| <b>Construction Activities</b> |                                                                  |                                                   |
| Cable laying                   | N/E                                                              | 19                                                |
| Cable trenching/cutting        | N/E                                                              | 8                                                 |
| Jack up rig                    | N/E                                                              | N/E                                               |
| Drilled piling                 | N/E                                                              | N/E                                               |

9.10.225 As Group 3 and 4 fish are the most sensitive to subsea noise, and the impact ranges presented in Table 9.46 were very low or not exceeded, it can reasonably be assumed that injury ranges for the other hearing groups

(and the shellfish IEFs, by proxy) will be similar or lower. Therefore, all fish and shellfish IEFs are deemed to be of low vulnerability, high recoverability (upon cessation of vessel use and construction activities and due to recoverable injury thresholds not being exceeded) and local to international value. The sensitivity of the receptor is therefore, considered to be low.

*Significance of the effect - piling*

9.10.226 Overall, for the herring IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will therefore be of minor to moderate adverse significance. Given that the noise contours presented in Figure 9.8 extend to herring spawning grounds and hotspots of larval density, a **Moderate** adverse significance has been concluded, which is significant in EIA terms.

9.10.227 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Significance of the effect – UXO clearance*

9.10.228 Overall, for the herring IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

9.10.229 For all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Significance of the effect – site investigation surveys*

9.10.230 Overall, for all IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Significance of the effect - other construction activities*

9.10.231 Overall, for all IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.232 For all fish and shellfish IEFs except herring, no Additional Mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.
- 9.10.233 A likely significant effect (moderate adverse) has been concluded for the herring IEF resulting from piling during the construction phase. Therefore, prior to the commencement of piling, appropriate Additional Mitigation measures will be discussed and agreed with NatureScot and other relevant stakeholders. These will be detailed and secured through the Piling Strategy developed post-consent. Measures included in the Piling Strategy will be dependent on the final design of the Proposed Development. Mitigation measures within the Piling Strategy will be agreed as part of a stepped strategy post consent and will follow the mitigation hierarchy – avoid, reduce, mitigate. It is expected that the measures secured within the Piling Strategy will reduce the significance of this impact to minor adverse for herring, which is not significant in EIA terms.

**O&M phase**

*Magnitude of impact*

- 9.10.234 Within the O&M phase, there is potential for subsea noise to be produced by the following:
- Site investigation surveys; and
  - Wind Turbine operation and movement of anchor mooring lines within the water column (Table 9.15).
- 9.10.235 The site investigation surveys will be of a similar extent, or lower, to that assessed in Paragraphs 9.10.163 to 9.10.167 for the construction phase. Therefore, the impact associated with these in the O&M phase is predicted to be of very local spatial extent, short term duration, intermittent and high reversibility, with the soundscape returning to near baseline conditions upon cessation of the survey. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.
- 9.10.236 Subsea noise could also be produced in the O&M phase due to Wind Turbine operation and the movement of anchor mooring lines within the water column. Due to a limited number of operational floating OWFs at the time of writing, and those in operation being of small scale, in terms of Wind Turbine numbers and size, it was not possible to define a representative operational subsea noise source level for use in modelling (see Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report for further detail). As such, this impact was assessed qualitatively in Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report, with a summary provided here.

- 9.10.237 As well as the structure-borne sounds resulting from the operation of any Wind Turbine (regardless of foundation type), in the case of floating structures there is the potential for subsea noise to be generated by the slackening and sudden re-tension in a mooring line resulting from higher sea-states (large amplitude and/or high frequency waves (Liu, 1973)). Whilst mooring lines are designed to be permanently taut and, therefore, should not exhibit these periods of slackening and tensioning, there is some evidence that mooring lines associated with floating OWF infrastructure could produce transient ‘pinging’ or ‘snapping’ sounds during their O&M phase, particularly with the development of novel mooring techniques and materials. ‘Snapping’ was identified during acoustic subsea noise measurements at the floating Hywind Floating OWF (Martin *et al.*, 2011). These data were subsequently analysed and results were extrapolated from a single Wind Turbine to a represent a theoretical floating OWF (Stephenson, 2015). The results demonstrated that this theoretical floating OWF could have up to 115 snapping events per day, with a resultant potential cumulative SEL over a 24 hour period of 156 dB re 1  $\mu\text{Pa}^2\text{s}$  at 150 m from the Wind Turbines (Stephenson, 2015). This value is below the ranges for recoverable injury and TTS for Groups 3 and 4 fish.
- 9.10.238 Limited though the existing studies are, both in number and in the number of turbines studied (see Volume 3, Technical Appendix 10.4: Subsea Noise Technical Report for a literature review), they do agree that the risk to marine fauna (including fish) from subsea noise, both from the structure-borne and from mooring lines, is low. For example, the upper bound limit for TTS from operational turbines at the Hywind Floating OWF was found to be 80 m for Very High Frequency (VHF) cetaceans (i.e. those with the highest sensitivity to subsea noise, such as harbour porpoise *Phocoena phocoena*) (Burns *et al.*, 2022). This is an order of magnitude less than the turbine separation and therefore presents a very low chance of injury (and thus magnitude of impact). The fish hearing groups were not included in this study, however as VHF cetaceans are more sensitive to subsea noise, it could be extrapolated that chances of injury would be even lower for fish and shellfish species.
- 9.10.239 Therefore, it has been concluded that the risk of effects on fish (either injury or behavioural responses) from operational subsea noise from Wind Turbines is very low, whether that is from the structure-borne noise regardless of foundation type, and the additional noise generated by movements in the mooring lines. Overall, for operation subsea noise from Wind Turbines and anchor mooring lines, the impact is predicted to be of local spatial extent, long term duration, continuous (but at very low levels), and low reversibility (although is reversible upon decommissioning). It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.



*Sensitivity of the receptor*

- 9.10.240 There have been few studies to date on the effect of operational noise from OWFs on fish and shellfish receptors. The thresholds and sensitivities presented for site investigation surveys and vessel use in the construction phase (see Paragraphs 9.10.220 to 9.10.225) are still relevant to the O&M phase, however further literature specific to operational noise from Wind Turbines and mooring lines is presented here to help characterise the sensitivity.

Marine Fish IEFs

- 9.10.241 While the literature on the direct effects of operational turbine noise on fish is sparse, there have been several studies on the fish communities at operational OWFs in general. For example, a recent meta-analysis of finfish abundance at operational OWFs indicated that there was generally a greater abundance of fish inside of wind farms (Methratta and Dardick, 2019), which can likely be attributed to artificial reef effects, availability of refuges, and increased foraging potential around these structures (see the impact of ‘Introduction of Artificial Habitat and Subsequent Colonisation of Hard Structures’ in Paragraphs 9.10.84 *et seq.*). Similarly, a study at the Lillgrund OWF in Sweden found that the demersal fish diversity and abundance was not significantly impacted at the scale of the entire OWF (Bergström *et al.*, 2013). Localised increased densities of some piscivore species were observed near foundations, with the authors suggesting that any potentially negative effects from the operational OWF (such as noise disturbance and EMFs) did not override the attractive effect of the introduced structures for any of the fish species investigated (Bergström *et al.*, 2013). Further, multi-year studies at the Block Island OWF in the USA demonstrated that there were no statistically significant changes in landings of demersal fish and shellfish species due to the operation of the OWF (Wilber *et al.*, 2022). Catches of black sea bass *Centropristis striata* and cod increased following turbine installation, and it can be inferred that these species were not deterred by operational noise from turbines (Wilber *et al.*, 2022). Flatfish abundance, size, and condition varied over time and space, but these changes were not consistently linked to the construction or operation of the Block Island OWF (Wilber *et al.*, 2022), further inferring that these species were not negatively impacted by operational noise.
- 9.10.242 A study by Sigraay and Andersson (2011) on cod and plaice demonstrated that Wind Turbines generate particle motion that these species can sense. Close to the turbine foundation, the maximum particle motion is comparable with levels observed in studies concerned with behavioural reactions. However, at distances of 10 m away, the amplitudes decreased to levels comparable with hearing thresholds of cod and plaice, suggesting that the physical area where the environment is affected by anthropogenically generated particle motion is restricted to the

immediate neighbourhood of the Wind Turbine (Sigray and Andersson, 2011). It should be noted that this study was on fixed bottom turbines, not floating. The results indicate that a single Wind Turbine has a limited impact on fish, corroborating a study made by Andersson and Öhman (2010).

- 9.10.243 ScotMER conference proceedings on operational noise of floating offshore Wind Turbines presented by Putland (2022) indicated that operational noise is comparable to that of fixed bottom foundations, generating low subsea noise levels which are unlikely to cause significance disturbance effects to fish. Risch *et al.* (2023) reported consistent results to this. In this study, acoustic data were collected from the Kincardine and Hywind floating OWFs. It was found that the predicted subsea noise fields for unweighted SPL were above the median ambient noise levels in the North Sea for a maximum of 3.5 km to 4.0 km from the centre of the Kincardine site and 3.0 km to 3.7 km from the centre of the Hywind site (Risch *et al.*, 2023). While fish species may be able to perceive noise, the levels are likely too low to result in injurious or behavioural effects.
- 9.10.244 Limited behavioural effects were recorded in a recent study specifically measuring operational turbine noise at the Miaoli OWF in Taiwan. A two year study reported that operational turbine noise (measured in the 20 Hz to 250 Hz frequency band) was significantly higher in autumn and winter and correlated with wind speed (Siddagangaiah *et al.*, 2024). The average SPL during these seasons was 138 to 143 dB re 1 µPa (Siddagangaiah *et al.*, 2024). Despite this, operational noise did not influence the seasonal fish chorusing patterns, which consistently began in spring, peaked in summer, decreased in autumn, and were absent in winter (Siddagangaiah *et al.*, 2024). Fish chorusing behaviour is essential for maintaining social cohesion, foraging, territorial defence, and spawning for some fish and shellfish species (Buscaino *et al.*, 2015, Siddagangaiah *et al.*, 2024, van Oosterom *et al.*, 2016). Thus, this recent study provided a novel insight into the evidence base around operational turbine noise on fish behaviour.
- 9.10.245 A study by Puig-Pons *et al.* (2021) on the behavioural responses of caged Atlantic bluefin tuna to turbine and vessel noise presented a strong relationship with ensonification pressure level and time. During the first exposure to simulated Wind Turbine noise with an SPL of 182 dB re 1 µPa, Atlantic bluefin tuna started to show behavioural changes after around eight minutes. These behavioural changes involved schooling behaviour and swimming depth: the shoal swam close to each other, swam in a smaller circle, moved closer to the surface, and some individuals changed direction (Puig-Pons *et al.*, 2021). After subsequent noise emissions, (taken up to 30 minutes apart to allow individuals to recover), the Atlantic bluefin tuna did not show any behavioural reaction of the turbine noise, perhaps indicating some level of habituation (Puig-Pons *et al.*, 2021). A similar study on the same species demonstrated that individuals exposed to turbine noise for a short duration did not exhibit clear behavioural

differences than under control conditions (Pérez-Arjona *et al.*, 2014). However, when exposed to this noise source for a longer duration, Atlantic bluefin tuna displayed altered behaviour, such as moving towards the surface, and some individuals were disorientated. However, individuals in this study also appeared to become habituated after several repetitions (Pérez-Arjona *et al.*, 2014). These two studies highlight that species may show altered behaviour due to Wind Turbine noise but are likely to show some degree of habituation over time, suggesting that population level effects (and thus impacts to marine food webs) are unlikely.

9.10.246 Finally, a recent study by Cresci *et al.* (2023) demonstrated that cod larvae orient towards the source of low-frequency subsea noise, similar to that generated by offshore Wind Turbines. Conducted in a Norwegian fjord using drifting behavioural chambers, this experiment showed that while exposure to a continuous noise source of 100 Hz did not affect cod larval swimming speeds or turning behaviour, it did influence their directional movement. Exposed cod larvae oriented towards the noise source, unlike control larvae, which oriented north-west (Cresci *et al.*, 2023). These findings suggest that subsea noise from offshore Wind Turbines could impact the dispersal of cod larvae (and potential the larvae of other species) (Cresci *et al.*, 2023). Similarly, work by Debusschere *et al.* (2016) demonstrated that pile driving and operational noise from offshore wind farms can significantly impact the early life stages of sea bass *Dicentrarchus labrax* larvae. The noise exposure was shown to potentially disrupt the development and behaviour of sea bass larvae, which are crucial for fish populations and serve as important prey for pelagic predators (Debusschere *et al.*, 2016). It is therefore possible that operational turbine noise could impact the larval stages of the IEFs. However, when compared to the various studies that have shown no significant negative impacts on fish communities as a whole due to the presence of operational OWFs (see Paragraph 9.10.241), it is likely that impacts upon larvae may not translate into population or ecosystem level effects.

9.10.247 Therefore, all marine fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

#### Diadromous Fish IEFs

9.10.248 There are currently no studies on the sensitivities of the diadromous fish IEFs to operational noise from turbines and anchor mooring lines. However, there is some, limited, research on the impact of tidal turbine noise on salmonids. Halvorsen *et al.* (2011) exposed juvenile Chinook salmon *Oncorhynchus tshawytscha* to simulated tidal turbine noise in experimental settings. However, the necropsies of the fish demonstrated that non-lethal, low levels of tissue damage may have occurred but there were no effects of noise exposure on their auditory systems. Similarly,

modelling by Schramm *et al.* (2017) demonstrated that rainbow trout were not likely to exhibit any responses to a tidal turbine.

9.10.249 The literature summarised and sensitivity assigned in Paragraphs 9.10.241 to 9.10.247 for the marine fish IEFs can be applied to the diadromous fish IEFs. This is because as some of the diadromous fish IEFs are classified as either a lower hearing group (i.e. lampreys in Group 1 and salmonids in Group 2, the least sensitive hearing groups to subsea noise) or equal hearing group (i.e. European eel in Group 3 and shads in Group 4) to the marine fish species detailed.

9.10.250 Therefore, the diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

#### Shellfish IEFs

9.10.251 To date, there is limited information on the sensitivity (if any) of shellfish species to operational noise from OWFs. However, many studies have shown refuge and reef effects associated with OWF foundations for shellfish species (Hooper and Austen, 2014, Linley *et al.*, 2007, Vattenfall, 2006). As detailed in Paragraph 9.10.241 for the marine fish IEFs, it may be that any potential disturbance from operational OWF noise does not override the attractive effect of the introduced structures for shellfish species, particularly crustaceans.

9.10.252 Given that the shellfish IEFs are considered to be less sensitive to subsea noise than the fish IEFs, it has been concluded that the sensitivity of shellfish IEFs to this impact will be of a lesser extent than that of the fish IEFs.

9.10.253 Therefore, the shellfish IEFs are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be negligible.

#### *Significance of the effect*

9.10.254 Overall, for the fish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

9.10.255 Overall, for the shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be negligible. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.256 No Additional Mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

***Decommissioning phase***

*Magnitude of impact*

- 9.10.257 Subsea noise may be produced from decommissioning activities in this phase. As detailed in Table 9.15, the approach for decommissioning is yet to be determined, however, for the purposes of the MDS it is assumed there will be a range of decommissioning activities such as removal of foundations, cables and cable. Details of these activities in the decommissioning phase are currently unavailable, and a decommissioning Programme will be submitted to MD-LOT for consultation and approval.
- 9.10.258 Therefore, for the purposes of the assessment, the magnitude of impact in the decommissioning phase is expected to be of a lower extent to that detailed in Paragraphs 9.10.166 to 9.10.167 for the construction phase. This is likely to be lower due to the absence of piling and UXO clearance in the decommissioning phase.
- 9.10.259 Therefore, the impact is predicted to be of very local spatial extent, short term duration, intermittent and high reversibility, with the soundscape returning to near baseline conditions upon completion of the decommissioning activities. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

- 9.10.260 The sensitivity of the receptor is as already presented for the construction phase (see Paragraphs 9.10.224 to 9.10.225) and is not repeated here.

*Significance of the effect*

- 9.10.261 Overall, for all fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.262 No Additional Mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

**IMPACT 6 - IMPACTS TO FISH AND SHELLFISH RECEPTORS DUE TO EMF**

- 9.10.263 EMFs may be emitted to the marine environment from IACs, interconnector, and export cables. This impact is relevant to the O&M phase of the Proposed Development.

### *O&M phase*

#### *Magnitude of impact*

- 9.10.264 Potential effects on the fish and shellfish IEFs may arise due to EMFs generated from up to 605 km of HVAC subsea electrical cables associated with the Proposed Development, as outlined in Table 9.15. This includes:
- Up to 185 km of 132 kV IAC (up to 173 km at the seabed and up to 12 km within the water column);
  - Up to 60 km of 275 kV interconnector cables; and
  - Up to 360 km of 275 kV export cables (up to 4 export cables, with a maximum length of 90 km each).
- 9.10.265 The conduction of electricity through subsea power cables will result in emission of localised EMFs. The MDS for this impact assessment also considers the impacts of EMFs from the dynamic cables in the water column (up to 12 km; Table 9.15).
- 9.10.266 EMFs comprise both the electrical fields, measured in volts per metre (V/m), and the magnetic fields, measured in microtesla ( $\mu$ T), millitesla (mT), milligauss (mG) or gauss. Within the North Sea, background magnetic field levels are approximately 50  $\mu$ T, and background electric field measurements are approximately 25  $\mu$ V/m (Tasker *et al.*, 2010). Subsea power cables are constructed using magnetic outer sheathing materials, which can partially block the direct electrical field, meaning that only the magnetic field and the resultant induced electrical field are emitted into the marine environment. Dynamic cables are typically double armoured to increase stability and manage weight, which may inadvertently reduce losses of EMFs (Hervé, 2021). By design, DC (Direct Current) and AC (Alternating Current) cables typically contain two and three conductor bundles, respectively, which are superimposed and twisted around each other. This design feature creates partial self-cancellation of the total magnetic field emitted (Hervé, 2021, Snyder *et al.*, 2019).
- 9.10.267 The strength of the magnetic field (and consequently, induced electrical fields) decreases rapidly horizontally and vertically with distance from source. On the seabed, it is standard industry practice to bury cables and use cable protection where burial is not possible (which has been incorporated into the MDS, see Table 9.15). This can reduce EMF levels at the seabed surface as a result of field decay with distance of the seabed from the cable (Chapman *et al.*, 2023, Gill *et al.*, 2005, Gill *et al.*, 2009, Snyder *et al.*, 2019). For example, a recent study by Snyder *et al.* (2019) demonstrated that inter-array and offshore export cables buried between depths of 1 m to 2 m reduced the magnetic field at the seabed surface four-fold. For unburied cables protected by thick concrete mattresses or rock berms, the field levels were found to be similar to those of the buried cables (Snyder *et al.*, 2019). This study also demonstrated that magnetic field levels directly over live AC IACs cables associated with offshore wind



projects ranged between 65 mG at the seabed and 5 mG at 1 m above the seabed (Snyder *et al.*, 2019). At horizontal distances from the cables, magnetic fields greatly reduced at the sea floor to between 10 mG and <0.1 mG (Snyder *et al.*, 2019).

- 9.10.268 Clear differences in the EMFs emitted between AC and DC systems are also apparent. The flow of electricity associated with an AC cable changes direction (as per the frequency of the AC transmission) and creates a constantly varying electrical field in the surrounding marine environment (ElectroMagneticWorks Inc, 2022, Huang, 2005). Conversely, DC cables transmit energy in one direction creating a static electrical field and magnetic field. Average magnetic field levels of DC cables are also higher than those of equivalent AC cables (ElectroMagneticWorks Inc, 2022, Huang, 2005). All the subsea cables associated with the Proposed Development will be AC cables (Table 9.15).
- 9.10.269 Overall, EMF levels in the vicinity of seabed and dynamic subsea cables are influenced by a variety of design and installation factors. These include distance between cables, cable sheathing material, number of conductors, and internal cable configuration.
- 9.10.270 Whilst the majority of cables will be buried beneath surface sediments to a minimum burial depth of 0.5 m, and a target burial depth of 1.5 m, there will be up to 12 km of dynamic IACs within the water column (Table 9.15). However, the intensity of EMF from subsea cables decreases at approximately the inverse square/power of the distance away from the cable (Hutchison *et al.*, 2021). This attenuation level is the same for buried, unburied, and dynamic cables (Hutchison *et al.*, 2021). So, whilst EMFs emitted from dynamic cables will be considerably higher than compared to buried cables (i.e. due to the lack of surface sediments/protection upon these), EMF levels are expected to return to the baseline level within a few metres distance from the cable, to a maximum of a few tens of metres (Bochert and Zettler, 2006, Hutchison *et al.*, 2021, Snyder *et al.*, 2019). Therefore, as for the buried cables at the seabed, the area of effect is highly limited in extent, particularly in the context of the Fish and Shellfish Ecology Study Area as a whole, and barrier effects are not anticipated to occur.
- 9.10.271 The Export Cable Corridor will be comprised of up to four buried export cables. Given that EMF levels are expected to return to baseline levels within metres to tens of metres from cables, barrier effects are not predicted to occur over the length of the Export Cable Corridor.
- 9.10.272 The impact is predicted to be of local spatial extent, long term duration (over the O&M phase), intermittent (as effects could only occur within metres of cables), and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

- 9.10.273 Many marine fish species are able to detect EMFs with electromagnetic sensing in fish and shellfish involving a variety of sensory systems (Hutchison *et al.*, 2020). Electro-receptive species are able to detect weak electric fields in order to locate prey and predators, communicate, find mates and/or orientate themselves (Kim, 2007). Electro-receptive species may also be able to respond to magnetic fields using electro-sensory apparatus with some species (particularly elasmobranchs) possessing both electro and magneto-sensory apparatus (Anderson *et al.*, 2017). Magneto-receptive species respond to small changes in the inclination, intensity and/or direction of a magnetic field (Nordmann *et al.*, 2017) and may rely on a magnetic compass and/or magnetic map to navigate (Lohmann *et al.*, 2008a).

Marine fish IEFs

- 9.10.274 Studies have been conducted examining the effects of EMFs from subsea power cables on marine fish behaviours to determine the thresholds for detection and response to EMFs. These studies have found limited evidence that EMFs from subsea power cables affected marine fish assemblages (Love *et al.*, 2016), the spatial distribution, swimming speed, acceleration, or distance moved by the lesser sandeel and herring larvae (Cresci *et al.*, 2020, 2022), or the size, morphology, or the cardiac functions of juvenile cod (Lorillard, 2023). While these studies cover larvae and juveniles of three key IEFs (cod, herring, and sandeel), literature surrounding the impact of EMFs on adult marine teleost fish is limited, with most focussing on elasmobranchs.
- 9.10.275 Elasmobranchs are known to be the most electro-receptive of all fish species. They possess specialised electro-receptors which enable them to detect very weak voltage gradients (down to 0.5  $\mu\text{V}/\text{m}$ ) which are naturally emitted from their prey (Gill *et al.*, 2005, Kim, 2007). There is also research to suggest that embryonic elasmobranchs (which could be preyed upon by larger species) are able to modulate their own bioelectrical signals to reduce predation risk (Kempster *et al.*, 2013).
- 9.10.276 Both attraction and repulsion reactions to electrical fields have been observed in elasmobranchs. Spurdog (an IEF) has been shown to avoid electrical fields at 10  $\mu\text{V}/\text{cm}$  (Gill and Taylor, 2001), although it should be noted that this level is considerably higher than levels associated with offshore electrical cables. Gill *et al.* (2009) demonstrated that the small spotted catshark and thornback ray (both IEFs) could respond to EMF of the type and intensity associated with subsea power cables. However, these responses were not predictable and did not always occur (Gill *et al.*, 2009). In terms of magnetosensitive and electrosensitive sharks, EMF from 50 Hz to 60 Hz AC sources appears undetectable; laboratory research conducted with skates indicated that as the frequency of EMF increases above 1 Hz, skates become less sensitive (Snyder *et al.*, 2019).

In a risk-based approach to investigate the effects of EMFs on southern North Sea elasmobranch species, Hermans *et al.* (2024) concluded that the risk from subsea power cables has a large uncertainty and varies across life stages and species ecology. Therefore, species and stimulus-specific sensitivities to EMFs are likely to present across the elasmobranch IEFs.

- 9.10.277 Further highlighting this, Kempster and Collin (2011) noted the physiological capacity for detection of EMFs in the basking shark, which is an IEF, but limited current evidence exists on specific impacts of EMFs of any strength on this species. The MarESA for basking shark lists this species as not sensitive to the pressure of ‘electromagnetic changes’ (Wilson *et al.*, 2020), however notes the absence of species-specific information. The conclusion of no sensitivity in the MarESA was therefore, rationalised as although individuals may avoid or move away from localised areas of strong electric and magnetic fields, any temporary attractive or avoidance responses are likely to result in anything other than small-scale energy loss (Wilson *et al.*, 2020).
- 9.10.278 Similarly, while there was no pressure relevant to EMFs presented on the MarESA for the common skate IEF, the FeAST for this species concluded a low sensitivity to ‘electromagnetic changes’ (NatureScot, 2025). The rationale for this sensitivity assessment stated that although skate species use electro and/or magnetic sensors for prey detection, orientation, and finding mates (Kalmijn, 1971, Kalmijn, 1982, Kalmijn, 1997), given the mobility of common skate, it was considered likely that local changes in the electromagnetic field will cause little impact to this species (NatureScot, 2025).
- 9.10.279 Although information on the potential sensitivities of the marine fish IEFs to this impact is varied within the literature, the range over which individuals could detect EMFs associated with the Proposed Development is limited to a scale of metres around the subsea cables at the seabed and in the water column (Bochert and Zettler, 2006, Hutchison *et al.*, 2021, Snyder *et al.*, 2019). Demersal marine fish species (such as elasmobranchs, gadoids, flatfish, etc) are more likely to come into the ZOI of subsea power cables on the seabed and thus encounter higher EMF levels when near them. Demersal species are also likely to be exposed for longer periods of time and may be more constrained in terms of lateral location. However, the rapid decay of the EMF with horizontal and vertical distance (Bochert and Zettler, 2006, Hutchison *et al.*, 2021, Snyder *et al.*, 2019) (i.e. within metres) reduces the extent of potential impacts.
- 9.10.280 Pelagic species (such as herring, tuna, and some elasmobranch species) generally swim well above the seafloor, though may still be exposed to the EMFs from the dynamic cables in the water column. The length of dynamic cables (up to 12 km) is small in the context of the Site Boundary and Fish and Shellfish Ecology Study Area as a whole. Further, EMFs from

these cables are likely to only be detected within a matter of metres (Hutchison *et al.*, 2021). Beyond this range, levels of EMFs will be expected to be at baseline levels, resulting in a highly localised Zol.

- 9.10.281 Therefore, the marine fish IEFs are deemed to be of low vulnerability, high recoverability (by swimming away) and local to international value. The sensitivity of the receptor is therefore, considered to be low.

Diadromous fish IEFs

- 9.10.282 As detailed in Paragraph 9.10.273, many animals are able to detect the Earth's natural electric and magnetic fields (referred to as 'magnetoreception'; Nordmann *et al.* (2017)) and used them as cues to guide their migration patterns. Given their life histories, accurate migration is essential for diadromous fish species. Magnetoreception and/or the possession of magneto-receptive material has been demonstrated in European eels (Moore and Riley, 2009, Naisbett-Jones *et al.*, 2017) and salmonid species (Lohmann and Lohmann, 2019, Moore *et al.*, 1990, Naisbett-Jones *et al.*, 2020, Putman *et al.*, 2014). EMFs within the marine environment may therefore interfere with the navigational ability of diadromous species. For example, Putman *et al.* (2014) reported that drifts in the Earth's magnetic field accounted for 23% and 44% of variation in migratory routes taken by two salmonid species in British Columbia, Canada. There is evidence of a response to electric and/or magnetic fields in the following diadromous IEFs: Atlantic salmon, European eel, river lamprey, sea lamprey, and sea trout (Gill and Bartlett, 2010, Gill *et al.*, 2005, Snyder *et al.*, 2019).
- 9.10.283 During the marine phase of their life cycles, diadromous fish species may be exposed to EMFs from the dynamic cables in the water column. EMFs emitted from these dynamic cables are likely to only be detected within a matter of metres; beyond which, baseline levels will be established. As such, potential impacts associated with EMFs from the dynamic cables will be highly localised. Lamprey species possess specialised ampullary electroreceptors that are sensitive to weak, low frequency electric fields (Bodznick and Northcutt, 1981, Bodznick and Preston, 1983). These are hypothesised to be used for detecting prey, although further research is required (Tricas and Carlson, 2012). Chung-Davidson *et al.* (2008) demonstrated that weak electric fields may play a role in the reproduction of sea lamprey and suggested that electrical stimuli may mediate different behaviours in feeding and spawning individuals. This study demonstrated that sea lamprey migratory behaviour was affected (i.e. adults did not move) when stimulated with electrical fields of intensities of between 2.5 mV/m and 100 mV/m, with normal behaviour observed at electrical field intensities higher and lower than this range (Chung-Davidson *et al.*, 2008). It should be noted, however, that these levels are considerably higher than modelled induced electrical fields expected from AC subsea

cables. There is currently no evidence of lamprey responses to magnetic fields (Gill and Bartlett, 2010).

- 9.10.284 Research on the effects of a HVDC cable on the migration patterns of a range of fish species, including salmonids, failed to demonstrate any effect in two studies from Sweden (Westerberg *et al.*, 2007, Wilhelmsson *et al.*, 2010). Research conducted at a DC undersea cable near San Francisco, California, found that migration success and survival of chinook salmon was not impacted by the cable (Kavet *et al.*, 2016). However, behavioural changes were noted when near the cable, with individual chinook salmon appearing to remain around it for longer periods (Kavet *et al.*, 2016). Yano *et al.* (1997) studied magnetic compass orientation in oceanic migrating chum salmon *Oncorhynchus keta*, off the coast of Japan. Four chum salmon were fitted with a tag which generated an artificial magnetic field which produced an alternating intensity of around 6 gauss, with polarity which reversed every 11.25 minutes. The authors did not observe any effects on horizontal or vertical movements of the chum salmon when the magnetic field was modified (Yano *et al.*, 1997). Further, Armstrong *et al.* (2015) investigated the effects of mains frequency (50 Hz) magnetic fields on behaviour of captive Atlantic salmon. This study found that large Atlantic salmon (62 cm to 85 cm long) demonstrated no significant differences in approach, traverse or departure times associated with coils emitting a magnetic field of 95  $\mu$ T. Post-smolts (24 cm to 41 cm in length) were exposed to three 30 minute periods of magnetic fields of 1.3  $\mu$ T, 11.4  $\mu$ T, and 95  $\mu$ T with 30 minutes of control conditions before each treatment. There was no evidence that the numbers of post-smolts passing through the coils was related to the sequence of intensity of the magnetic fields. There were also no observations of unusual behaviours in association with magnetic fields up to 95  $\mu$ T (Armstrong *et al.*, 2015). Salmonids are thought to use chemical and olfactory signals in coastal waters to locate their natal rivers (Ueda, 2014) and EMFs during offshore migrations (Gill and Bartlett, 2010, Lohmann *et al.*, 2008b). As Atlantic salmon are a pelagic species during their marine phase, the potential effects of EMF would therefore mostly be perceived in shallower waters (Snyder *et al.*, 2019).
- 9.10.285 European eel have also been suggested to use the earth's magnetic field for navigational purposes during migration (Gill and Bartlett, 2010, Snyder *et al.*, 2019). Studies on this species have highlighted some limited effects of subsea cables (Westerberg and Lagenfelt, 2008), with evidence of direct detection of EMF through its lateral line (Moore and Riley, 2009). Westerberg and Lagenfelt (2008) demonstrated short term changes in European eel swimming speed during migration (i.e. tens of minutes) due to exposure to AC electric subsea cables, even though the overall direction remained unaffected. A review by Ohman *et al.* (2007) concluded that any delaying effect (i.e. on average 40 minutes) were not likely to impact fitness over the 7,000 km migration route of European eel, with

little to no impact on migratory behaviour noted beyond 500 m from OWF infrastructure. A review by Gill and Bartlett (2010) concluded that migrating European eels may interact with EMFs if they pass directly next to the cable (particularly in shallow waters of <20 m). The effect, if any, could be trivial temporary changes in swimming direction or avoidance behaviour, but the biological significance of this could not be determined (Gill and Bartlett, 2010). The research summarised in this paragraph indicates that behavioural effects in response to EMF are limited both temporally and spatially and may not cause barriers to migration for European eel.

- 9.10.286 This reviewed literature demonstrates that while EMFs can result in altered patterns of fish behaviour, these changes are temporary and highly localised to within metres of the cable and are therefore not likely to represent large-scale barriers to migration, impede population health, or cause trophic level effects. It should be noted that although there is limited information available in the literature on the impacts and sensitivities of shellfish species to EMFs (Paragraphs 9.10.288 et seq.), freshwater pearl mussel would not be directly impacted by EMFs produced by subsea cables associated with the Proposed Development given that they are a freshwater resident species. There will be no subsea cables associated with the Proposed Development in any freshwater habitats.
- 9.10.287 The diadromous fish IEFs are deemed to be of low vulnerability, high recoverability (by swimming away) and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

#### Shellfish IEFs

- 9.10.288 Crustaceans, such as lobster and crab species, have been recorded to demonstrate a response to magnetic fields and may use magnetoreception for navigation. For example, a field experiment demonstrated that Caribbean spiny lobster *Panulirus argus* have a magnetic compass by tethering individuals inside a magnetic coil (Lohmann et al., 1995). Exposure to EMF has thus been suggested to affect a variety of physiological processes within crustaceans. For example, Lee and Weis (1980) demonstrated that EMF exposure affected moulting in species of fiddler crab (*Uca pugilator* and *Uca pugnax*).
- 9.10.289 Love et al. (2017) conducted field experiments on crab movement off southern California and in the Puget Sound. Dungeness crab *Metacarcinus magister* and red rock crab *Cancer productus* were given a choice of walking over an energized power cable to a baited trap or walking directly away from that cable to a second baited trap. The authors found no evidence that the EMF emitted by the energized subsea power cable



influenced the catchability of these two crab species (Love *et al.*, 2017). In addition, there was no difference in the crabs' responses to lightly buried versus unburied cables (Love *et al.*, 2017). Similarly, no significant change in distance or speed of travel over time when American lobster were exposed to magnetic fields of 53  $\mu$ T to 65  $\mu$ T (Hutchison *et al.*, 2020). Similarly, a field study by Hutchison *et al.* (2018) observed the behaviour of American lobster to AC and DC fields from a buried subsea cable. The authors found that these AC and DC fields did not cause a barrier to movement or migration of American lobster, which were able to freely cross the cable (Hutchison *et al.*, 2018). However, studies by Scott *et al.* (2018) and Woodruff *et al.* (2012) on edible crab and Dungeness crab reported behavioural changes during exposure to increased EMF levels, and both species showed increased activity when not exposed.

9.10.290 With the exception of edible crab, the research presented in the preceding paragraphs does not focus on shellfish IEFs relevant to this assessment. Limited research undertaken on the European lobster IEF demonstrated no neurological response to magnetic field strengths considerably higher than those expected directly over an average buried power cable (Normandeau Associates Inc *et al.*, 2011, Ueno *et al.*, 1986). However, European lobster exposed to EMFs have been demonstrated to have a significant decrease in egg volume at later stages of egg development and more larval deformities (Scott *et al.*, 2020). Similarly, Harsanyi *et al.* (2022) noted that chronic exposure to EMF effects could lead to physiological deformities and reduced swimming test rates the larvae of European lobster and edible crab. However, these deformities were in response to EMF levels of 2,800  $\mu$ T, and therefore are considerably higher than EMF effects expected for buried cables (Harsanyi *et al.*, 2022). A capture-mark-recapture study by Langhamer *et al.* (2016) demonstrated the presence of the Lillgrund OWF (Sweden) had no impact on the population of common shore crab, although it should be noted that EMFs were not specifically assessed in this study.

9.10.291 Regarding the edible crab IEF, Scott (2019) demonstrated that EMF exposure could result in varying egg volumes for this species, compared to control conditions. Exposed larvae were significantly smaller, but there were no statistically significant differences in hatched larval numbers, deformities, mortalities, or fitness (Scott, 2019). More recently, Scott *et al.* (2021) measured stress related parameters (l-Lactate, d-Glucose, total haemocyte count) in addition to behavioural and response parameters (shelter preference and time spent resting/roaming) in edible crab over 24 hour periods. Although, EMF strengths of 250  $\mu$ T were recorded to have limited physiological and behavioural impacts, exposure to 500  $\mu$ T and 1,000  $\mu$ T were found to disrupt the l-Lactate and d-Glucose circadian rhythm and alter total haemocyte count (thus suggesting a stress response in edible crab) (Scott *et al.*, 2021). Individuals showed a clear attraction to shelters with a significant reduction in time spent roaming

when exposed to EMFs of 500  $\mu$ T and 1,000  $\mu$ T, but not at 250  $\mu$ T (Scott *et al.*, 2021). Normandeau Associates Inc *et al.* (2011) reported maximum magnetic fields of 78.27  $\mu$ T at an unburied subsea cable. Therefore, as these physiological and behavioural impacts on edible crab did not occur at levels of 250  $\mu$ T (Scott *et al.*, 2021), it can be assumed that the magnetic fields generated by the subsea cables associated with the Proposed Development will be lower than 250  $\mu$ T, and therefore will not result in the adverse impacts recorded by Scott *et al.* (2021).

- 9.10.292 Regarding the squid and octopi IEF, there is currently no evidence for electroreception or magnetic sensitivity in cephalopods (Williamson, 1995), with their excellent vision believed to be largely responsible for their navigational behaviour (Pungor and Niell, 2023). There is little scientific literature about the potential sensitivity of the common whelk, king scallop, and queen scallop IEFs to EMFs. However, as these species are not migratory, it is less likely that magnetoreception could be impaired by EMFs generated by subsea power cables.
- 9.10.293 As with the sensitivity of marine fish IEFs and diadromous IEFs, the range over which the shellfish IEFs could be sensitive to EMFs is limited to within metres of the subsea cables (Snyder *et al.*, 2019). Further, demersal shellfish IEFs (e.g. crustaceans, common whelk, and scallops) that dwell on the seabed, are unlikely to come into contact with EMFs emitted from dynamic cables and may only encounter higher EMF levels when near the touchdown points or the buried cables. These IEFs could be exposed for longer periods of time and may be largely constrained in terms of location. However, the rapid decay of the EMF with horizontal and vertical distance (Bochert and Zettler, 2006, Hervé, 2021) (i.e. within metres) reduces the potential for individuals to detect emitted EMFs.
- 9.10.294 The shellfish IEFs are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

*Significance of the effect*

- 9.10.295 Overall, for all fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.296 No Additional Mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

## **IMPACT 7 - IMPACTS TO FISH AND SHELLFISH RECEPTORS DUE TO ENTANGLEMENT**

9.10.297 Fish and shellfish receptors may experience secondary entanglement in marine debris which has become entangled in infrastructure in the water column associated with the Proposed Development. This impact is relevant to the O&M phase of the Proposed Development. Research on the risk of entanglement for fish and shellfish is limited and largely focusses on marine mammals, with basking shark occasionally considered alongside marine mammals under ‘marine megafauna’.

### ***O&M phase***

#### ***Magnitude of impact***

9.10.298 The MDS for this impact is considered to be up to 135,816 m (135.82 km) of dynamic cables and mooring lines associated with the O&M phase of the Proposed Development. This value is comprised of:

- Up to 12 km of dynamic IACs in the water column (with a minimum diameter of 155 mm and a maximum external diameter of 200 mm); and
- Up to 123,816 m (123.82 km) of mooring lines within the water column (catenary mooring lines for up to 67 floating semi-submersible Wind Turbine foundations: up to 1,848 m per foundation) (Table 9.15).

9.10.299 Therefore, the MDS for this impact is largely comprised of mooring lines for the floating Wind Turbines foundations. The PDE considers various mooring line design options for different floating foundations (semi-submersible or TLP) including catenary, semi-taut and taut mooring lines and shared anchor options (see Volume 1, Chapter 3: Project Description). While the semi-submersible taut mooring line options represent a greater length within the water column than the catenary option, the latter has been considered as the MDS due to the greater potential for entanglement (Benjamins *et al.* (2014). The potential impact of mooring lines can be assessed by the concept of swept volumes, which considers the volume of the water column occupied by mooring lines under energetic conditions (Benjamins *et al.*, 2014). Curvature is also a useful physical parameter in the assessment of entanglement this considers the bending of mooring lines with taut configurations exhibiting smaller curvatures compared to catenary configurations (Benjamins *et al.*, 2014). Harnois *et al.* (2015) found that the catenary moorings with chain configurations have the highest curvature values (i.e. are more susceptible to bending and possess an elevated risk of snagging of debris and associated secondary entanglement for marine fauna).

9.10.300 The material used for mooring lines may also contribute to entanglement risk, with synthetic materials, such as nylon, posing a greater risk (Benjamins *et al.*, 2014). It can be anticipated that, there will be some horizontal movement of the floating Wind Turbines and therefore the

mooring lines may experience stretching (i.e. the maximum length in the water column) or slackness (i.e. the maximum length resting on the seabed). To address this, clump weights may be strategically placed around the touchdown point to mitigate the length of the mooring line between the anchor and the Wind Turbine. Harnois *et al.* (2015) concluded that the absolute risk of primary entanglement is low regardless of mooring configuration. All mooring line configurations (catenary, semi-taut, and taut) have too much tension to create a loop that could entangle an animal, such as a whale (Copping *et al.*, 2020, Garavelli, 2020). The literature on this topic focusses on marine mammals, although could reasonably be applied to large fish (such as basking shark), with even lower, and potentially, negligible potential for primary entanglement for smaller fish and shellfish receptors.

- 9.10.301 Given the above, the assessment of this potential impact focusses on secondary entanglement only (i.e. entanglement in marine debris, such as lost and discarded fishing nets, that have become entangled with the mooring lines and/or dynamic IACs themselves).
- 9.10.302 Lost fishing gear is made of synthetic materials, such as nylon and polyester, that do not biodegrade naturally, and may persist in the marine environment for extended periods. Indirect entanglement in anthropogenic debris floating in the marine environment or caught on mooring lines and IACs (e.g. secondary entanglement) could pose a risk of direct injury to fish and shellfish receptors.
- 9.10.303 As a part of the Embedded Mitigation of an Entanglement Management Plan, or equivalent (Table 9.22), mooring lines and dynamic IACs will undergo regular inspections during the O&M phase. Inspections are anticipated to be more frequent initially, and likely to decline in frequency over the O&M phase, following a risk-based approach. Any inspected or detected debris on the floating lines and cables will be recovered based on a risk assessment which considers impact on environment including risk to sensitive receptors, risk to asset integrity, and health and safety. As such, the removal of debris from mooring lines and dynamic IACs further reduces the likelihood of secondary entanglement and any population-level effects on fish and shellfish due to entanglement are considered unlikely.
- 9.10.304 The impact is, therefore, predicted to be of local spatial extent (in terms of the Fish and Shellfish Ecology Study Area as a whole), long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

*Sensitivity of the receptor*

Marine Fish IEFs

- 9.10.305 As detailed in Paragraphs 9.10.299 to 9.10.301, there is no risk of primary entanglement with infrastructure within the water column associated with the Proposed Development. The sensitivity of the receptor presented here, therefore, only relates to secondary entanglement.
- 9.10.306 Secondary entanglement refers to materials, such as discarded fishing gear and other marine debris, being caught on proposed development infrastructure, such as cables or lines, which subsequently results in the entanglement of marine life. Ghost fishing refers to abandoned, lost and discarded fishing gear, such as nets, lines, and traps, that continue to catch and entangle marine life. Ghost gear that becomes entangled with infrastructure has potential to create lethal traps for fish and shellfish. Discarded pots have been shown continue to trap shellfish indefinitely and can contribute to significant losses in fisheries (Cerbule *et al.*, 2023, Sheldon, 1975). Studies indicate that certain fish and shellfish species are attracted to artificial structures (Fabi *et al.*, 2002, Schroeder and Love, 2004), which makes them more susceptible to entanglement in any debris accumulated around these installations. Ghost gear and debris may act as a platform for the accumulation of marine life, causing more and perhaps larger animals to cluster and potentially snag on the derelict gear, resulting in further accumulation of animals (Cliff *et al.*, 2002).
- 9.10.307 Secondary entanglement may result in death of organisms that become entangled, or a range of non-lethal effects that significantly impact their health and behaviour. Physical injuries such as cuts and abrasions can lead to infections and impair their ability to swim (Afonso and Fidelis, 2023, Colmenero *et al.*, 2017), making them vulnerable to predators and less effective at feeding or reproducing. The energy spent in the struggle to escape secondary entanglement leads to a weakened state, reducing scope for growth and reproduction. Entangled fish will likely face difficulty foraging, leading to malnutrition and increased risk of starvation. Their vulnerability to predators rises due to their restricted movement and weakened state. Additionally, entanglement can disrupt natural behaviours like migration and social interactions, while chronic stress weakens their immune systems, making them more susceptible to disease. Finally, discarded anthropogenic debris has the potential to damage important habitats, further disrupting marine ecosystems.
- 9.10.308 While this impact is of larger concern to marine mammals (see Volume 2, Chapter 10: Marine Mammals), secondary entanglement was still proposed to be scoped in for fish and shellfish IEFs (Table 9.7). There is limited information available to quantify the sensitivity of fish and shellfish species to secondary entanglement. The available literature focusses on large, pelagic elasmobranchs, wherein secondary entanglement may represent a threat at the individual level. For example, a global review of

shark and ray entanglement in anthropogenic marine debris reported that ghost gear was the most common source of entanglement, followed by plastic strapping bands and other plastic products (Parton *et al.*, 2019). The authors suggested, however, that this issue is likely a far lesser threat to elasmobranchs than direct or indirect take in fisheries.

- 9.10.309 Recoverability of entangled species can be inferred from post-release mortality rates derived from fisheries. Post-release mortality can be extremely high for certain species, for example, the total mortality rate of silky sharks *Carcharhinus falciformis* captured as bycatch in purse seine gear was reported to exceed 84% in Hutchinson *et al.* (2015). Similarly, post-release survival rates of silky sharks and shortfin mako sharks *Isurus oxyrinchus* released from pelagic long lines were reported as 52.3% and 48.6%, respectively (Francis *et al.*, 2023). Survival was noted to be greater in large (>150 cm fork length) uninjured sharks (Francis *et al.*, 2023), however it should be noted that secondary entanglement can cause significant injury (Afonso and Fidelis, 2023, Cliff *et al.*, 2002, Colmenero *et al.*, 2017). In addition, some species and/or individuals may not be able to free themselves from secondary entanglement, and thus survivability would be low in comparison to the studies from fisheries bycatch.
- 9.10.310 However, it is possible that some animals may be able to disentangle themselves. Basking sharks, for example, have been observed with injuries and scars consistent with entanglement in ropes or nets (Gore *et al.*, 2016, The Shark Trust, 2020). Therefore, there is evidence that some animals may be able to survive and recover. There is also evidence of a high capacity for wound healing across a range of elasmobranch species (Chin *et al.*, 2015, Marra *et al.*, 2019, McGregor *et al.*, 2019, Womersley *et al.*, 2021), suggesting some potential for recoverability.
- 9.10.311 Therefore, as a precaution, the elasmobranch IEFs are deemed to have medium vulnerability, medium recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be medium.
- 9.10.312 There is little published literature on the sensitivity of the teleost fish IEFs to this impact. However, given that many are commercial species which are targeted by a range of fishing gears, it is possible that they could experience secondary entanglement from ghost gear and other marine debris. Further, it is possible that certain species may aggregate around snagged marine debris and therefore risk becoming entangled. As suggested by Parton *et al.* (2019) for elasmobranchs, it is possible that secondary entanglement is less of a threat to teleost fish than direct or indirect take in fisheries.
- 9.10.313 Therefore, as a precaution, the teleost fish IEFs are deemed to have medium vulnerability, low recoverability and local to national value. The sensitivity of the receptor is therefore, considered to be medium.



Diadromous fish IEFs

- 9.10.314 There is little information available on the impact of entanglement for diadromous fish species, with the majority of the literature focussing on elasmobranchs. Salmonids have been recorded as bycatch in fisheries (Raby *et al.*, 2012, Yochum *et al.*, 2021), and can become entangled in gill nets (Mäkinen *et al.*, 2000, Veneranta *et al.*, 2018). Various post-release studies on salmonids caught as bycatch by fishing gear have shown that released individuals experienced physiological stress characteristic of exhaustive exercise and hypoxia (Raby *et al.*, 2012), suffered extensive scale loss and physical injuries (Veneranta *et al.*, 2018), and negatively impacted upstream migration behaviour (Mäkinen *et al.*, 2000). It is therefore plausible that these species may be vulnerable to secondary entanglement in marine debris snagged on infrastructure associated with the Proposed Development.
- 9.10.315 In addition, the parasitic marine phase of sea lamprey attaches itself to a wide range of larger marine animals (such as elasmobranchs and marine mammals) (Silva *et al.*, 2014). These larger hosts may be vulnerable to secondary entanglement and thus increase the vulnerability of sea lamprey to this impact, by proxy.
- 9.10.316 Therefore, as a precaution, diadromous fish IEFs are deemed to have medium vulnerability, low recoverability and national to international value. The sensitivity of the receptor is therefore, considered to be medium. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also, indirectly, considered to be medium.

Shellfish IEFs

- 9.10.317 The only shellfish IEFs with the potential to be present within the water column, and thus within the ZoI for secondary entanglement, are the squid and octopi IEFs. The other shellfish IEFs are benthic invertebrates living on or attached to the seabed, where they will be at a much lower risk of entanglement. This is because debris is more likely to become entangled on the dynamic cables within the water column, much less so on the seabed. Further, given their smaller size, and slower movements, the shellfish IEFs (excluding squid and octopi) are less likely to become entangled in any debris present near the seabed, and are assumed to be able to avoid it.
- 9.10.318 There is no information available in the literature to quantify the sensitivity of the shellfish IEFs to secondary entanglement. As these shellfish species are commonly targeted in commercial fisheries, this impact is not expected to represent a significant additional impact than the threat of commercial fishing.

- 9.10.319 The squid and octopi IEF is deemed to have low vulnerability, low recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.
- 9.10.320 The other remaining shellfish IEFs are deemed to have no vulnerability, high recoverability (due to avoidance) and local value. The sensitivity of the receptor is therefore, considered to be negligible.

*Significance of the effect*

- 9.10.321 Overall, for all marine fish and diadromous fish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.10.322 For the squid and octopi IEF, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.10.323 For the remaining shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. The effect will therefore be of negligible to minor adverse significance. As a precaution, a **Minor** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.324 No Additional Mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

**IMPACT 8 – ACCIDENTAL POLLUTION IMPACTING FISH AND SHELLFISH RECEPTORS**

- 9.10.325 There is potential for accidental pollution to occur in all phases of the Proposed Development which could impact on fish and shellfish receptors. This could occur through the accidental release of pollutants associated with collision, allision or grounding of vessels operating in the area or through use of machinery and equipment on site during the construction, O&M and decommissioning phases.
- 9.10.326 Vessel movements associated with the construction, O&M or decommissioning phases of an OWF, and the installation and operation of new infrastructure, increase the risk of vessel-to-vessel encounters (collision) or encounters between vessels and infrastructure (allision). The presence of new or partially constructed infrastructure and associated constraints on navigable sea space can increase the risk that a vessel may be involved in a collision or allision event. Such an event could lead to vessel damage resulting in pollution to the surrounding environment and potential impacts on fish and shellfish species.
- 9.10.327 Navigational risk associated with the Proposed Development is considered fully as part of the shipping and navigation assessment and is presented

within the Volume 3, Annex 14.1: Navigation Risk Assessment and within Volume 2, Chapter 14: Shipping and Navigation. The shipping and navigation assessment concludes that all navigational risks are as low as reasonably practicable (ALARP), and the risk deemed tolerable, and that significant effects associated with collision/allision risk are minor and not significant in EIA terms with Embedded Mitigation in place. Assumptions are made that all vessels will be navigating with the appropriate equipment, lighting arrangements and in compliance with Annex III of the COLREGs, which is listed under the Embedded Mitigation in Table 9.22. Navigational risk is managed through the inclusion of a number of other Embedded Mitigation measures that will help reduce the potential for collision and/or allision to occur to as low as reasonably practical (see Table 9.22) and thus reduce the potential for accidental pollution from a vessel incident.

### **Construction phase**

#### *Magnitude of impact*

- 9.10.328 The MDS for this impact includes the maximum number of vessels on site at any one time and the maximum number of return trips, alongside the structures within the Site Boundary which could increase the risk of vessel collision and/or allision and subsequent damage which could lead to the release of pollutants (see Table 9.15). There will be a total of:
- 16 vessels working on the Export Cable Corridor at any one time, with an estimated 642 return trips in total; and
  - 30 vessels working in the Array Area at any one time, with up to 2,181 return trips in total (Table 9.15).
- 9.10.329 The following structures will be installed in the construction phase:
- up to 67 Wind Turbines, with a minimum spacing between them of 1,086 m; and
  - up to two OSPs, with topsides up to 80 m length and 60 m width and up to eight legs per OSP jacket foundation (Table 9.15).
- 9.10.330 Vessel traffic modelling has been undertaken with results detailed in Volume 3, Technical Appendix 14.1: Navigation Risk Assessment. The results indicate that the risk of a collision event is low within the Array Area with the modelled risk of a collision greatest on routes with higher vessel traffic density. Collision risk would be reduced to ALARP through Embedded Mitigation such as the EMP and MCP, CMS, CoCP, VMP, NSP and the use of Safety Zones (see Table 9.22 for details of all relevant Embedded Mitigation).
- 9.10.331 Based on the analysis in Volume 3, Technical Appendix 14.1: Navigation Risk Assessment, although the modelled increase in total collision frequency was 17.6% larger compared to the base case, the total frequency with the Proposed Development *in situ* was modelled as one collision event every 1,520 years, which is very low to negligible considering the five year

construction phase. Allision modelling showed that the highest modelled allision frequencies for the Array Area are for fishing vessels, at one in 314 years. The total allision probability of one in 150 years is still considered very low to negligible considering the five year construction phase.

- 9.10.332 The MDS for this impact includes a range of consumables associated with the Wind Turbines and OSPs, such as grease, oils, diesel fuel, SF6, and glycol/coolants (see Table 9.15). Spilling and accidental release of these consumables could occur during the transit and construction of the Wind Turbines and OSPs. In the marine environment, oil and other hydrocarbon spills often pose the most serious environmental risk. Chemical spills, although they can have localised highly toxic effects to fish and shellfish receptors, are generally of lower risk, as inventories of stored chemicals are often much smaller in volume than those of hydrocarbons. In addition, chemical pollutants commonly exhibit solubility in water when compared to hydrocarbons and can dilute rapidly on contact with the sea in the event of a spill. Oil and other liquid hydrocarbons are insoluble with water, typically floating on the surface and can persist in the marine environment for long periods of time, depending on the type of hydrocarbon released.
- 9.10.333 Measures that will be outlined in the MPCP, (see Volume 4, Appendix 25: Marine Pollution Contingency Plan) such as operating procedures, Risk Assessment Method Statements (RAMS), meetings with contractors, toolbox talks and experience working in the marine environment, will allow construction activities to be undertaken in such a manner to reduce the risk of accidental spills. In the unlikely event of an accidental spill, the MPCP contains tiered control measures to be put in place to contain and manage a spill and reduce the risk of impact to the surrounding environment.
- 9.10.334 Based on the results of the navigational risk modelling, and taking into consideration the Embedded Mitigation in place (EMP, MPCP and a range of navigational safety measures, see Table 9.22 for full details), the risk of a collision or allision event and subsequent release of any pollutants from a damaged vessel is considered to be low. The requirements of the EMP and MPCP mitigate the risk of accidental pollution occurring and secure the processes and procedures to reduce the potential impacts of accidental pollution should it occur.
- 9.10.335 The impact is, therefore, predicted to be of local spatial extent (in terms of Fish and Shellfish Ecology Study Area as a whole), short term duration (in terms of the limited length of time in which pollutants could be released), intermittent and medium reversibility. It is predicted that the impact will affect the receptor directly. Based on the risk modelling conclusions and the Embedded Mitigation detailed in Paragraph 9.10.334, the magnitude of impact is therefore considered to be negligible.

*Sensitivity of the receptor*

All Fish and Shellfish IEFs

- 9.10.336 A vessel collision/allision event or potential spill from equipment use during project activities could result in loss of fuel inventory or release of other pollutants. This could result in pollutants becoming available for uptake by fish and shellfish receptors. There is an indirect risk to some species, as pollutants may bioaccumulate in the tissues prey species, such as polychaete worms and marine bivalves, which are subsequently consumed by predatory fish and shellfish. The majority of the fish IEFs recorded within the Fish and Shellfish Ecology Study Area are highly mobile and will be able to move away from potentially polluted areas (International Tanker Owners Pollution Federation Limited (ITOPF, 2011), California Office of Environmental Health Hazard Assessment (California OEHHA, 2025))).
- 9.10.337 Of the shellfish IEFs with a MarESA available (king scallop, common shore crab, edible crab, and Norway lobster), low to very low sensitivity was concluded for most species against the following pressures:
- synthetic compound contamination;
  - heavy metal contamination; and
  - hydrocarbon contamination (Hill and Sabatini, 2008, Marshall and Wilson, 2008, Neal and Pizzolla, 2008, Neal and Wilson, 2008).
- 9.10.338 However, for common shore crab, a medium sensitivity was concluded for hydrocarbon contamination and edible crab was assessed as having a medium sensitivity to synthetic compound contamination (Neal and Pizzolla, 2008, Neal and Wilson, 2008). Therefore, as a precaution, a medium sensitivity has been assumed for all the shellfish IEFs.
- 9.10.339 Of the fish IEFs with a MarESA available (basking shark and common skate), no sensitivity conclusions to the relevant pressures were provided due to lack of information available to quantify them (Neal and Pizzolla, 2006, Wilson *et al.*, 2020). Further, the sensitivity assessments on FeAST for sandeel and flapper skate were also inconclusive due to limited information (NatureScot, 2025).
- 9.10.340 Overall, as a precaution, all fish and shellfish IEFs are deemed to have medium vulnerability, low to medium recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be medium.

*Significance of the effect*

- 9.10.341 For all fish and shellfish fish IEFs, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. As per the matrix outlined in Table 9.20, the effect will therefore be of negligible to minor adverse significance. Given the Embedded

Mitigation outlined in Table 9.22 a **Negligible** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.342 No Additional Mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

**O&M phase**

*Magnitude of impact*

- 9.10.343 The MDS for this impact includes the maximum number of vessels on site at any one time and the maximum number of return trips, alongside the structures within the Site Boundary which could increase the risk of vessel collision and/or allision and subsequent damage which could lead to the release of pollutants (see Table 9.15). There will be a total of up to:
- ten vessels on site at the Array Area at any one time over the 30 year O&M phase, making up to 643 return trips per year; and
  - two vessels on site at the Export Cable Corridor any one time over the 30 year O&M phase, making a total of up to 19 return trips per year (Table 9.15).
- 9.10.344 The following structures will be present throughout the O&M phase:
- up to 67 Wind Turbines, with a minimum spacing between them of 1,086 m; and
  - up to two OSPs, with topsides up to 80 m length and 60 m width and up to eight legs per OSP jacket foundation (Table 9.15).
- 9.10.345 Collision risk modelling results indicated that the frequency of collision events in the O&M phase would be low. The total collision frequency with the Proposed Development *in situ* was modelled as one collision event every 1,520 years, which is considered to be very low to negligible given the 30 year O&M phase (Volume 3, Technical Appendix 14.1: Navigation Risk Assessment). Considering these modelling results, and the increased familiarity with the Proposed Development during the O&M phase compared to during construction, the risk of a vessel collision has been considered to be as low as reasonably practical. Similarly, allision modelling demonstrated the highest modelled allision frequencies of one in 150 years, which is still considered to be very low to negligible given the 30 year O&M phase (Volume 3, Technical Appendix 14.1: Navigation Risk Assessment).
- 9.10.346 The MDS for this impact also includes a range of consumables associated with the Wind Turbines and OSPs, such as grease, oils, diesel fuel, SF6, and glycol/coolants (see Table 9.15). As detailed in Paragraph 9.10.332 for the construction phase, oil and other hydrocarbon spills represent the highest risk for fish and shellfish receptors. However, control measures relevant to the O&M phase (such as those surrounding leakage from infrastructure and during O&M machinery use) will reduce the potential



for accidental spills to occur. The requirements of the EMP and MPCP mitigate the risk of accidental pollution occurring and the processes and procedures to reduce the potential impacts of accidental pollution should it occur.

9.10.347 Based on the results of the navigational risk modelling and taking into consideration the Embedded Mitigation applicable (EMP, MPCP and a range of navigational safety measures, see Table 9.22 for full details), the risk of a collision or allision event and subsequent release of any pollutants from a damaged vessel is considered to be low. The requirements of the EMP and MPCP mitigate the risk of accidental pollution occurring and secure the processes and procedures to reduce the potential impacts of accidental pollution should it occur.

9.10.348 The impact is, therefore, predicted to be of local spatial extent (in terms of Fish and Shellfish Ecology Study Area as a whole), short term duration (in terms of the limited length of time in which pollution events could occur), intermittent and medium reversibility. It is predicted that the impact will affect the receptor directly. Based on the risk modelling conclusions and the Embedded Mitigation detailed in Paragraph 9.10.346, the magnitude of impact is therefore considered to be negligible.

*Sensitivity of the receptor*

9.10.349 The sensitivity of the receptor is as presented in Paragraphs 9.10.336 to 9.10.340 and is not repeated here.

*Significance of the effect*

9.10.350 For all fish and shellfish IEFs, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. As per the matrix outlined in Table 9.20, the effect will therefore be of negligible to minor adverse significance. Given the Embedded Mitigation outlined in Table 9.22 a **Negligible** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

9.10.351 No Additional Mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

***Decommissioning phase***

*Magnitude of impact*

9.10.352 The magnitude of impact in the decommissioning phase is considered to be equal to or lesser than that defined in Paragraphs 9.10.328 to 9.10.335 for the construction phase and is not repeated here.

*Sensitivity of the receptor*

9.10.353 The sensitivity of the receptor is as presented in Paragraphs 9.10.336 to 9.10.340 and is not repeated here.

*Significance of the effect*

- 9.10.354 Overall, for all fish and shellfish IEFs, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is, precautionarily, considered to be medium. As per the matrix outlined in Table 9.20, the effect will therefore be of negligible to minor adverse significance. Given the Embedded Mitigation outlined in Table 9.22 a **Negligible** adverse significance has been concluded, which is not significant in EIA terms.

*Additional Mitigation and residual effect*

- 9.10.355 No Additional Mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

## **9.11 Inter-Related Effects**

- 9.11.1 A description of the likely inter-related effects arising from the Proposed Development on fish and shellfish ecology is provided in Volume 2, Chapter 23: Inter-Related Effects.
- 9.11.2 For fish and shellfish ecology the following potential impacts have been considered within the inter-related assessment:
- temporary habitat loss and/or disturbance;
  - long term habitat loss and/or disturbance;
  - introduction of artificial habitat and subsequent colonisation of hard structures;
  - increased SSCs and associated deposition;
  - subsea noise impacting fish and shellfish receptors;
  - impacts to fish and shellfish receptors due to EMF;
  - impacts to fish and shellfish receptors due to entanglement; and
  - accidental pollution impacting fish and shellfish receptors.
- 9.11.3 Table 9.47 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, O&M phase, and decommissioning of the Proposed Development and also the inter-related effects (receptor-led effects) that are predicted to arise for fish and shellfish receptors.
- 9.11.4 Effects on fish and shellfish ecology also have the potential to lead to secondary effects on other receptors and these effects are fully considered in the topic-specific chapters. These receptors and effects are:
- Marine mammals;
  - changes to the fish and shellfish community within the Fish and Shellfish Ecology Study Area resulting from impacts associated with the Proposed Development may lead to changes in prey availability for marine mammals (see Volume 2, Chapter 10: Marine Mammals).

- Offshore ornithology;
  - changes in prey availability, as above for marine mammals (see Volume 2, Chapter 11: Offshore Ornithology).
- Commercial fisheries;
  - changes to the fish and shellfish community within the Fish and Shellfish Ecology Study Area resulting from impacts associated with the Proposed Development may affect the commercial fisheries industry (see Volume 2, Chapter 13: Commercial Fisheries).

**Table 9.47: Summary of Likely Significant Inter-Related Effects for Fish and Shellfish Ecology from Individual Effects Occurring Across the Construction, O&M and Decommissioning Phase of the Proposed Development (Project Lifetime Effects) and from Multiple Effects Interacting Across all Phases (Receptor-led Effects)**

| Description of Impact                                                             | Phase                                                                   |     |   | Likely Significant Inter-Related Effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------|-----|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                   | C                                                                       | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Project Lifetime Effects                                                          |                                                                         |     |   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Temporary habitat loss and/or disturbance                                         | ✓                                                                       | ✓   | ✓ | <p>If considered additively across the construction, O&amp;M, and decommissioning phases, the total area of temporary habitat loss and disturbance is larger than for each individual stage. It should be noted, however, that across the three phases of the Proposed Development, there is potential for the same areas to be repeatedly disturbed, as the footprints of impact are localised to the various infrastructure on the seabed. Repeated disturbance could occur at single Wind Turbines, the OSPs, and specific sections of the cables. Therefore, a total footprint of impact across all three phases would likely be an overestimation, with overlap in footprints across phases.</p> <p>Further, the seabed habitats potentially disturbed within the Site Boundary are widespread across the Fish and Shellfish Ecology Study Area. Therefore, project lifetime effects will be proportionally small in this wider context. This is further bolstered by the recoverability of temporarily disturbed seabed, and the high potential for fish and shellfish receptors to return to affected areas. Therefore, across the lifetime of the Proposed Development, the effects of this impact are not anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for each individual phase (e.g. <b>minor</b> adverse throughout).</p> <p>Overall, no likely significant inter-related effects are anticipated across the lifetime of the Proposed Development.</p>                                                                                                                                                          |
| Long term habitat loss and/or disturbance                                         | ✓ (combined as one phase in the assessment of significance: Table 9.15) |     | ✓ | <p>In the assessment of significance for this impact, the construction and O&amp;M phases were combined as the infrastructure resulting in long term habitat loss and disturbance installed throughout the construction phase will persist into the O&amp;M phase (i.e. the footprints of long term habitat loss in the construction phase will be in the same locations as in the O&amp;M phase). The MDS for the decommissioning phase considered that the majority of the infrastructure was left <i>in situ</i>, and the footprints of infrastructure left <i>in situ</i> will also be in the same locations as they were in the combined construction and O&amp;M phases. Therefore, the footprint of long term habitat loss and disturbance will not differ if considered additively across the combined construction &amp; O&amp;M phase and the decommissioning phase (i.e. the total area of long term habitat loss and disturbance over all three phases will not be larger than described for the individual phases).</p> <p>Further, the seabed habitats potentially disturbed within the Site Boundary are widespread across the Fish and Shellfish Ecology Study Area. Therefore, project lifetime effects will be proportionally small in this wider context. Therefore, across the lifetime of the Proposed Development, the effects of this impact are not anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for each individual phase (e.g. <b>minor</b> adverse throughout).</p> <p>Overall, no likely significant inter-related effects are anticipated across the lifetime of the Proposed Development.</p> |
| Introduction of artificial habitat and subsequent colonisation of hard structures | ✓ (combined as one phase in the assessment of significance: Table 9.15) |     | ✓ | As above for ‘long term habitat loss and/or disturbance’.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Increased SSCs and associated deposition                                          | ✓                                                                       | ✓   | ✓ | <p>Effects from increased SSCs and associated deposition in each phase of the Proposed Development will be short lived and intermittent. Fish and shellfish receptors potentially affected by this impact in each phase are likely to have recovered in the intervening period between both:</p> <div><div>a)</div><div>individual activities resulting in increased SSCs and associated deposition (such as seabed preparation); and</div><div>b)</div><div>phases.</div></div> <p>Further, the fish and shellfish IEFs were considered to be of low sensitivity and/or high recoverability to this impact. Therefore, across the lifetime of the Proposed Development, the effects of this impact are not</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Description of Impact                                                                                                                                                                                                                                                                                                                                                                   | Phase                                       |                 |                                             | Likely Significant Inter-Related Effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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|                                                                                                                                                                                                                                                                                                                                                                                         | C                                           | O&M             | D                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                                                                                                                                                                                                                                                                                                                                                                         |                                             |                 |                                             | <p>anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for each individual phase (e.g. <b>minor</b> adverse throughout).</p> <p>Overall, no likely significant inter-related effects are anticipated across the lifetime of the Proposed Development.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Subsea noise impacting fish and shellfish receptors</b>                                                                                                                                                                                                                                                                                                                              | ✓                                           | ✓               | ✓                                           | <p>Subsea noise could occur during all phases of the Proposed Development, however those with the highest impact ranges would only occur in the construction phase (e.g. piling and UXO clearance). However, subsea noise produced as a result of piling during construction is likely to reach over a larger area compared to other noise-producing activities associated. Therefore, it is considered unlikely that piling would act additively with other noise-producing activities occurring at the same time, as the noise produced during piling is likely to mask other noise sources. Piling noise, although occurring during construction phase only, would contribute to the overall duration of noise impacts over the lifetime of the Proposed Development. The effects of this noise source are not anticipated to interact in such a way with other noise sources (such as those in the O&amp;M phase) as to result in inter-related effects of greater significance than the assessments presented for each individual phase.</p> <p>Increased subsea noise during UXO clearance could interact with other noise sources. However, UXO clearance is planned using low order techniques which has the potential to result in localised disturbance only. For each UXO clearance event, the duration of the impact – including mitigation techniques – will be very short (i.e. hours). Subsea noise from UXO clearance, although occurring during construction phase only, could contribute to the overall duration of noise impacts throughout all phases of the Proposed Development. Significance was considered to be minor adverse and therefore not significant in EIA terms. The effects of this noise source are not anticipated to interact in such a way with other noise sources as to result in inter-related effects of greater significance than the assessments presented for each individual phase (e.g. <b>minor</b> adverse throughout).</p> <p>Elevated subsea noise during site-investigation surveys, construction activities, and operational noise from floating foundations and mooring lines could be additive over all phase of the Proposed Development, with sequential noise from site-investigation surveys leading to an extended effect on fish and shellfish receptors. However, these noise producing activities will occur intermittently, during short term events with cessation of noise in between events. Therefore, these impacts will be highly localised. Additive effects are possible (though unlikely given intermittency of these noise producing activities) and the duration of elevated subsea noise from all activities could be extended. Significance was considered to be minor adverse and therefore not significant in EIA terms. The effects of these noise sources are not anticipated to interact in such a way with other noise sources as to result in inter-related effects of greater significance than the assessments presented for each individual phase (e.g. <b>minor</b> adverse throughout).</p> |
| <b>Impacts to fish and shellfish receptors due to EMF</b>                                                                                                                                                                                                                                                                                                                               | ×                                           | ✓               | ×                                           | This impact will only occur during the O&M phase, and will not overlap with other phases, therefore no likely significant inter-related effects are anticipated across the lifetime of the Proposed Development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Impacts to fish and shellfish receptors due to entanglement</b>                                                                                                                                                                                                                                                                                                                      | ×                                           | ✓               | ×                                           | This impact will only occur during the O&M phase, and will not overlap with other phases, therefore no likely significant inter-related effects are anticipated across the lifetime of the Proposed Development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Accidental pollution impacting fish and shellfish receptors</b>                                                                                                                                                                                                                                                                                                                      | ✓                                           | ✓               | ✓                                           | Although accidental pollution to the surrounding environment could occur in all phases of the Proposed Development, this is highly unlikely due to the Embedded Mitigation measures outlined in Section 9.9, and the risk of this occurring will not be worsened through interactions across different phases.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Receptor-led Effects</b>                                                                                                                                                                                                                                                                                                                                                             |                                             |                 |                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ul style="list-style-type: none"> <li>• <b>Temporary habitat loss and/or disturbance.</b></li> <li>• <b>Long term habitat loss and/or disturbance.</b></li> <li>• <b>Introduction of artificial habitat and subsequent colonisation.</b></li> <li>• <b>Increased SSCs and associated deposition.</b></li> <li>• <b>Subsea noise impacting fish and shellfish receptors.</b></li> </ul> | ✓ (all impacts except EMF and entanglement) | ✓ (all impacts) | ✓ (all impacts except EMF and entanglement) | There is potential for temporal and spatial interactions between the impacts listed across all phases of the Proposed Development. However, these individual impacts were largely assigned as negligible to minor adverse significance as standalone impacts. Although potential receptor-led effects may arise, it is important to recognise that the individual activities will not necessarily occur simultaneously or in the same physical areas of the Site Boundary. For example, the activities considered in the MDS for multiple impacts associated with the construction phase may not temporally overlap (such as UXO clearance, sandwave clearance, piling, and cable laying).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Description of Impact                                                                                                                                                                                                                               | Phase |     |   | Likely Significant Inter-Related Effects                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                     | C     | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"><li>• Impacts to fish and shellfish receptors due to EMF.</li><li>• Impacts to fish and shellfish receptors due to entanglement.</li><li>• Accidental pollution impacting fish and shellfish receptors.</li></ul> |       |     |   | Therefore, across the phases of the Proposed Development, receptor-led effects are not anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for individual impacts in isolation (e.g. <b>minor</b> adverse throughout). Overall, no likely significant inter-related effects are anticipated across the lifetime of the Proposed Development. |



## 9.12 Cumulative Effects Assessment

### Methodology

- 9.12.1 The Cumulative Effects Assessment (CEA) assesses the impacts associated with the Proposed Development together with other relevant projects and activities. Cumulative effects are defined as the effect of the Proposed Development in combination with the effects from a number of different projects, on the same receptor or resource. Further details on CEA methodology are provided in Volume 1, Chapter 4: EIA Methodology.
- 9.12.2 The projects selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see Volume 3, Technical Appendix 4.4: Cumulative Effects Screening). Volume 3, Technical Appendix 4.4: Cumulative Effects Screening provides further information in relation to other projects and how this information is obtained and applied to the assessment. Each project on the CEA long list has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.
- 9.12.3 In order to assess the potential for temporal overlap between projects on the CEA long list and the Proposed Development, the following temporal assumptions have been applied. Seabed preparation activities for the Proposed Development are scheduled to begin in Q2 2030, with commissioning expected to be completed in Q4 2034, with an operational period of 30 years.
- 9.12.4 In undertaking the CEA for the Proposed Development, it is important to bear in mind that other projects under consideration will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to a cumulative impact alongside the Proposed Development. Therefore, a tiered approach has been adopted. This provides a framework for placing relative weight upon the potential for each project to be included in the CEA to ultimately be realised, based upon the project's current stage of maturity and certainty in the projects' parameters. The tiered approach which will be utilised within the Proposed Development CEA employs the following tiers:
- Tier 1 – The onshore elements of the Project;
  - Tier 2 – Projects that have an application submitted, are consented, under construction or operational to the extent not already captured with the baseline;
  - Tier 3 – Projects which have submitted a scoping report and/or have received a scoping opinion; and
  - Tier 4 – Reasonably foreseeable projects including those with Crown Estate Scotland option or lease agreements.
- 9.12.5 The specific projects scoped into the CEA for fish and shellfish ecology are outlined in Table 9.48. As detailed in the bullets above, Tier 1

encompasses only the onshore elements of the Project. There are not anticipated to be any receptor impact pathways for fish and shellfish ecology between the onshore elements of the Project and the Proposed Development, therefore there is no Tier 1 assessment included in the CEA for fish and shellfish ecology.

- 9.12.6 Some of the potential impacts considered within the Proposed Development alone assessment are specific to a particular phase of development (e.g. construction, O&M or decommissioning). Where the potential for cumulative effects with other projects only have potential to occur where there is spatial or temporal overlap with the Proposed Development during certain phases of development, impacts associated with a certain phase may be omitted from further consideration where no projects have been identified that have the potential for cumulative effects during this period.
- 9.12.7 For the impact of subsea noise, a buffer of 100 km (with an area of 43,267.39 km<sup>2</sup>) has been implemented to identify relevant projects and activities. This is standard practice, to account for the wider ranging Zol for subsea noise, in comparison to all other potential impacts to fish and shellfish ecology. For the impact of increased SSCs and associated deposition, the CEA screening buffer used in Volume 2, Chapter 7: Physical Processes was used to identify relevant projects (i.e. one spring tidal excursion). This is because the assessment for this impact is based on that presented in Volume 2, Chapter 7: Physical Processes. For all other impacts, a buffer of 50 km (with an area of 14,913.51 km<sup>2</sup>) has been implemented, which is suitably precautionary given the localised nature of the impacts. These buffers were presented during Scoping and agreed upon through the Scoping Opinion process (see Table 9.7). These buffers were applied to both the Array Area and the Export Cable Corridor, so there were some projects screened into the CEA that were within these buffers from one but not the other. As a precaution, any projects that were within these buffers from either the Array Area or Export Cable Corridor were included for consideration in the CEA, even if they fell outwith the buffer for one.

**Table 9.48: List of Other Projects Considered within the CEA for Fish and Shellfish Ecology**

| Project                                             | Status      | Distance to the Array Area (km) | Distance to the Export Cable Corridor (km) | Description of Project                                                                                                 | Dates of Construction (If Applicable)<br><br>Proposed Development:<br>2030 – 2034 | Dates of Operation (If Applicable)<br><br>Proposed Development:<br>2034/2035 – 2065 | Overlap with the Proposed Development                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------|-------------|---------------------------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Tier 2</b>                                       |             |                                 |                                            |                                                                                                                        |                                                                                   |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Offshore Wind Projects and Associated Cables</b> |             |                                 |                                            |                                                                                                                        |                                                                                   |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Beatrice OWF</b>                                 | Operational | 58.57                           | 21.70                                      | Beatrice OWF consists of 84 turbines at a capacity of 588 MW.                                                          | Operational                                                                       | Present day – 2044 (with decommissioning between 2045 – 2046)                       | The O&M and decommissioning phases of the Beatrice OWF overlap with the construction and up to ten years of the O&M phase of the Proposed Development.                                                                                                                                                                                                                                                                                                                         |
| <b>Beatrice OWF Offshore Export Cable Route</b>     | Operational | 67.01                           | 29.49                                      | Beatrice OWF export cable consists of up to two cables at a capacity of 220 kV.                                        | Operational                                                                       | Present day – 2044 (with decommissioning between 2045 – 2046)                       | The O&M and decommissioning phases of the Beatrice OWF Export Cable Route overlap with the construction and up to ten years of the O&M phase of the Proposed Development.                                                                                                                                                                                                                                                                                                      |
| <b>Caledonia OWF (North and South)</b>              | Planning    | 48.30                           | 17.55                                      | Caledonia OWF is proposed for up to 150 turbines at a capacity of 2,000 MW.                                            | 2028 – 2032                                                                       | 2032 – 2067                                                                         | Construction, O&M and decommissioning phases of Caledonia OWF overlap with those of the Proposed Development.                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Moray East OWF</b>                               | Operational | 67.72                           | 34.41                                      | Moray East OWF consists of up to 100 turbines at a capacity of 950 MW.                                                 | Operational (with a lifecycle of 25 years)                                        | 2022 – 2057                                                                         | The O&M and decommissioning phases of the Moray East OWF overlap with the construction and the O&M phase of the Proposed Development. This project is considered to be part of the baseline, however, has been screened in for potential ongoing impacts. Although the O&M phase of the Moray East OWF may be longer than 25 years (2022 – 2057), its decommissioning phase is not likely to overlap with the decommissioning of the Proposed Development (from 2065 onwards). |
| <b>Moray West OWF</b>                               | Operational | 82.82                           | 45.19                                      | Moray West Offshore Wind Farm is consented for up to 60 turbines at a capacity of 882 MW.                              | Operational (with a lifecycle of 25 years)                                        | 2025 – 2050                                                                         | The O&M and decommissioning phases of Moray West OWF overlap with the construction and O&M phases of the Proposed Development. Although the O&M phase of the Moray West OWF may be longer than 25 years (2025 – 2050), its decommissioning phase is not likely to overlap with the decommissioning of the Proposed Development (from 2065 onwards).                                                                                                                            |
| <b>Pentland Floating OWF</b>                        | Consented   | 84.29                           | 43.42                                      | Pentland floating Offshore Wind Farm is consented for up to six turbines with a maximum generating capacity of 100 MW. | 2024 – 2026                                                                       | 2026 – 2056                                                                         | The O&M and decommissioning phases of Pentland Floating OWF overlap with the construction and O&M phases of the Proposed Development.                                                                                                                                                                                                                                                                                                                                          |
| <b>West of Orkney Wind Farm</b>                     | Consented   | 88.69                           | 60.50                                      | West of Orkney Wind Farm is proposed for up to 125 turbines at a capacity of 2000 MW.                                  | 2028 – 2031                                                                       | 2031 – 2061                                                                         | Construction, O&M, and decommissioning phases of West of Orkney OWF overlap with the construction and O&M phases of the Proposed Development. As outwith the 50 km screening buffer but within the 100 km screening buffer, this project is only included in the CEA for the impact of subsea noise.                                                                                                                                                                           |
| <b>Marine Aggregates and Disposal</b>               |             |                                 |                                            |                                                                                                                        |                                                                                   |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| Project                     | Status      | Distance to the Array Area (km) | Distance to the Export Cable Corridor (km) | Description of Project                                                                                                                                                                                                      | Dates of Construction (If Applicable)<br><br>Proposed Development: 2030 – 2034 | Dates of Operation (If Applicable)<br><br>Proposed Development: 2034/2035 - 2065 | Overlap with the Proposed Development                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------|-------------|---------------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Scapa - FI055               | Operational | 39.95                           | 27.94                                      | Capital dredging and sea deposits managed under Marine Scotland licence.                                                                                                                                                    | Not Applicable (ongoing dredging activities)                                   | Present day - unknown                                                            | Ongoing dredging activity associated with these marine aggregates and disposal projects may overlap with the construction and possibly the O&M phases of the Proposed Development. There is limited information on dredging parameters publicly available, however, they have been included as a precaution. These have been collectively referred to as the ‘Tier 2 marine aggregates and disposal projects’ henceforth, for brevity. |
| Scrabster Extension - FI008 | Operational | 66.83                           | 24.55                                      | Dredging activities to facilitate the St. Ola Pier refurbishment, managed under Marine Scotland licence.                                                                                                                    | Not Applicable (ongoing dredging activities)                                   | Present day - unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Gills Bay - FI030           | Operational | 45.03                           | 14.34                                      | Licensed for dredge material disposal, with specific coordinates provided.                                                                                                                                                  | Not Applicable (ongoing dredging activities)                                   | Present day - unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Stromness C - FI045         | Operational | 58.78                           | 49.10                                      | Part of the marine renewables sector, with disposal activities regulated by Marine Scotland.                                                                                                                                | Not Applicable (ongoing dredging activities)                                   | Present day - unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Stromness B - FI050         | Operational | 48.54                           | 41.42                                      | Similar to Stromness C, involved in marine renewables and regulated by Marine Scotland.                                                                                                                                     | Not Applicable (ongoing dredging activities)                                   | Present day - unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| South Head - CR009          | Operational | 55.00                           | 10.02                                      | Information on this specific site is limited, but it is managed under general dredged-material disposal regulations.                                                                                                        | Not Applicable (ongoing dredging activities)                                   | Present day - unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Oil and Gas                 |             |                                 |                                            |                                                                                                                                                                                                                             |                                                                                |                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| P1270 (Lybster)             | Operational | 76.70                           | 26.22                                      | Operational oil and gas licence in block 11/24a (Lybster) under Star Energy Group Ltd.                                                                                                                                      | Operational                                                                    | Licence ends in 2031, with decommissioning possible after.                       | The decommissioning of this project may overlap with the construction phase of the Proposed Development. Although no there are no publicly available parameters or information surrounding decommissioning activities, this project has been included in the CEA as a precaution for impacts which could occur due to decommissioning activities.                                                                                      |
| Coastal Construction        |             |                                 |                                            |                                                                                                                                                                                                                             |                                                                                |                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 23/289/NATEIA               | Planning    | 34.10                           | 33.00                                      | Construct a deep water quay including 597 m, 2.7 ha quayside and quay extension, excavate landform and reclaim land to create an 18 ha laydown including rock armour revetments, construct an access road, vehicle parking, | 2025 - 2028                                                                    | Not applicable                                                                   | The presence of this project (once constructed) could contribute to the cumulative impact of long term habitat loss and/or disturbance.                                                                                                                                                                                                                                                                                                |

| Project                                                                                                                 | Status       | Distance to the Array Area (km) | Distance to the Export Cable Corridor (km) | Description of Project                                                                                                                                                    | Dates of Construction (If Applicable)<br><br>Proposed Development: 2030 – 2034 | Dates of Operation (If Applicable)<br><br>Proposed Development: 2034/2035 – 2065 | Overlap with the Proposed Development                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                         |              |                                 |                                            | water tanks and associated infrastructure                                                                                                                                 |                                                                                |                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Cables and Pipelines</b>                                                                                             |              |                                 |                                            |                                                                                                                                                                           |                                                                                |                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Piper B 30" Oil Export Pipeline</b>                                                                                  | Operational  | 0.92                            | 0.00                                       | Oil pipeline.                                                                                                                                                             | Operational                                                                    | Present day – unknown                                                            | Although already operational, these cable and pipeline projects may have ongoing impacts during their O&M phases which could overlap with that of the Proposed Development (e.g. EMFs and impacts associated with cable repair and reburial). However, information and specific parameters on these potential ongoing impacts are not available. These cable and pipeline projects (collectively referred to as the ‘Tier 2 cable and pipeline projects’ hereafter, for brevity) have still been screened in as a precaution. |
| <b>SHEFA-2 Seg 8</b>                                                                                                    | Operational  | 1.20                            | 4.94                                       | Subsea telecommunications cable.                                                                                                                                          | Operational                                                                    | Present day – unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>SHEFA-2 Seg 9</b>                                                                                                    | Operational  | 18.19                           | 0.00                                       | Subsea telecommunications cable.                                                                                                                                          | Operational                                                                    | Present day – unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Shetland HVDC</b>                                                                                                    | Operational  | 0.00                            | 0.39                                       | 260 km subsea power cable between Shetland and mainland Scotland.                                                                                                         | Operational                                                                    | Present day – unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>R100 projects (telecommunication cables between islands in eastern Orkney)</b>                                       | Operational  | Various cables                  |                                            | Subsea telecommunications cables between the Orkney islands.                                                                                                              | Operational                                                                    | Present day – unknown                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>SSE distribution cable projects between islands in eastern Orkney (hereafter referred to as ‘Orkney Connection’)</b> | Construction | 58.76                           | 19.60                                      | HVAC transmission system between Finstown in Orkney and Dounreay in Caithness, capable of transmitting no less than 220 MW of power.                                      | Unknown                                                                        | Unknown                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>SSEN-T Spittal to Peterhead HVDC</b>                                                                                 | Construction | 42.50                           | 0.00                                       | HVDC cable from Spittal to Peterhead.                                                                                                                                     | 2026 – 2029                                                                    | 2030 – 2070                                                                      | This project will overlap temporally with the of the Proposed Development (and possibly the decommissioning phase). In addition, this project will overlap spatially with the Export Cable Corridor.                                                                                                                                                                                                                                                                                                                          |
| <b>Tier 3</b>                                                                                                           |              |                                 |                                            |                                                                                                                                                                           |                                                                                |                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Offshore Wind Projects and Associated Cables</b>                                                                     |              |                                 |                                            |                                                                                                                                                                           |                                                                                |                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Broadshore Hub OWFs</b>                                                                                              | Scoping      | 58.93                           | 51.81                                      | The Broadshore Hub OWFs (comprising Broadshore OWF, Sinclair OWF and Scaraben OWF) is proposed for up to 72 turbines at a capacity of 1,100 MW across the three projects. | 2028 – 2029                                                                    | 2029 – unknown                                                                   | As outwith the 50 km screening buffer but within the 100 km screening buffer, this project is only included in the CEA for the impact of subsea noise.                                                                                                                                                                                                                                                                                                                                                                        |

| Project                     | Status                | Distance to the Array Area (km) | Distance to the Export Cable Corridor (km) | Description of Project                                                                                   | Dates of Construction (If Applicable)<br><br>Proposed Development:<br>2030 – 2034 | Dates of Operation (If Applicable)<br><br>Proposed Development:<br>2034/2035 – 2065 | Overlap with the Proposed Development                                                                                                                                                                                                                                                                                                                    |
|-----------------------------|-----------------------|---------------------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Buchan OWF</b>           | Planning <sup>1</sup> | 53.11                           | 66.39                                      | Buchan OWF is proposed for up to 70 turbines at a capacity of 1000 MW.                                   | 2028 – 2030                                                                       | 2030 – unknown                                                                      | Construction and O&M phases of Buchan OWF overlap with the construction and O&M phases of the Proposed Development. The decommissioning phases may also overlap and are included as a precaution. As outwith the 50 km screening buffer but within the 100 km screening buffer, this project is only included in the CEA for the impact of subsea noise. |
| <b>Marram OWF</b>           | Scoping               | 92.06                           | 105.42                                     | Marram OWF is proposed for up to 150 turbines at a capacity of 3,000 MW.                                 | 2026 – 2029                                                                       | 2029 – unknown                                                                      | As outwith the 50 km screening buffer but within the 100 km screening buffer, this project is only included in the CEA for the impact of subsea noise.                                                                                                                                                                                                   |
| <b>Stromar OWF</b>          | Scoping               | 14.01                           | 10.84                                      | Stromar is proposed for up to 71 turbines at a 1,500 MW capacity.                                        | 2026 – 2032                                                                       | 2032 – unknown                                                                      | Construction and O&M phases of Stromar OWF overlap with the construction and O&M phases of the Proposed Development. The decommissioning phases may also overlap and are included as a precaution.                                                                                                                                                       |
| <b>Tidal Farms</b>          |                       |                                 |                                            |                                                                                                          |                                                                                   |                                                                                     |                                                                                                                                                                                                                                                                                                                                                          |
| <b>Westray South</b>        | Scoping               | 38.97                           | 42.82                                      | Westray South Tidal Array consists of up to 70 turbines at a capacity of 170 MW.                         | Unknown                                                                           | Unknown                                                                             | There may be temporal overlap between all phases of the Westray South Tidal Array and those of the Proposed Development, although these dates are currently unavailable at the time of writing. This project was therefore included in the CEA as a precaution.                                                                                          |
| <b>Coastal Construction</b> |                       |                                 |                                            |                                                                                                          |                                                                                   |                                                                                     |                                                                                                                                                                                                                                                                                                                                                          |
| <b>24/079/SCO</b>           | Scoping               | 41                              | 34                                         | Scoping opinion request to construct an ultra deep-water quay including reclamation, and an access road. | 2027 – 2029                                                                       | Not applicable                                                                      | O&M phase of this project overlaps with the construction phase of the Proposed Development.                                                                                                                                                                                                                                                              |

<sup>1</sup> Buchan OWF is a Tier 2 project as of end of August 2025 as it is now in the planning phase with the EIA Report submitted. However, according to the CEA methodology described in Volume 1, Chapter 4; Environmental Impact Assessment Methodology, this project has remained assessed as a Tier 3 project within the CEA presented here for fish and shellfish ecology.



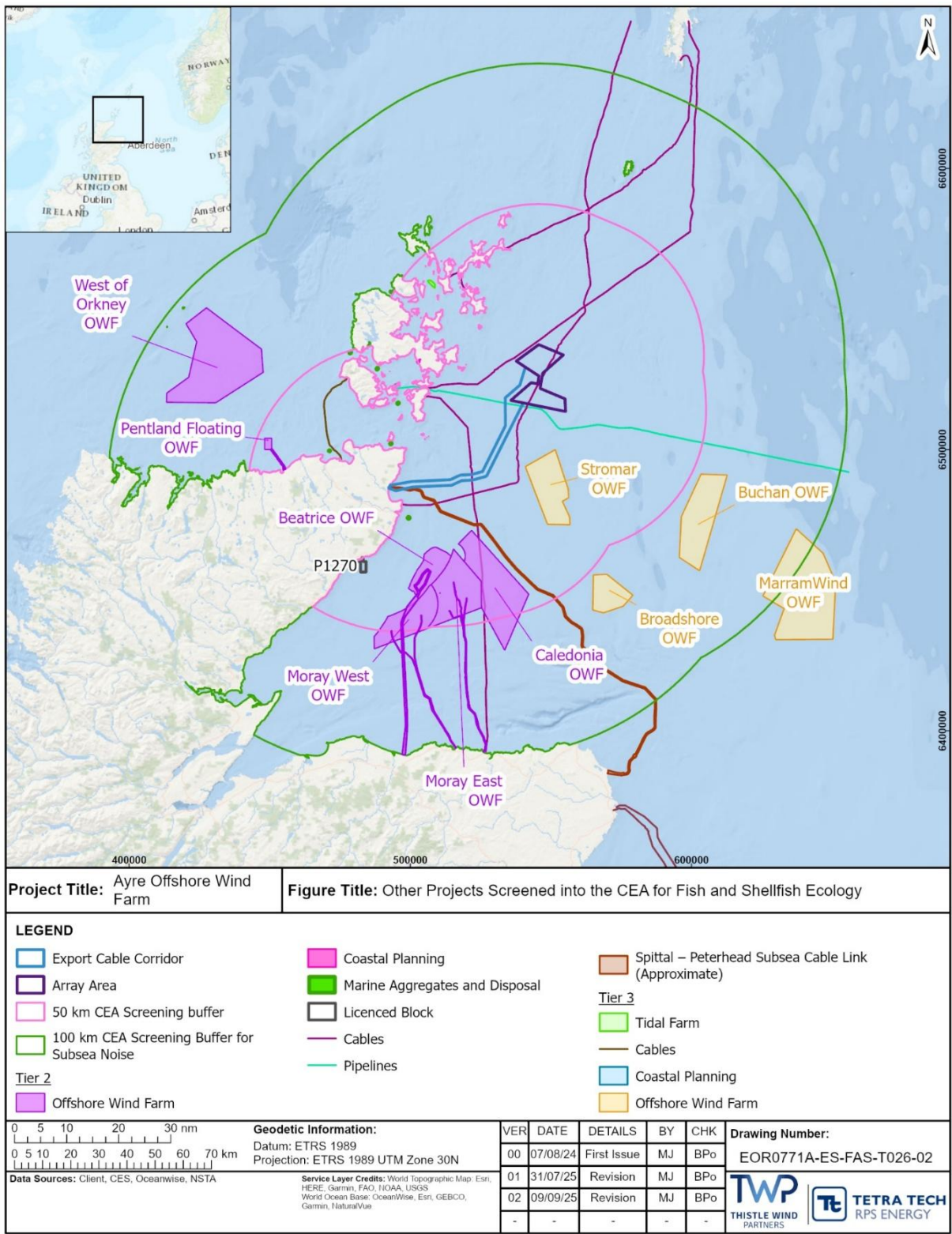


Figure 9.10: Other Projects Screened into the CEA for Fish and Shellfish Ecology

### **Maximum Design Scenario**

- 9.12.8 The MDS identified in Table 9.49 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the details provided in Volume 1, Chapter 3: Project Description as well as the information available on other projects (see Volume 3, Technical Appendix 4.4: Cumulative Effects Screening) to inform an MDS. Any other development scenario within the PDE will result in in the same, or less, level of environmental effect.

**Table 9.49: Maximum Design Scenario Considered for Each Impact as part of the Assessment of Likely Significant Cumulative Effects on Fish and Shellfish Ecology**

| Potential Cumulative Effect                      | Phase* |     |   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------|--------|-----|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                  | C      | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Temporary habitat loss and/or disturbance</b> | ✓      | ✓   | ✓ | <p>The MDS is as detailed for the Proposed Development alone in Table 9.15, cumulatively with the following projects:</p> <p><b>Tier 1</b></p> <ul style="list-style-type: none"> <li>No projects identified.</li> </ul> <p><b>Tier 2</b></p> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Beatrice OWF (decommissioning phase);</li> <li>Beatrice OWF Export Cable Route (decommissioning phase);</li> <li>Caledonia OWF (all phases);</li> <li>Moray East OWF (O&amp;M phase and decommissioning);</li> <li>Moray West OWF (decommissioning phase); and</li> <li>Pentland Floating OWF (O&amp;M and decommissioning phases).</li> </ul> <p><u>Marine Aggregates and Disposal</u></p> <ul style="list-style-type: none"> <li>Tier 2 marine aggregates and disposal projects (ongoing dredging activities).</li> </ul> <p><u>Oil and Gas</u></p> <ul style="list-style-type: none"> <li>Licence P1270 (decommissioning phase).</li> </ul> <p><u>Cables and Pipelines</u></p> <ul style="list-style-type: none"> <li>Tier 2 cable and pipeline projects (O&amp;M phase); and</li> <li>Spittal to Peterhead Subsea Cable Link (construction phase).</li> </ul> <p><b>Tier 3</b></p> | <p>A precautionary buffer of 50 km was used to screen in plans and projects from the CEA long list into the CEA for this impact. The Tier 2 to Tier 4 projects detailed in the previous column have been screened in as they have the potential to cause temporary habitat loss and/or disturbance within their respective footprints and therefore require consideration at a cumulative scale with the Proposed Development. Tier 2 projects which have not assessed this impact (or the parameters associated with it) have not been included in the CEA. For example, the O&amp;M phase of the Moray West OWF overlaps with temporally with the Proposed Development, however Moray West OWF not assess this impact in its O&amp;M phase.</p> |

| Potential Cumulative Effect                      | Phase* |     |   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Justification                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------|--------|-----|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                  | C      | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                                  |        |     |   | <ul style="list-style-type: none"> <li>• Tier 2 Projects.<br/><u>Offshore Wind Projects and Associated Cables</u></li> <li>• Stromar OWF (all phases).<br/><u>Tidal Farms</u></li> <li>• Westray South Tidal Farm (all phases).<br/><u>Coastal Construction</u></li> <li>• 24/079/SCO Scoping Opinion request to construct an ultra deep water quay (construction phase).</li> </ul> <b>Tier 4</b> <ul style="list-style-type: none"> <li>• Tier 2 and 3 Projects.<br/><u>Cables and Pipelines</u></li> <li>• Orkney Connection (all phases).</li> </ul>                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Long term habitat loss and/or disturbance</b> | ✓      | ✓   | ✓ | <p>The MDS is as detailed for the Proposed Development alone in Table 9.15, cumulatively with the following projects:</p> <p><b>Tier 1</b></p> <ul style="list-style-type: none"> <li>• No projects identified.</li> </ul> <p><b>Tier 2</b></p> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>• Beatrice OWF (O&amp;M and decommissioning phases);</li> <li>• Beatrice OWF Export Cable Route (O&amp;M and decommissioning phases);</li> <li>• Caledonia OWF (all phases);</li> <li>• Moray East OWF (O&amp;M and decommissioning phases);</li> <li>• Moray West OWF (O&amp;M and decommissioning phases);</li> </ul> <p>and</p> | <p>A precautionary buffer of 50 km was used to screen in plans and projects from the CEA long list into the CEA for this impact. The Tier 2 to Tier 4 projects detailed in the previous column have been screened in as they have the potential to cause long term habitat loss and/or disturbance within their respective footprints and therefore require consideration at a cumulative scale with the Proposed Development.</p> |

| Potential Cumulative Effect | Phase* |     |   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Justification |
|-----------------------------|--------|-----|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|                             | C      | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |
|                             |        |     |   | <ul style="list-style-type: none"> <li>Pentland Floating OWF (O&amp;M and decommissioning phases).</li> </ul> <u>Coastal Construction</u> <ul style="list-style-type: none"> <li>23/289/NATEIA deep water quay construction (construction phase).</li> </ul> <u>Cables and Pipelines</u> <ul style="list-style-type: none"> <li>Tier 2 cable and pipeline projects (O&amp;M phase); and</li> <li>Spittal to Peterhead Subsea Cable Link (all phases).</li> </ul> <b>Tier 3</b> <ul style="list-style-type: none"> <li>Tier 2 Projects.</li> </ul> <u>Offshore Wind Projects and Associated Cables</u> <ul style="list-style-type: none"> <li>Stromar OWF (all phases).</li> </ul> <u>Tidal Farms</u> <ul style="list-style-type: none"> <li>Westray South Tidal Farm (all phases).</li> </ul> <u>Coastal Construction</u> <ul style="list-style-type: none"> <li>24/079/SCO Scoping Opinion request to construct an ultra deep water quay (construction phase).</li> </ul> <b>Tier 4</b> <ul style="list-style-type: none"> <li>Tier 2 and 3 Projects.</li> </ul> <u>Cables and Pipelines</u> <ul style="list-style-type: none"> <li>Orkney Connection (all phases).</li> </ul> |               |

| Potential Cumulative Effect                                                              | Phase* |     |   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Justification                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------|--------|-----|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                          | C      | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Introduction of artificial habitat and subsequent colonisation of hard structures</b> | ✓      | ✓   | ✓ | <p>The MDS is as detailed for the Proposed Development alone in Table 9.15, cumulatively with the following projects:</p> <p><b>Tier 1</b></p> <ul style="list-style-type: none"> <li>No projects identified.</li> </ul> <p><b>Tier 2</b></p> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Beatrice OWF (decommissioning phase);</li> <li>Beatrice OWF Export Cable Route (decommissioning phase);</li> <li>Caledonia OWF (all phases);</li> <li>Moray East OWF (O&amp;M and decommissioning phases);</li> <li>Moray West OWF (O&amp;M and decommissioning phases); and</li> <li>Pentland Floating OWF (O&amp;M and decommissioning phases).</li> </ul> <p><u>Coastal Construction</u></p> <ul style="list-style-type: none"> <li>23/289/NATEIA deep water quay construction (construction phase).</li> </ul> <p><u>Cables and Pipelines</u></p> <ul style="list-style-type: none"> <li>Tier 2 cable and pipeline projects (O&amp;M phase); and</li> <li>Spittal to Peterhead Subsea Cable Link (all phases).</li> </ul> <p><b>Tier 3</b></p> <ul style="list-style-type: none"> <li>Tier 2 Projects.</li> </ul> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Stromar OWF (all phases).</li> </ul> | <p>A precautionary buffer of 50 km was used to screen in plans and projects from the CEA long list into the CEA for this impact. The Tier 2 to Tier 4 projects detailed in the previous column have been screened in as they have the potential to introduce artificial hard structures within their respective footprints and therefore require consideration at a cumulative scale with the Proposed Development.</p> |



| Potential Cumulative Effect                     | Phase* |     |   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------|--------|-----|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                 | C      | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                 |        |     |   | <u>Tidal Farms</u> <ul style="list-style-type: none"> <li>• Westray South Tidal Farm (all phases).</li> </ul> <u>Coastal Construction</u> <ul style="list-style-type: none"> <li>• 24/079/SCO Scoping Opinion request to construct an ultra deep water quay (construction phase).</li> </ul> <b>Tier 4</b> <ul style="list-style-type: none"> <li>• Tier 2 and 3 Projects.</li> </ul> <u>Cables and Pipelines</u> <ul style="list-style-type: none"> <li>• Orkney Connection (all phases).</li> </ul>                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Increased SSCs and associated deposition</b> | ✓      | x   | x | <p>The MDS is as detailed for the Proposed Development alone in Table 9.15, cumulatively with the following projects:</p> <p><b>Tier 1</b></p> <ul style="list-style-type: none"> <li>• No projects identified.</li> </ul> <p><b>Tier 2</b></p> <u>Marine Aggregates and Disposal</u> <ul style="list-style-type: none"> <li>• South Head - CR009 (ongoing dredging activities).</li> </ul> <u>Cables and Pipelines</u> <ul style="list-style-type: none"> <li>• Spittal to Peterhead Subsea Cable Link (construction phase).</li> </ul> <p><b>Tier 3</b></p> <ul style="list-style-type: none"> <li>• Tier 2 Projects.</li> </ul> <u>Offshore Wind Projects and Associated Cables</u> <ul style="list-style-type: none"> <li>• Stromar OWF (construction phase).</li> </ul> | <p>This impact was informed by Volume 2, Chapter 7: Physical Processes. Therefore, the projects and phases included in the CEA for this impact include only those considered for the same impact in the CEA in Volume 2, Chapter 7: Physical Processes. The screening buffer used was one spring tidal excursion and also incorporated any projects within Sinclair's Bay (see Volume 2, Chapter 7: Physical Processes for further detail).</p> <p>The Tier 2 to Tier 4 projects detailed in the previous column have been screened in as they have the potential to result in increased SSCs and associated</p> |

| Potential Cumulative Effect                                | Phase* |     |   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Justification                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------|--------|-----|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                            | C      | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                            |        |     |   | <b>Tier 4</b> <ul style="list-style-type: none"> <li>No projects identified.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | deposition, and therefore require consideration at a cumulative scale with the Proposed Development.                                                                                                                                                                                                                                                                                       |
| <b>Subsea noise impacting fish and shellfish receptors</b> | ✓      | ✓   | ✓ | <p>The MDS is as detailed for the Proposed Development alone in Table 9.15, cumulatively with the following projects:</p> <p><b>Tier 1</b></p> <ul style="list-style-type: none"> <li>No projects identified.</li> </ul> <p><b>Tier 2</b></p> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Beatrice OWF (decommissioning phase);</li> <li>Caledonia OWF (all phases);</li> <li>Moray East OWF (O&amp;M and decommissioning phases);</li> <li>Moray West OWF (O&amp;M and decommissioning phases);</li> <li>Pentland Floating OWF (O&amp;M and decommissioning phases); and</li> <li>West of Orkney Windfarm (all phases).</li> </ul> <p><b>Tier 3</b></p> <ul style="list-style-type: none"> <li>Tier 2 Projects.</li> </ul> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Broadshore Hub OWFs (O&amp;M and decommissioning phases);</li> <li>Buchan OWF (all phases);</li> <li>Marram OWF (O&amp;M and decommissioning phases); and</li> </ul> | <p>A wider, but still precautionary, buffer of 100 km was used to screen in plans and projects from the CEA long list into the CEA for this impact. The Tier 2 and Tier 3 projects detailed in the previous column have been screened in as they have the potential to generate subsea noise, and therefore require consideration at a cumulative scale with the Proposed Development.</p> |

| Potential Cumulative Effect                               | Phase* |     |   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Justification                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------|--------|-----|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | C      | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                              |
|                                                           |        |     |   | <ul style="list-style-type: none"> <li>Stromar OWF (all phases).</li> </ul> <u>Tidal Farms</u> <ul style="list-style-type: none"> <li>Westray South Tidal Farm (all phases).</li> </ul> <b>Tier 4</b> <ul style="list-style-type: none"> <li>No projects identified.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                              |
| <b>Impacts to fish and shellfish receptors due to EMF</b> | x      | ✓   | x | <p>The MDS is as detailed for the Proposed Development alone in Table 9.15, cumulatively with the following projects:</p> <p><b>Tier 1</b></p> <ul style="list-style-type: none"> <li>No projects identified.</li> </ul> <p><b>Tier 2</b></p> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Beatrice OWF (O&amp;M phase);</li> <li>Beatrice OWF Export Cable Route (O&amp;M phase);</li> <li>Caledonia OWF (O&amp;M phase);</li> <li>Moray East OWF (O&amp;M phase);</li> <li>Moray West OWF (O&amp;M phase); and</li> <li>Pentland Floating OWF (O&amp;M phase).</li> </ul> <p><u>Cables and Pipelines</u></p> <ul style="list-style-type: none"> <li>Tier 2 cable projects (O&amp;M phase); and</li> <li>Spittal to Peterhead Subsea Cable Link (O&amp;M phase).</li> </ul> <p><b>Tier 3</b></p> <ul style="list-style-type: none"> <li>Tier 2 Projects.</li> </ul> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Stromar OWF (O&amp;M phase).</li> </ul> <p><u>Tidal Farms</u></p> | <p>A precautionary buffer of 50 km was used to screen in plans and projects from the CEA long list into the CEA for this impact. The Tier 2 to Tier 4 projects detailed in the previous column have been screened in as they have the potential to release EMFs and therefore require consideration at a cumulative scale with the Proposed Development.</p> |

| Potential Cumulative Effect                                        | Phase* |     |   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Justification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------|--------|-----|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                    | C      | O&M | D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                    |        |     |   | <ul style="list-style-type: none"> <li>Westray South Tidal Farm (O&amp;M phase).</li> </ul> <b>Tier 4</b> <ul style="list-style-type: none"> <li>Tier 2 and 3 Projects.<br/><u>Cables and Pipelines</u></li> <li>Orkney Connection (O&amp;M phase).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Impacts to fish and shellfish receptors due to entanglement</b> | x      | ✓   | x | <p>The MDS is as detailed for the Proposed Development alone in Table 9.15, cumulatively with the following projects:</p> <p><b>Tier 1</b></p> <ul style="list-style-type: none"> <li>No projects identified.</li> </ul> <p><b>Tier 2</b></p> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Caledonia OWF (O&amp;M phase); and</li> <li>Pentland Floating OWF (O&amp;M phase)</li> </ul> <p><b>Tier 3</b></p> <ul style="list-style-type: none"> <li>Tier 2 Projects.</li> </ul> <p><u>Offshore Wind Projects and Associated Cables</u></p> <ul style="list-style-type: none"> <li>Stromar OWF (O&amp;M phase).</li> </ul> <p><u>Tidal Farms</u></p> <ul style="list-style-type: none"> <li>Westray South Tidal Farm (O&amp;M phase).</li> </ul> <p><b>Tier 4</b></p> <ul style="list-style-type: none"> <li>No projects identified.</li> </ul> | <p>A precautionary buffer of 50 km was used to screen in plans and projects from the CEA long list into the CEA for this impact. The Tier 2 and Tier 3 projects detailed in the previous column have been screened in as they could pose a risk of entanglement for fish and shellfish receptors, and therefore require consideration at a cumulative scale with the Proposed Development. These projects were all either floating OWFs or tidal farms, which could have cables and mooring lines within the water column and therefore pose and entanglement risk.</p> |

\* Project Phase refers to construction (C), O&M, and decommissioning (D).

### Cumulative Effects Assessment

- 9.12.9 An assessment of the likely significance of the cumulative effects of the Proposed Development upon fish and shellfish receptors arising from each identified impact is given below.

### TEMPORARY HABITAT LOSS AND/OR DISTURBANCE

#### *Tier 2*

#### *Construction phase*

#### Magnitude of impact

- 9.12.10 The maximum cumulative temporary habitat loss and/or disturbance associated with the Tier 2 projects together with the construction phase of the Proposed Development is estimated at up to 41.09 km<sup>2</sup> (Table 9.50). This represents up to 0.28% of the 50 km CEA screening buffer applied and up to 0.09% of the Fish and Shellfish Ecology Study Area. However, it is important to note that the cumulative footprint of 41.09 km<sup>2</sup> will not be one continuous area. Instead, this footprint is comprised of isolated areas of temporary habitat loss and disturbance over the 50 km CEA screening buffer. The cumulative magnitude of impact of the Proposed Development with Tier 2 projects is therefore not expected to represent a material additional impact to that defined for the assessment of the Proposed Development alone.
- 9.12.11 Site preparation and construction activities associated with the Proposed Development are anticipated to occur intermittently. They will be spread out across the full allotted construction timeframe with a small proportion of the total area being affected at any one time. Given that the activities with the potential for temporary habitat loss and disturbance associated with the Tier 2 projects will occur intermittently at their respective locations, the cumulative impact will also be temporally intermittent. There will be no spatial overlap between the Site Boundary and the majority of the Tier 2 projects, except the Spittal to Peterhead Subsea Cable Link, Piper B Oil Pipeline, Shefa-2 Seg 9 Cable and the Shetland HVDC Cable (see Figure 9.10 and Table 9.48), and this overlap is limited to the locations that these cables and pipelines intersect with the Proposed Development.
- 9.12.12 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

**Table 9.50: Cumulative Footprint of Temporary Habitat Loss and/or Disturbance for the Tier 2 Projects overlapping with the Construction Phase of the Proposed Development**

| Project                                               | MDS                                                                                                                                                                                                                                                                                                                                               | Component Parts of Temporary Habitat Loss and/or Disturbance                                        | Reference                                                                            |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Proposed Development</b>                           | 18,000,341.50 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                      | See Table 9.15                                                                                      | N/A                                                                                  |
| <b>Offshore Wind Projects and Associated Cables</b>   |                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                      |
| <b>Caledonia OWF</b>                                  | Construction: 17,603,592 m <sup>2</sup>                                                                                                                                                                                                                                                                                                           | Foundation installation, jack-up vessel use, anchoring, seabed preparation, and cable installation. | Caledonia OWF Ltd (2024b), Caledonia OWF Ltd (2024c)                                 |
|                                                       | O&M: 815,800 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                       | Jack-up vessel use for repairs, cable repair and reburial activities.                               |                                                                                      |
| <b>Moray East OWF</b>                                 | O&M: 711,900 m <sup>2</sup> for the Moray East OWF Array, however values of temporary habitat loss and disturbance during the O&M phase were not provided or assessed for the Moray East OWF Transmission Infrastructure.                                                                                                                         | Jack-up vessel use for repairs.                                                                     | Moray Offshore Renewables Limited (2019b), Moray Offshore Renewables Limited (2019c) |
| <b>Pentland Floating OWF</b>                          | O&M: 2,205,000 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                     | Temporary seabed disturbance from lateral movement of mooring lines.                                | Pentland Floating OWF (2022a)                                                        |
| <b>Marine Aggregates and Disposal</b>                 |                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                      |
| <b>Tier 2 marine aggregates and disposal projects</b> | Ongoing dredging activities: there are no footprints of disturbance available for any of these projects. However, due to the limited nature of aggregates and disposal sites, these are not expected to be similar to nor exceed the footprints of temporary disturbance listed above for the Proposed Development and other Tier 2 OWF projects. | Dredging and disposal activities.                                                                   | N/A                                                                                  |



| Project                                   | MDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Component Parts of Temporary Habitat Loss and/or Disturbance                                                         | Reference                                   |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| <b>Oil and Gas</b>                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                      |                                             |
| <b>Licence P1270</b>                      | Decommissioning:<br>No information is currently available on the decommissioning activities on the Oil and Gas Licence P1270, but the precautionary approach of assuming all infrastructure will be removed means this could cause a potential cumulative temporary habitat loss and/or disturbance with the Proposed Development. However, based on this development being 26.22 km from the Site Boundary, any temporary habitat loss is unlikely to physically overlap, and therefore the cumulative increase is likely to be minimal. | Likely to be from disturbance due to infrastructure removal and any associated jack-up vessel and anchor placements. | North Sea Transition Authority (NSTA, 2025) |
| <b>Cables and Pipelines</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                      |                                             |
| <b>Tier 2 cable and pipeline projects</b> | O&M: there is no publicly available information on footprints of disturbance associated with the O&M activities of the Tier 2 cable and pipeline projects. These are likely to include cable and pipeline repair and reburial events. However, this is expected to be similar or lesser than the footprints of temporary disturbance listed above for the Proposed Development and other Tier 2 OWF projects.                                                                                                                             | Cable repair and reburial.                                                                                           | N/A                                         |

| Project                                                     | MDS                                                      | Component Parts<br>of Temporary<br>Habitat Loss and/or Disturbance | Reference                                                                       |
|-------------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------|
| <b>Spittal to Peterhead Subsea<br/>Cable Link</b>           | Construction: 1,755,126 m <sup>2</sup>                   | Cable installation                                                 | Scottish and Southern<br>Electricity Networks<br>Transmission (SSENT)<br>(2025) |
| <b>Total (Proposed Development<br/>and Tier 2 Projects)</b> | <b>41,091,759.5 m<sup>2</sup> (41.09 km<sup>2</sup>)</b> |                                                                    |                                                                                 |

Sensitivity of receptor

- 9.12.13 The sensitivity of the receptor is as defined in Paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

Significance of effect

- 9.12.14 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.15 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.16 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the embedded measures outlined in Section 9.9) is not significant in EIA terms.

*O&M phase*

Magnitude of impact

- 9.12.17 There were several Tier 2 projects with the potential for cumulative temporary habitat loss and/or disturbance during the O&M phase of the Proposed Development (Table 9.51). The maximum total temporary habitat loss and/or disturbance associated with the Tier 2 projects together with the Proposed Development in the O&M phase is estimated at up to 39.39 km<sup>2</sup> (Table 9.51). This represents up to 0.26% of the 50 km CEA screening buffer applied and up to 0.09% of the Fish and Shellfish Ecology Study Area. This may be an underestimation due to the lack of information available on footprints of temporary habitat loss and disturbance for some of the Tier 2 projects (see Table 9.51). It is important to note that the cumulative footprint of 39.39 km<sup>2</sup> will not be one continuous area. Instead, this footprint is comprised of isolated temporary habitat loss and disturbance over the 50 km CEA screening buffer. The cumulative magnitude of impact of the Proposed Development with the Tier 2 projects is therefore not expected to represent a material additional impact to that defined for the assessment of the Proposed Development alone.
- 9.12.18 O&M activities resulting in temporary habitat loss and/or disturbance associated with the Proposed Development are anticipated to occur intermittently. They will be spread out across the full 30-year O&M phase with only a small proportion of the total area for this impact being affected at any one time. Based on the similar O&M activities associated with the Tier 2 projects (Table 9.51), it is likely that they will also occur

intermittently in their respective areas. There will be no spatial overlap between the Site Boundary and the majority of the Tier 2 projects, except the Piper B Oil Pipeline, Shefa-2 Seg 9 Cable and the Shetland HVDC Cable (see Figure 9.10 and Table 9.48).

**Table 9.51: Cumulative Footprint of Temporary Habitat Loss and/or Disturbance for the Tier 2 Projects overlapping with the O&M Phase of the Proposed Development**

| Project                                             | MDS                                                                                                                          | Component Parts of Temporary Habitat Loss and/or Disturbance                   | Reference                                            |
|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------------------|
| <b>Proposed Development</b>                         | 2,632,500 m <sup>2</sup>                                                                                                     | See Table 9.15                                                                 | N/A                                                  |
| <b>Offshore Wind Projects and Associated Cables</b> |                                                                                                                              |                                                                                |                                                      |
| <b>Beatrice OWF</b>                                 | Decommissioning: less than or equal to that of the construction phase for the cable installation (1,640,000 m <sup>2</sup> ) | Cable removal.                                                                 | Beatrice OWF Limited (2012c)                         |
| <b>Beatrice OWF Export Cable Route</b>              | Decommissioning: less than or equal to that of the construction phase for the cable installation (2,330,000 m <sup>2</sup> ) | Cable removal.                                                                 |                                                      |
| <b>Caledonia OWF</b>                                | O&M: 815,800 m <sup>2</sup>                                                                                                  | Jack-up vessel use for repairs, cable repair and reburial activities.          | Caledonia OWF Ltd (2024b), Caledonia OWF Ltd (2024c) |
|                                                     | Decommissioning: less than or equal to that of the construction phase (17,603,592 m <sup>2</sup> )                           | Removal of infrastructure and associated jack-up vessel and anchor placements. |                                                      |
| <b>Moray East OWF</b>                               | O&M: 711,900 m <sup>2</sup>                                                                                                  | Jack-up vessel use for repairs                                                 | Moray Offshore Renewables Limited (2019b)            |
|                                                     | Decommissioning: less than or equal to that of the construction phase (5,990,000 m <sup>2</sup> )                            | Removal of infrastructure and associated jack-up vessel and anchor placements. |                                                      |
| <b>Moray West OWF</b>                               | Decommissioning: 6,940,059 m <sup>2</sup> .                                                                                  | Removal of infrastructure and associated jack-up vessel placements.            | Moray West OWF Limited (2018)                        |
| <b>Pentland Floating OWF</b>                        | Decommissioning: Footprints were not provided; however, they were considered to be less than presented for the construction  | Removal of infrastructure and associated jack-up vessel and anchor placements. | Pentland Floating OWF (2022a)                        |

| Project                                                 | MDS                                                                                                                                                                                                                                                                                                                                                                                                           | Component Parts of Temporary Habitat Loss and/or Disturbance | Reference |
|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|-----------|
|                                                         | phase (731,700 m <sup>2</sup> ), which included seabed preparation activities, which would not occur during decommissioning.                                                                                                                                                                                                                                                                                  |                                                              |           |
| <b>Marine Aggregates and Disposal</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                               |                                                              |           |
| <b>Tier 2 marine aggregates and disposal projects</b>   | Ongoing dredging activities: there are no footprints of disturbance available for any of these projects. However, due to the limited nature of aggregates and disposal sites, these are not expected to be similar to nor exceed the footprints of temporary disturbance listed above for the Proposed Development and other Tier 2 OWF projects.                                                             | Dredging and disposal activities.                            | N/A       |
| <b>Cables and Pipelines</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                               |                                                              |           |
| <b>Tier 2 cable and pipeline projects</b>               | O&M: there is no publicly available information on footprints of disturbance associated with the O&M activities of the Tier 2 cable and pipeline projects. These are likely to include cable and pipeline repair and reburial events. However, this is expected to be similar or lesser than the footprints of temporary disturbance listed above for the Proposed Development and other Tier 2 OWF projects. | Cable repair and reburial.                                   | N/A       |
| <b>Total (Proposed Development and Tier 2 Projects)</b> | <b>39,395,551 m<sup>2</sup> (39.39 km<sup>2</sup>)</b>                                                                                                                                                                                                                                                                                                                                                        |                                                              |           |



- 9.12.19 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.20 The sensitivity of the receptor is as defined in Paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

Significance of effect

- 9.12.21 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.12.22 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.23 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

*Decommissioning phase*

Magnitude of impact

- 9.12.24 There were several Tier 2 projects with the potential for cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development (Table 9.52). The maximum total temporary habitat loss and/or disturbance associated with the Tier 2 projects together with the Proposed Development in the decommissioning phase is estimated at up to 35.60 km<sup>2</sup> (Table 9.52). This represents up to 0.22% of the 50 km CEA screening buffer applied and up to 0.08% of the Fish and Shellfish Ecology Study Area. This may be an underestimation due to the lack of information available on footprints of temporary habitat loss and disturbance for some of the Tier 2 projects (see Table 9.52). It is important to note that the cumulative footprint of 35.60 km<sup>2</sup> will not be one continuous area. Instead, this footprint is comprised of isolated temporary habitat loss and disturbance over the 50 km CEA screening buffer. The cumulative magnitude of impact of the Proposed Development with the Tier 2 projects is therefore not expected to represent a material additional impact to that defined for the assessment of the Proposed Development alone.
- 9.12.25 Decommissioning activities resulting in temporary habitat loss and/or disturbance associated with the Proposed Development are anticipated

to occur intermittently, with only a small proportion of the total area for this impact being affected at any one time. Based on the similar activities associated with the Tier 2 projects in this phase (Table 9.51), it is likely that they will also occur intermittently in their respective areas. It is likely that this will be similar for the activities at the Tier 2 projects which may also result in temporary habitat loss and/or disturbance during this phrase. There will be no spatial overlap between the Site Boundary and the majority of the Tier 2 projects, except the Piper B Oil Pipeline, Shefa-2 Seg 9 Cable and the Shetland HVDC Cable (see Figure 9.10 and Table 9.48).

- 9.12.26 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

**Table 9.52: Cumulative Footprint of Temporary Habitat Loss and/or Disturbance for the Tier 2 Projects overlapping with the Decommissioning Phase of the Proposed Development**

| Project                                               | MDS                                                                                                                                                                                                                                                                                                                                                                | Component Parts of Temporary Habitat Loss and/or Disturbance                                                       | Reference                 |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------|
| <b>Proposed Development</b>                           | No greater than that of the construction phase, but likely to be lower:<br>18,000,341.50 m <sup>2</sup>                                                                                                                                                                                                                                                            | See Table 9.15                                                                                                     | N/A                       |
| <b>Offshore Wind Projects and Associated Cables</b>   |                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |                           |
| <b>Caledonia OWF</b>                                  | Decommissioning: less than or equal to that of the construction phase<br>(17,603,592 m <sup>2</sup> )                                                                                                                                                                                                                                                              | Removal of infrastructure and associated jack-up vessel and anchor placements.                                     | Caledonia OWF Ltd (2024c) |
| <b>Marine Aggregates and Disposal</b>                 |                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |                           |
| <b>Tier 2 marine aggregates and disposal projects</b> | Ongoing dredging activities: there are no footprints of disturbance available for any of these projects. However, due to the limited nature of aggregates and disposal sites, these are not expected to be similar to nor exceed the footprints of temporary disturbance listed above for the Proposed Development and other Tier 2 OWF projects.                  | Dredging and disposal activities.                                                                                  | N/A                       |
| <b>Cables and Pipelines</b>                           |                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |                           |
| <b>Tier 2 cable and pipeline projects</b>             | O&M: there is no publicly available information on footprints of disturbance associated with the O&M activities of the Tier 2 cable and pipeline projects. These are likely to include cable and pipeline repair and reburial events. However, this is expected to be similar or lesser than the footprints of temporary disturbance listed above for the Proposed | Cable repair and reburial (and potential for decommissioning, however details of this are not publicly available). | N/A                       |

| Project                                                 | MDS                                                      | Component Parts<br>of Temporary<br>Habitat Loss and/or Disturbance | Reference |
|---------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------|-----------|
|                                                         | Development and other Tier 2 OWF projects.               |                                                                    |           |
| <b>Total (Proposed Development and Tier 2 Projects)</b> | <b>35,603,933.5 m<sup>2</sup> (35.60 km<sup>2</sup>)</b> |                                                                    |           |

Sensitivity of receptor

- 9.12.27 The sensitivity of the receptor is as defined in paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

Significance of effect

- 9.12.28 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.29 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.30 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

***Tier 3***

*Construction phase*

Magnitude of impact

- 9.12.31 In addition to the Tier 2 projects, there were three Tier 3 projects with the potential for cumulative temporary habitat loss and/or disturbance during the construction phase of the Proposed Development:
- Stromar OWF (possibly in its construction and O&M phase);
  - Westray South Tidal Farm (possibly in its construction and O&M phase); and
  - 24/079/SCO Scoping Opinion request to construct an ultra deep water quay (construction phase) (Table 9.49).
- 9.12.32 There is limited publicly available information to define footprints of temporary habitat loss and/or disturbance for these projects. Temporary habitat loss and/or disturbance associated with the Stromar OWF is expected to be similar in nature and extent to that calculated for the Proposed Development and/or the Tier 2 OWF developments detailed in Table 9.50. Footprints of impact associated with the Westray South Tidal Farm and the ultra deep water quay construction are likely to be of a lower extent to those calculated for the Proposed Development or the other Tier 2 OWF developments. As with the Proposed Development and the Tier 2 projects, the site preparation and construction activities of the Tier 3 projects are expected to be intermittent, temporary and reversible (such as cable installation, seabed preparation, and jack-up vessel use).
- 9.12.33 As with the Tier 2 projects, it is important to note that cumulative temporary habitat loss and/or disturbance associated with the Tier 3

projects will not be one continuous area. Instead, this footprint will be comprised of isolated temporary habitat loss and disturbance over the 50 km CEA screening buffer. There will also be no spatial overlap between the Site Boundary and the Tier 3 projects (Figure 9.10). The cumulative magnitude of impact of the Tier 3 projects, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 projects.

- 9.12.34 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.35 The sensitivity of the receptor is as defined in Paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

Significance of effect

- 9.12.36 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.37 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.38 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

*O&M phase*

Magnitude of impact

- 9.12.39 In addition to the Tier 2 projects, there were two Tier 3 projects with the potential for cumulative temporary habitat loss and/or disturbance during the O&M phase of the Proposed Development:
- Stromar OWF (likely in its O&M phase); and
  - Westray South Tidal Farm (likely in its O&M phase) (Table 9.49).
- 9.12.40 There is limited publicly available information to define footprints of temporary habitat loss and/or disturbance for these projects. Temporary habitat loss and/or disturbance associated with the Stromar OWF is expected to be similar in nature and extent to that calculated for the Proposed Development and/or the Tier 2 OWF developments detailed in Table 9.51. Footprints of impact associated with the Westray South Tidal Farm are likely to be of a lower extent to those calculated for the



Proposed Development or the other Tier 2 OWF developments. As with the Proposed Development and the Tier 2 projects, the O&M activities of the Tier 3 projects are expected to be intermittent, temporary and reversible (such as cable repairs and reburial).

9.12.41 As with the Tier 2 projects, it is important to note that cumulative temporary habitat loss and/or disturbance associated with the Tier 3 projects will not be one continuous area. Instead, this footprint will be comprised of isolated temporary habitat loss and disturbance over the 50 km CEA screening buffer. There will also be no spatial overlap between the Site Boundary and the Tier 3 projects (Figure 9.10). The cumulative magnitude of impact of the Tier 3 projects, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 projects.

9.12.42 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

9.12.43 The sensitivity of the receptor is as defined in Paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

Significance of effect

9.12.44 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

9.12.45 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

9.12.46 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

*Decommissioning phase*

Magnitude of impact

9.12.47 In addition to the Tier 2 projects, there were two Tier 3 projects with the potential for cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development:

- Stromar OWF (possibly in its O&M and decommissioning phases); and
- Westray South Tidal Farm (possibly in its O&M and decommissioning phases) (Table 9.49).

- 9.12.48 There is limited publicly available information to define footprints of temporary habitat loss and/or disturbance for these projects. Temporary habitat loss and/or disturbance associated with the Stromar OWF is expected to be similar in nature and extent to that calculated for the Proposed Development and/or the Tier 2 OWF developments detailed in Table 9.52. Footprints of impact associated with the Westray South Tidal Farm are likely to be of a lower extent to those calculated for the Proposed Development or the other Tier 2 OWF developments. As with the Proposed Development and the Tier 2 projects, the decommissioning activities of the Tier 3 projects are expected to be intermittent, temporary and reversible (such as infrastructure removal).
- 9.12.49 As with the Tier 2 projects, it is important to note that cumulative temporary habitat loss and/or disturbance associated with the Tier 3 projects will not be one continuous area. Instead, this footprint will be comprised of isolated temporary habitat loss and disturbance over the 50 km CEA screening buffer. There will also be no spatial overlap between the Site Boundary and the Tier 3 projects (Figure 9.10). The cumulative magnitude of impact of the Tier 3 projects, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 projects.
- 9.12.50 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.51 The sensitivity of the receptor is as defined in Paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

Significance of effect

- 9.12.52 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.53 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.54 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

#### ***Tier 4***

##### *Construction phase*

##### Magnitude of impact

- 9.12.55 In addition to the Tier 2 and 3 projects, there was one Tier 4 project with the potential for cumulative temporary habitat loss and/or disturbance during the construction phase of the Proposed Development:
- Orkney Connection (possibly in its construction and O&M phase) (Table 9.49).
- 9.12.56 As a Tier 4 project, there was no publicly available parameters to define footprints of temporary habitat loss and/or disturbance and cannot be combined with those of the Proposed Development and the Tier 2 projects.
- 9.12.57 It is possible that the construction and/or O&M phases of this cable project could overlap with the construction phase of the Proposed Development. However, given that this is a Tier 4 project, there is no information on the footprints of temporary habitat loss and/or disturbance currently available. It has reasonably been assumed that this these would be of a similar extent to those associated with the Export Cable Corridor (see Table 9.15). As with the Proposed Development and the Tier 2 and 3 projects, the site preparation and construction activities of the Tier 4 project are expected to be intermittent, temporary and reversible (such as cable installation, seabed preparation, and jack-up vessel use).
- 9.12.58 As with the Tier 2 and 3 projects, it is important to note that cumulative temporary habitat loss and/or disturbance associated with the Tier 4 project will not be one continuous area. Instead, this footprint will be comprised of isolated temporary habitat loss and disturbance over the 50 km CEA screening buffer. The cumulative magnitude of impact of the Tier 4 project, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 and 3 projects.
- 9.12.59 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

##### Sensitivity of receptor

- 9.12.60 The sensitivity of the receptor is as defined in Paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

##### Significance of effect

- 9.12.61 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be

medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.12.62 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.63 No Additional mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

*O&M phase*

Magnitude of impact

- 9.12.64 In addition to the Tier 2 and 3 projects, there was one Tier 4 project with the potential for cumulative temporary habitat loss and/or disturbance during the O&M phase of the Proposed Development:
- Orkney Connection (possibly in its construction and O&M phase) (Table 9.49).
- 9.12.65 There is limited publicly available information to define footprints of temporary habitat loss and/or disturbance for this project. It is possible that the construction and/or O&M phases of this cable project could overlap with the O&M phase of the Proposed Development. However, given that this is a Tier 4 project, there is no information on the footprints of temporary habitat loss and/or disturbance currently available. It has reasonably been assumed that these would be of a similar extent to those associated with the Export Cable Corridor (see Table 9.15). As with the Proposed Development and the Tier 2 and 3 projects, the O&M activities of the Tier 4 project are expected to be intermittent, temporary and reversible (such as cable repair and reburial).
- 9.12.66 As with the Tier 2 and 3 projects, it is important to note that cumulative temporary habitat loss and/or disturbance associated with the Tier 4 project will not be one continuous area. Instead, this footprint will be comprised of isolated temporary habitat loss and disturbance over the 50 km CEA screening buffer. The cumulative magnitude of impact of the Tier 4 project, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 and 3 projects.
- 9.12.67 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.68 The sensitivity of the receptor is as defined in Paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

Significance of effect

- 9.12.69 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.70 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.71 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the embedded measures outlined in Section 9.9) is not significant in EIA terms.

*Decommissioning phase*

Magnitude of impact

- 9.12.72 In addition to the Tier 2 and 3 projects, there was one Tier 4 project with the potential for cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development:
- Orkney Connection (possibly in its O&M and/or decommissioning phases) (Table 9.49).
- 9.12.73 There is limited publicly available information to define footprints of temporary habitat loss and/or disturbance for these projects. It is possible that the O&M and/or decommissioning phases of these cable projects could overlap with the decommissioning phase of the Proposed Development. However, given that this is a Tier 4 project, there is no information on the footprints of temporary habitat loss and/or disturbance currently available. It has reasonably been assumed that these would be of a similar extent to those associated with the Export Cable Corridor (see Table 9.15). As with the Proposed Development and the Tier 2 and 3 projects, the decommissioning activities of the Tier 4 project are expected to be intermittent, temporary and reversible (such as infrastructure removal).
- 9.12.74 As with the Tier 2 and 3 projects, it is important to note that cumulative temporary habitat loss and/or disturbance associated with the Tier 4 project will not be one continuous area. Instead, this footprint will be comprised of isolated temporary habitat loss and disturbance over the 50 km CEA screening buffer. The cumulative magnitude of impact of the Tier 4 project, therefore, represents no additional material impact to that

defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 and 3 projects.

- 9.12.75 The cumulative impact is predicted to be of local spatial extent, medium term duration, intermittent, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.76 The sensitivity of the receptor is as defined in Paragraphs 9.10.12 to 9.10.36 above for the alone assessment.

Significance of effect

- 9.12.77 Overall, for the sandeel IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.12.78 For all other fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.79 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

## **LONG TERM HABITAT LOSS AND/OR DISTURBANCE**

### ***Tier 2***

#### *Construction, O&M and decommissioning phases*

Magnitude of impact

- 9.12.80 There were several Tier 2 projects with the potential for cumulative long term habitat loss and/or disturbance during the construction, O&M, and decommissioning phases of the Proposed Development (Table 9.53). Finalised decommissioning plans are not available/quantified for the Proposed Development and Tier 2 projects. Although infrastructure may be removed during their respective decommissioning phases, as a precautionary measure, it has been assumed that infrastructure will be left *in situ*, and the cumulative long term habitat loss and/or disturbance footprint will persist into and beyond the decommissioning phase of the Proposed Development (Table 9.53). Hence, all three phases have been combined for this cumulative impact.
- 9.12.81 The maximum cumulative long term habitat loss and/or disturbance associated with the Tier 2 projects together with that of the Proposed Development is estimated at up to 22.25 km<sup>2</sup> (Table 9.53). This represents

up to 0.15% of the 50 km CEA screening buffer applied and up to 0.05% of the Fish and Shellfish Ecology Study Area. It is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of habitat loss and/or disturbance across the 50 km CEA screening buffer. There will be no spatial overlap between the Site Boundary and the majority of Tier 2 projects, except the Spittal to Peterhead Subsea Cable Link, Piper B Oil Pipeline, Shefa-2 Seg 9 Cable and the Shetland HVDC Cable (see Figure 9.10 and Table 9.48). The cumulative magnitude of impact of the Proposed Development with the Tier 2 projects is therefore not expected to represent a material additional impact to that defined for the assessment of the Proposed Development alone.

- 9.12.82 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.



**Table 9.53: Cumulative Footprint of Long Term Habitat Loss and/or Disturbance for the Tier 2 Projects Overlapping with the Construction, O&M, and Decommissioning Phases of the Proposed Development**

| Project                                             | MDS                                                                                                                                                                                      | Component Parts of Long Term Habitat Loss and/or Disturbance                                        | Reference                                 |
|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------|
| <b>Proposed Development</b>                         | 3,042,840 m <sup>2</sup>                                                                                                                                                                 | See Table 9.15                                                                                      | N/A                                       |
| <b>Offshore Wind Projects and Associated Cables</b> |                                                                                                                                                                                          |                                                                                                     |                                           |
| <b>Beatrice OWF</b>                                 | O&M: 3,800,000 m <sup>2</sup>                                                                                                                                                            | Footprint of all turbine and OSP foundations and associated scour protection, and cable mattresses. | Beatrice OWF Limited (2012a)              |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of long term habitat loss persisting in decommissioning used as a precautionary approach. |                                                                                                     |                                           |
| <b>Beatrice OWF Export Cable Route</b>              | O&M: 260,000 m <sup>2</sup>                                                                                                                                                              | Worst case scenario cable protection through rock armouring or concrete mattresses.                 | Beatrice OWF Limited (2012c)              |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of long term habitat loss persisting in decommissioning used as a precautionary approach. |                                                                                                     |                                           |
| <b>Caledonia OWF</b>                                | Construction and O&M: 9,366,000 m <sup>2</sup>                                                                                                                                           | Footprint of all WTG and OSP foundations and associated scour protection, and cable protection.     | Caledonia OWF Ltd (2024c)                 |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of long term habitat loss persisting in decommissioning used as a precautionary approach. |                                                                                                     |                                           |
| <b>Moray East OWF Array</b>                         | O&M: 3,760,000 m <sup>2</sup>                                                                                                                                                            | Footprint of all gravity base foundations, turbines and all                                         | Moray Offshore Renewables Limited (2019b) |
|                                                     | Decommissioning: detailed methods for decommissioning phase not                                                                                                                          |                                                                                                     |                                           |

| Project                                    | MDS                                                                                                                                                                                       | Component Parts of Long Term Habitat Loss and/or Disturbance                                                                                                                             | Reference                                       |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
|                                            | developed; worst case scenario of long term habitat loss persisting in decommissioning used as a precautionary approach.                                                                  | associated scour protection, and cable protection.                                                                                                                                       |                                                 |
| Moray East OWF Transmission                | O&M: 580,000 m <sup>2</sup>                                                                                                                                                               | Footprint of OSP/converter foundations and associated scour protection, OSPs, Alternating Current/Direct Current (AC/DC) converters, cable protection and use of rock cutting equipment. | Moray Offshore Renewables Limited (2019d)       |
|                                            | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of long term habitat loss persisting in decommissioning used as a precautionary approach.  |                                                                                                                                                                                          |                                                 |
| Moray West OWF                             | O&M: 630,716 m <sup>2</sup>                                                                                                                                                               | Footprint of gravity base foundations and associated scour protection, OSP foundations and associated scour protection, and cable protection                                             | Moray West Offshore Windfarm Limited (2018)     |
|                                            | Decommissioning: detailed methods for decommissioning phase not quantified; worst case scenario of long term habitat loss persisting in decommissioning used as a precautionary approach. |                                                                                                                                                                                          |                                                 |
| Pentland Floating OWF                      | O&M: 307,090 m <sup>2</sup>                                                                                                                                                               | Combined permanent footprint of infrastructure associated with the Array Area and export cables.                                                                                         | Pentland Floating OWF (2022a)                   |
|                                            | Decommissioning: detailed methods for decommissioning phase not quantified; worst case scenario of long term habitat loss persisting in decommissioning used as a precautionary approach. |                                                                                                                                                                                          |                                                 |
| Coastal Construction                       |                                                                                                                                                                                           |                                                                                                                                                                                          |                                                 |
| 23/289/NATEIA deep water quay construction | Construction: 191,000 m <sup>2</sup>                                                                                                                                                      | Footprint of quayside and quay extension, and laydown of rock armour revetments                                                                                                          | Orkney Islands Council Harbour Authority (2024) |

| Project                                          | MDS                                                                                                                                                                                                                                                                                        | Component Parts of Long Term Habitat Loss and/or Disturbance                                                                                                               | Reference    |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Cables and Pipelines                             |                                                                                                                                                                                                                                                                                            |                                                                                                                                                                            |              |
| Tier 2 cable and pipeline projects               | O&M: there is no publicly available information on footprints of disturbance associated with these cable projects. However, this is expected to be similar or lesser than the footprints of long term disturbance listed above for the Proposed Development and other Tier 2 OWF projects. | Cable protection                                                                                                                                                           | N/A          |
| Spittal to Peterhead Subsea Cable Link           | Construction and O&M: 308,374 m <sup>2</sup>                                                                                                                                                                                                                                               | Footprint of rock placement and concrete mattresses installed in the construction phase which will persist into the O&M phase and possibly into the decommissioning phase. | SSENT (2025) |
|                                                  | Decommissioning: detailed methods for decommissioning phase not quantified; worst case scenario of long term habitat loss persisting in decommissioning used as a precautionary approach.                                                                                                  |                                                                                                                                                                            |              |
| Total (Proposed Development and Tier 2 Projects) | 22,246,020 m <sup>2</sup> (22.25 km <sup>2</sup> )                                                                                                                                                                                                                                         |                                                                                                                                                                            |              |

Sensitivity of receptor

- 9.12.83 The sensitivity of the receptor is as defined in Paragraphs 9.10.57 to 9.10.73 above for the alone assessment.

Significance of effect

- 9.12.84 Overall, for the herring and sandeel IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.85 For all remaining fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.86 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

**Tier 3**

*Construction, O&M and decommissioning phases*

Magnitude of impact

- 9.12.87 In addition to the Tier 2 projects, there were three Tier 3 projects with the potential for cumulative long term habitat loss and/or disturbance during the construction, O&M and decommissioning phases of the Proposed Development:
- Stromar OWF (possibly in its construction, O&M and decommissioning phases);
  - Westray South Tidal Farm (possibly in its construction, O&M and decommissioning phases); and
  - 24/079/SCO Scoping Opinion request to construct an ultra deep water quay (construction phase) (Table 9.49).
- 9.12.88 There is limited publicly available information to define footprints of temporary habitat loss and/or disturbance for these projects. Long term habitat loss and/or disturbance associated with the Stromar OWF is expected to be similar in nature and extent to that calculated for the Proposed Development and/or the Tier 2 OWF developments detailed in Table 9.53. Footprints of impact associated with the Westray South Tidal Farm and the ultra deep water quay construction are likely to be of a lower extent to those calculated for the Proposed Development or the other Tier 2 OWF developments.
- 9.12.89 As with the Tier 2 projects, it is important to note that the cumulative footprint will not be one continuous area, but comprised of isolated areas of long term habitat loss and/or disturbance across the 50 km CEA

screening buffer. There will also be no spatial overlap between the Site Boundary and the Tier 3 projects (Figure 9.10). The cumulative magnitude of impact of the Tier 3 projects, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 projects.

- 9.12.90 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.91 The sensitivity of the receptor is as defined in Paragraphs 9.10.57 to 9.10.73 above for the alone assessment.

Significance of effect

- 9.12.92 Overall, for the herring and sandeel IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.93 For all remaining fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.94 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

***Tier 4***

*Construction, O&M and decommissioning phases*

Magnitude of impact

- 9.12.95 In addition to the Tier 2 and 3 projects, there was one Tier 4 project with the potential for cumulative long term habitat loss and/or disturbance during the construction, O&M, and decommissioning phases of the Proposed Development:
- Orkney Connection (possibly in its construction, O&M and decommissioning phases) (Table 9.49).
- 9.12.96 There is limited publicly available information to define footprint of temporary habitat loss and/or disturbance for this project. It is possible that the construction, O&M and/or decommissioning phases of these cable projects could overlap with the construction, O&M and/or decommissioning phases of the Proposed Development. However, given that this is a Tier 4 project, there is no information on the footprint of long term habitat loss and/or disturbance currently available. It has

reasonably been assumed that these would be of a similar extent to those associated with the Export Cable Corridor (Table 9.15).

9.12.97 As with the Tier 2 and 3 projects, it is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of long term habitat loss and/or disturbance across the 50 km CEA screening buffer. The cumulative magnitude of impact of the Tier 4 project, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 projects.

9.12.98 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

9.12.99 The sensitivity of the receptor is as defined in Paragraphs 9.10.57 to 9.10.73 above for the alone assessment.

Significance of effect

9.12.100 Overall, for the herring and sandeel IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

9.12.101 For all remaining fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

9.12.102 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

## **INTRODUCTION OF ARTIFICIAL HABITAT AND SUBSEQUENT COLONISATION OF HARD STRUCTURES**

### ***Tier 2***

#### *Construction and O&M phases*

Magnitude of impact

9.12.103 There were several Tier 2 projects with the potential for cumulative effect associated with the introduction of artificial hard structures and subsequent colonisation during the construction and O&M phases of the Proposed Development (Table 9.54). The maximum cumulative footprint for introduction of artificial structures and subsequent colonisation associated with the Tier 2 projects together with the construction and O&M phases of the Proposed Development is estimated at up to 22.40 km<sup>2</sup>

(Table 9.54). This represents up to 0.15% of the 50 km CEA screening buffer applied and up to 0.05% of the Fish and Shellfish Ecology Study Area. It is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of introduced artificial structures and their subsequent colonisation across the 50 km CEA screening buffer. There will be no spatial overlap between the Site Boundary and the majority of Tier 2 projects, except the Spittal to Peterhead Subsea Cable Link, Piper B Oil Pipeline, Shefa-2 Seg 9 Cable and the Shetland HVDC Cable (see Figure 9.10 and Table 9.48). The cumulative magnitude of impact of the Proposed Development with the Tier 2 projects is therefore not expected to represent a material additional impact to that defined for the assessment of the Proposed Development alone.

- 9.12.104 Where no quantification was given for the introduction of artificial structures and subsequent colonisation for the Tier 2 projects, the values for long term habitat loss and/or disturbance were used as an indication of the potential footprint.
- 9.12.105 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and of low reversibility during the lifetime of the Proposed Development (up to 30 years). It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.



**Table 9.54: Cumulative Footprint of Introduction of Artificial Structures and Subsequent Colonisation for the Tier 2 Projects Overlapping with the Construction and O&M Phase of the Proposed Development**

| Project                                             | MDS                                                                                                                                                                                                                                     | Artificial Hard Structures Present                                                                                                       | Reference                    |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| <b>Proposed Development</b>                         | 3,412,840 m <sup>2</sup>                                                                                                                                                                                                                | See Table 9.15                                                                                                                           | N/A                          |
| <b>Offshore Wind Projects and Associated Cables</b> |                                                                                                                                                                                                                                         |                                                                                                                                          |                              |
| <b>Beatrice OWF</b>                                 | O&M: 3,800,000 m <sup>2</sup>                                                                                                                                                                                                           | Footprint of concrete gravity base foundations and rock scour protection.                                                                | Beatrice OWF Limited (2012a) |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                          |                              |
| <b>Beatrice OWF Export Cable Route</b>              | O&M: 260,000 m <sup>2</sup>                                                                                                                                                                                                             | Worst case scenario cable protection through rock armouring or concrete mattresses.                                                      | Beatrice OWF Limited (2012c) |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                          |                              |
| <b>Caledonia OWF</b>                                | Construction and O&M: 10,162,205 m <sup>2</sup>                                                                                                                                                                                         | Total surface area of introduced hard substrates from all WTG and OSP foundations and associated scour protection, and cable protection. | Caledonia OWF Ltd (2024c)    |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                          |                              |
| <b>Moray East OWF Array</b>                         | O&M: 2,630,000 m <sup>2</sup>                                                                                                                                                                                                           |                                                                                                                                          |                              |

| Project                     | MDS                                                                                                                                                                                                                                     | Artificial Hard Structures Present                                                                                                                            | Reference                                   |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
|                             | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. | Footprint of all turbines and all associated scour protection, one met mast foundation, and cable protection.                                                 | Moray Offshore Renewables Limited (2019b)   |
| Moray East OWF Transmission | O&M: 610,000 m <sup>2</sup>                                                                                                                                                                                                             | Footprint of OSP/converter foundations and associated scour protection, OSPs, AC/DC converters, and cable protection.                                         | Moray Offshore Renewables Limited (2019d)   |
|                             | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                                               |                                             |
| Moray West OWF              | O&M: 686,709 m <sup>2</sup>                                                                                                                                                                                                             | Surface area of gravity base foundations and associated scour protection, OSP foundations and associated scour protection, and cable protection.              | Moray West Offshore Windfarm Limited (2018) |
|                             | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                                               |                                             |
| Pentland Floating OWF       | O&M: 350,304 m <sup>2</sup>                                                                                                                                                                                                             | Combined overall surface area below water of substructures, and footprint of infrastructure associated with the Array Area, export cables, and drilled piles. | Pentland Floating OWF (2022a)               |
|                             | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                                               |                                             |
| Coastal Construction        |                                                                                                                                                                                                                                         |                                                                                                                                                               |                                             |

| Project                                          | MDS                                                                                                                                                                                                                                                                                                                                                                               | Artificial Hard Structures Present                                                                                                                                         | Reference                                       |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| 23/289/NATEIA deep water quay construction       | Construction: 180,000 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                                              | Laydown of rock armour revetments                                                                                                                                          | Orkney Islands Council Harbour Authority (2024) |
| Cables and Pipelines                             |                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                            |                                                 |
| Tier 2 cable and pipeline projects               | O&M: there is no publicly available information on footprints the introduction of artificial structures associated with the O&M activities of the Tier 2 cable and pipeline projects. However, this is expected to be similar or lesser than the footprints of the introduction of artificial structures listed above for the Proposed Development and other Tier 2 OWF projects. | Cable repair and reburial.                                                                                                                                                 | N/A                                             |
| Spittal to Peterhead Subsea Cable Link           | Construction and O&M: 308,374 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                                      | Footprint of rock placement and concrete mattresses installed in the construction phase which will persist into the O&M phase and possibly into the decommissioning phase. | SSENT (2025)                                    |
|                                                  | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach.                                                                                                                                           |                                                                                                                                                                            |                                                 |
| Total (Proposed Development and Tier 2 Projects) | 22,400,432 m <sup>2</sup> (22.40 km <sup>2</sup> )                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                            |                                                 |

Sensitivity of receptor

- 9.12.106 The sensitivity of the receptor is as defined in Paragraphs 9.10.90 to 9.10.101 above for the alone assessment.

Significance of effect

- 9.12.107 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.108 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

*Decommissioning phase*

Magnitude of impact

- 9.12.109 There were several Tier 2 projects with the potential for cumulative introduction of artificial structures and subsequent colonisation during the decommissioning phase of the Proposed Development (Table 9.55). The maximum cumulative footprint for introduction of artificial structures and subsequent colonisation associated with the Tier 2 projects together with the decommissioning phase of the Proposed Development is estimated at up to 23.01 km<sup>2</sup> (Table 9.55). This represents up to 0.15% of the 50 km CEA screening buffer applied and up to 0.05% of the Fish and Shellfish Ecology Study Area. It is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of introduced artificial structures and their subsequent colonisation across the 50 km CEA screening buffer. There will be no spatial overlap between the Site Boundary and the majority of Tier 2 projects, except the Spittal to Peterhead Subsea Cable Link, Piper B Oil Pipeline, Shefa-2 Seg 9 Cable and the Shetland HVDC Cable (see Figure 9.10 and Table 9.48). The cumulative magnitude of impact of the Proposed Development with the Tier 2 projects is therefore not expected to represent a material additional impact to that defined for the assessment of the Proposed Development alone.
- 9.12.110 Where no quantification was given for the introduction of artificial structures and subsequent colonisation for the Tier 2 projects, the values for long term habitat loss and/or disturbance were used as an indication of the potential footprint.
- 9.12.111 Finalised decommissioning plans are not available/quantified for the Proposed Development and Tier 2 projects. For the Proposed Development MDS it is currently proposed that all scour protection, cable protection, and cable crossing protection will be left *in situ* (subject to the final material used; Table 9.15). This will be reviewed throughout the

lifetime of the Proposed Development and good practise guidance will be followed at the time. For the Tier 2 projects, although infrastructure may be removed during their respective decommissioning phases, as a precautionary measure it has been assumed that the cumulative footprint of introduced artificial hard structures will persist into and into and beyond the decommissioning phase of the Proposed Development.

**Table 9.55: Cumulative Footprint of Introduction of Artificial Structures and Subsequent Colonisation for the Tier 2 Projects Overlapping with the Decommissioning Phase of the Proposed Development**

| Project                                             | MDS                                                                                                                                                                                                                                     | Artificial Hard Structures Present                                                                                                       | Reference                    |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| <b>Proposed Development</b>                         | 3,412,840 m <sup>2</sup>                                                                                                                                                                                                                | See Table 9.15                                                                                                                           | N/A                          |
| <b>Offshore Wind Projects and Associated Cables</b> |                                                                                                                                                                                                                                         |                                                                                                                                          |                              |
| <b>Beatrice OWF</b>                                 | O&M: 3,800,000 m <sup>2</sup>                                                                                                                                                                                                           | Footprint of concrete gravity base foundations and rock scour protection.                                                                | Beatrice OWF Limited (2012a) |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                          |                              |
| <b>Beatrice OWF Export Cable Route</b>              | O&M: 260,000 m <sup>2</sup>                                                                                                                                                                                                             | Worst case scenario cable protection through rock armouring or concrete mattresses.                                                      | Beatrice OWF Limited (2012c) |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                          |                              |
| <b>Caledonia OWF</b>                                | Construction and O&M: 10,162,205 m <sup>2</sup>                                                                                                                                                                                         | Total surface area of introduced hard substrates from all WTG and OSP foundations and associated scour protection, and cable protection. | Caledonia OWF Ltd (2024c)    |
|                                                     | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                          |                              |

| Project                            | MDS                                                                                                                                                                                                                                     | Artificial Hard Structures Present                                                                                                                            | Reference                                   |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| <b>Moray East OWF Array</b>        | O&M: 3,240,000 m <sup>2</sup>                                                                                                                                                                                                           | Footprint of all turbines and all associated scour protection, one met mast foundation, and cable protection.                                                 | Moray Offshore Renewables Limited (2019b)   |
|                                    | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                                               |                                             |
| <b>Moray East OWF Transmission</b> | O&M: 610,000 m <sup>2</sup>                                                                                                                                                                                                             | Footprint of OSP/converter foundations and associated scour protection, OSPs, AC/DC converters, and cable protection.                                         | Moray Offshore Renewables Limited (2019d)   |
|                                    | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                                               |                                             |
| <b>Moray West OWF</b>              | O&M: 686,709 m <sup>2</sup>                                                                                                                                                                                                             | Surface area of gravity base foundations and associated scour protection, OSP foundations and associated scour protection, and cable protection.              | Moray West Offshore Windfarm Limited (2018) |
|                                    | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach. |                                                                                                                                                               |                                             |
| <b>Pentland Floating OWF</b>       | O&M: 350,304 m <sup>2</sup>                                                                                                                                                                                                             | Combined overall surface area below water of substructures, and footprint of infrastructure associated with the Array Area, export cables, and drilled piles. | Pentland Floating OWF (2022a)               |
|                                    | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial                                                                                                        |                                                                                                                                                               |                                             |



| Project                                          | MDS                                                                                                                                                                                                                                                                                                                                                                               | Artificial Hard Structures Present                                                                                                                                         | Reference                                       |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
|                                                  | structures and subsequent colonisation persisting in decommissioning used as a precautionary approach.                                                                                                                                                                                                                                                                            |                                                                                                                                                                            |                                                 |
| Coastal Construction                             |                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                            |                                                 |
| 23/289/NATEIA deep water quay construction       | Construction: 180,000 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                                              | Laydown of rock armour revetments.                                                                                                                                         | Orkney Islands Council Harbour Authority (2024) |
| Cables and Pipelines                             |                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                            |                                                 |
| Tier 2 cable and pipeline projects               | O&M: there is no publicly available information on footprints the introduction of artificial structures associated with the O&M activities of the Tier 2 cable and pipeline projects. However, this is expected to be similar or lesser than the footprints of the introduction of artificial structures listed above for the Proposed Development and other Tier 2 OWF projects. | Cable repair and reburial.                                                                                                                                                 | N/A                                             |
| Spittal to Peterhead Subsea Cable Link           | Construction and O&M: 308,374 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                                      | Footprint of rock placement and concrete mattresses installed in the construction phase which will persist into the O&M phase and possibly into the decommissioning phase. | SSENT (2025)                                    |
|                                                  | Decommissioning: detailed methods for decommissioning phase not developed; worst case scenario of the introduction of artificial structures and subsequent colonisation persisting in decommissioning used as a precautionary approach.                                                                                                                                           |                                                                                                                                                                            |                                                 |
| Total (Proposed Development and Tier 2 Projects) | 23,010,432 m <sup>2</sup> (23.01 km <sup>2</sup> )                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                            |                                                 |

- 9.12.112 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and of low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low

Sensitivity of receptor

- 9.12.113 The sensitivity of the receptor is as defined in Paragraphs 9.10.90 to 9.10.101 above for the alone assessment.

Significance of effect

- 9.12.114 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.115 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

***Tier 3***

*Construction and O&M phases*

Magnitude of impact

- 9.12.116 In addition to the Tier 2 projects, there were three Tier 3 projects with the potential for cumulative introduction of artificial structures and subsequent colonisation during the construction and O&M phases of the Proposed Development:

- Stromar OWF (likely in its construction and O&M phase);
- Westray South Tidal Farm (likely in its construction and O&M phase); and
- 24/079/SCO Scoping Opinion request to construct an ultra deep water quay (construction phase) (Table 9.49).

- 9.12.117 There is limited publicly available information to define footprints of temporary habitat loss and/or disturbance for these projects. The introduction of artificial structures and subsequent colonisation associated with the Stromar OWF is expected to be similar in nature and extent to that calculated for the Proposed Development and/or the Tier 2 OWF developments detailed in Table 9.54. Footprints of impact associated with the Westray South Tidal Farm and the ultra deep water quay construction are likely to be of a lower extent to those calculated for the Proposed Development or the other Tier 2 OWF developments.

- 9.12.118 As with the Tier 2 projects, it is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of introduced artificial structures and subsequent colonisation across the 50 km CEA screening buffer. There will also be no spatial overlap between

the Site Boundary and the Tier 3 projects (Figure 9.10). The cumulative magnitude of impact of the Tier 3 projects, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 projects.

- 9.12.119 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and of low reversibility during the lifetime of the Proposed Development (up to 30 years). It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.120 The sensitivity of the receptor is as defined in Paragraphs 9.10.90 to 9.10.101 above for the alone assessment.

Significance of effect

- 9.12.121 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.122 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

*Decommissioning phase*

Magnitude of impact

- 9.12.123 In addition to their Tier 2 projects, there were two Tier 3 projects with the potential for cumulative introduction of artificial structures and subsequent colonisation during the decommissioning phase of the Proposed Development:

- Stromar OWF (likely in its O&M and decommissioning phases); and
- Westray South Tidal Farm (likely in its O&M and decommissioning phases).

- 9.12.124 There is limited publicly available information to define footprints of temporary habitat loss and/or disturbance for these projects. The introduction of artificial structures and subsequent colonisation associated with the Stromar OWF is expected to be similar in nature and extent to that calculated for the Proposed Development and/or the Tier 2 OWF developments detailed in Table 1.31. Footprints of impact associated with the Westray South Tidal Farm are likely to be of a lower extent to those calculated for the Proposed Development or the other Tier 2 OWF developments.

- 9.12.125 As with the Tier 2 projects, it is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas

of introduced artificial structures and subsequent colonisation across the 50 km CEA screening buffer. There will also be no spatial overlap between the Site Boundary and the Tier 3 projects (Figure 9.10). The cumulative magnitude of impact of the Tier 3 projects, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 projects.

- 9.12.126 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and of low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.127 The sensitivity of the receptor is as defined in Paragraphs 9.10.90 to 9.10.101 above for the alone assessment.

Significance of effect

- 9.12.128 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.129 No Additional mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

***Tier 4***

*Construction and O&M phases*

Magnitude of impact

- 9.12.130 In addition to the Tier 2 and 3 projects, there was one Tier 4 project with the potential for cumulative introduction of artificial structures and subsequent colonisation during the construction and O&M phase of the Proposed Development:

- Orkney Connection (possibly in its construction and O&M phases) (Table 9.49).

- 9.12.131 As a Tier 4 project, there are no publicly available parameters to define footprints of the introduction of artificial structures and cannot be combined with those of the Proposed Development and the Tier 2 and 3 projects.

- 9.12.132 It is possible that the construction and O&M phases of this cable project could overlap with the construction and O&M phases of the Proposed Development. However, given that this is a Tier 4 project, there is no information on the footprints of the introduction of artificial structures and subsequent colonisation currently available. It has reasonably been

assumed that these would be of a similar extent to those associated with the Export Cable Corridor (see Table 9.15).

9.12.133 As with the Tier 2 and 3 projects, it is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of the introduction of artificial structures and subsequent colonisation across the 50 km CEA screening buffer. The cumulative magnitude of impact of the Tier 4 project, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 and 3 projects.

9.12.134 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and of low reversibility during the lifetime of the Proposed Development (up to 30 years). It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

9.12.135 The sensitivity of the receptor is as defined in Paragraphs 9.10.90 to 9.10.101 above for the alone assessment.

Significance of effect

9.12.136 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

9.12.137 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

*Decommissioning phase*

Magnitude of impact

9.12.138 In addition to the Tier 2 and 3 projects, there was one Tier 4 project with the potential for cumulative introduction of artificial structures and subsequent colonisation during the decommissioning phase of the Proposed Development:

- Orkney Connection (possibly in its O&M and/or decommissioning phases) (Table 9.49).

9.12.139 As a Tier 4 project, there are no publicly available parameters to define footprints of the introduction of artificial structures and subsequent colonisation and cannot be combined with those of the Proposed Development and the Tier 2 and 3 projects.

9.12.140 It is possible that the O&M and/or decommissioning phases of this cable project could overlap with decommissioning phase of the Proposed

Development. However, given that this is a Tier 4 project, there is no information on the footprints of the introduction of artificial structures and subsequent colonisation currently available. It has reasonably been assumed that these would be of a similar extent to those associated with the Export Cable Corridor (see Table 9.15).

9.12.141 As with the Tier 2 and 3 projects, it is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of the introduction of artificial structures and subsequent colonisation across the 50 km CEA screening buffer. The cumulative magnitude of impact of the Tier 4 project, therefore, represents no additional material impact to that defined for the assessment of the Proposed Development alone, and cumulatively with the Tier 2 and 3 projects.

9.12.142 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and of low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

9.12.143 The sensitivity of the receptor is as defined in Paragraphs 9.10.90 to 9.10.101 above for the alone assessment.

Significance of effect

9.12.144 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

9.12.145 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

## **INCREASED SSCS AND ASSOCIATED DEPOSITION**

### ***Tier 2***

#### *Construction phase*

Magnitude of impact

9.12.146 There were two Tier 2 projects identified with the potential to have a cumulative risk of impact with the Proposed Development during their construction phases: Dredge disposal site CR009 and the Spittal to Peterhead Subsea Cable Link (Table 9.49).

9.12.147 Dredge disposal site CR009 is within a distance of one spring tidal excursion ellipse from the near shore Export Cable Corridor. Should Offshore Export Cable installation be occurring at the same time as

dredge disposal activities at this site, there could theoretically be the potential for cumulative changes in SSCs.

- 9.12.148 Dredge disposal site CR009 is located at a distance of approximately 10 km from the nearshore Export Cable Corridor, in relation to the orientation of the tidal axis (Table 9.48). At this distance apart, any cumulative increase in either the spatial footprint or peak concentration of sediment plumes is expected to be indistinguishable from that previously reported for the Offshore Export Cable installation on its own (see Volume 2, Chapter 7: Physical Processes). Any associated cumulative changes in seabed level will also be immeasurable. It is also worth noting that spring tidal excursion ellipses are strongly rectilinear within the vicinity of the dredge disposal sites nearby to the Offshore Export Cable Corridor. This means that although at times during the construction phase some plume interaction may occur, the number of occurrences is expected to be less than for an equivalent setting with more rotary tidal excursion characteristics.
- 9.12.149 In addition, part of the Spittal to Peterhead Subsea Cable Link's cable route comes within the spring tidal excursion buffer around the Proposed Development Export Cable Corridor. Therefore, there could be the potential for cumulative temporary increases in SSC and seabed levels.
- 9.12.150 Given that the Spittal to Peterhead Subsea Cable Link is within a spring tidal excursion distance of nearshore region of the Export Cable Corridor, there is some potential for sediment plume interaction during construction/installation operations. However, it is noted that cable installation vessels typically request a vessel safety zone when installing or handling cables, it is reasonable to assume that this zone could be around 500 m. As set out in Volume 2, Chapter 7: Physical Processes, at a distance of greater than 500 m from the source of pre-lay trenching bed disturbance, any increases in SSC are expected to be modest (tens to low hundreds of mg/l) and fine sediment is unlikely to deposit in measurable thickness. In addition to direct communications between the ships, this process will likely be managed via vessel management plans and official bulletins, such as notice to mariners. Accordingly, whilst plume interaction may still theoretically occur, the potential for much higher concentration and/or more persistent plumes than that previously described in the Proposed Development alone assessments of SSC is small. Cumulative increases in seabed level could also theoretically occur, although the potential for this to occur is expected to be very low, given the expected separation distance of the vessels and the fact that seabed sediments are regularly reworked and transported by tidal currents in this region.
- 9.12.151 Therefore, the cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.



Sensitivity of receptor

- 9.12.152 The sensitivity of the receptor is as defined in Paragraphs 9.10.117 to 9.10.137 above for the alone assessment.

Significance of effect

- 9.12.153 Overall, for herring and sandeel, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.154 For all other fish and shellfish IEFS, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.155 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Volume 2, Chapter 7: Physical Processes) is not significant in EIA terms.

***Tier 3***

*Construction phase*

Magnitude of impact

- 9.12.156 In addition to the Tier 2 projects identified in Table 9.49, the construction periods of the Tier 3 Stromar OWF and the Proposed Development may overlap. Consequently, sediment-disturbing activities such as drilling of foundations, sandwave clearance, and dredging could occur simultaneously. This overlap may potentially result in cumulative changes in SSCs.
- 9.12.157 The Stromar Array Area is located approximately 14 km to the south of the Array Area, aligned with the tidal ellipse which runs approximately north-west to south-east. The distance between the Proposed Development and the Stromar OWF Array Area is large, greater than the extent of the spring tidal excursion ellipse. The modelled scenarios (see Volume 2: Chapter 7: Physical Processes) also show the limited spatial footprint and transient nature of the plumes created from disturbance activities in these individual locations. This therefore suggests any cumulative impacts are unlikely and will be of low magnitude and short duration if they do occur.
- 9.12.158 Therefore, the cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.159 The sensitivity of the receptor is as defined in Paragraphs 9.10.117 to 9.10.137 above for the alone assessment.

Significance of effect

- 9.12.160 Overall, for herring and sandeel, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.161 For all other fish and shellfish IEFS, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.162 No Additional mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Volume 2, Chapter 7: Physical Processes) is not significant in EIA terms.

**SUBSEA NOISE IMPACTING FISH AND SHELLFISH RECEPTORS**

***Tier 2***

*Construction phase*

Magnitude of impact

- 9.12.163 There were six Tier 2 projects with the potential for cumulative impacts associated with subsea noise in the construction phase of the Proposed Development. The results of subsea noise modelling assessments for these projects are summarised in Table 9.56. Injury and disturbance associated with subsea noise in the various phases of the Tier 2 projects overlapping with the construction phase of the Proposed Development were not concluded to be significant for the fish and shellfish species assessed in their individual EIAs (Table 9.56). Subsea noise modelling results (where available) were of a similar scale to those associated with the Proposed Development. Given the location of the Tier 2 projects within the North Sea, the fish and shellfish species assessed are comparable to the fish and shellfish IEFs identified for the Proposed Development alone assessment.
- 9.12.164 It should be noted that the majority of the Tier 2 projects will already be constructed during the construction of the Proposed Development. This greatly reduces the potential for cumulative effects as the highest potential for impact is associated with piling noise in the construction phase of an OWF. Of the six Tier 2 projects assessed, only the construction phases of the Caledonia OWF (up to five years; 2028 - 2032) and West of

Orkney OWF (up to four years; 2028 - 2031) overlap with that of the Proposed Development (2027 - 2034).

**Table 9.56: Cumulative Subsea Noise Modelling Results for the Tier 2 Projects Overlapping with the Construction Phase of the Proposed Development**

| Project                                             | MDS                                                                                                                                                                                                                                                                                                                              | Subsea Noise Modelling Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Reference                                            |
|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| <b>Offshore Wind Projects and Associated Cables</b> |                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                      |
| <b>Beatrice OWF</b>                                 | O&M: up to 277 Wind Turbines, with a capacity of 3.6 MW each.                                                                                                                                                                                                                                                                    | There was no subsea noise modelling undertaken for the O&M phase of this project (which corresponds with the construction phase of the Proposed Development). Operational noise was assessed via a literature review in the EIA, with no significant effects predicted for any fish and shellfish species.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Beatrice OWF Limited (2012b)                         |
| <b>Caledonia OWF</b>                                | Construction: concurrent piling of up to 140 Wind Turbines and four OSPs on either monopile or pin pile foundations. A maximum hammer energy of 4,400 kJ represents the MDS for pin piles and 6,600 kJ for monopiles.<br>The assessment also included UXO clearance, but parameters of size, number and type were not available. | The maximum TTS impact area (used as a proxy for disturbance) was modelled at 14,000 km <sup>2</sup> /45,000 m for Group 3 and 4 fish (using the 186 dB cumulative SEL metric). Ranges were lower for the less sensitive hearing groups and for injurious effects. This was not assessed as having population-level effects on the fish and shellfish IEFs (including herring and cod). The subsea noise contours for disturbance modelled for the Caledonia OWF extended over the width of the Moray Firth, so would potentially overlap with those modelled for the Proposed Development alone (Figure 9.5). However, piling activities are unlikely to overlap temporally with those of the Proposed Development. Piling at the Caledonia OWF is estimated to occur over 9 to 18 months, beginning at the end of the first year of the construction period (therefore between 2028 and 2030, as a precaution) (Caledonia OWF Ltd, 2024a). For the Proposed Development, piling could begin midway through 2031, therefore the potential for concurrent piling of the Proposed Development and Caledonia OWF is unlikely.<br><br>For UXO clearance, the risk of mortality and potential mortal injury was modelled as less than 50 m at 234 dB SPL <sub>pk</sub> rising to 60 m at 229 dB SPL <sub>pk</sub> . Spatial overlap | Caledonia OWF Ltd (2024a), Caledonia OWF Ltd (2024c) |

| Project                     | MDS                                                                                                                                    | Subsea Noise Modelling Results                                                                                                                                                                                                                                                                                                                                                                                                                            | Reference                                   |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
|                             |                                                                                                                                        | between these ranges and those associated with the Proposed Development alone are therefore not predicted. In addition, UXO clearance will be undertaken in the first year of the construction phase of Caledonia OWF (2027) and in 2030 for the Proposed Development.                                                                                                                                                                                    |                                             |
|                             | O&M: operational noise from 140 floating Wind Turbines and four OSPs (including anchor mooring lines).                                 | Subsea noise modelling showed that operational noise from Wind Turbines was below the TTS threshold (based on 186 dB cumulative SEL) for fish and shellfish species and TTS and recoverable injury impact ranges of less than less than 100 m when extrapolated from the Popper <i>et al.</i> (2014) criteria for continuous noise. Individuals would need to be closer than 20 m for 12 hours continuously to have any effect associated with O&M noise. | Caledonia OWF Ltd (2024c)                   |
| <b>Moray East OWF Array</b> | O&M: operational noise from 339 fixed foundation Wind Turbines.                                                                        | There was no subsea noise modelling undertaken for the O&M phase of this project (which corresponds with the construction phase of the Proposed Development). Operational noise was assessed via a literature review in the EIA, with no significant effects predicted for any fish and shellfish species.                                                                                                                                                | Moray Offshore Renewables Limited (2019b)   |
| <b>Moray West OWF</b>       | O&M: the MDS for this project considered vessel movements for scheduled and unscheduled maintenance (no maximum values were provided). | There was no subsea noise modelling undertaken for the O&M phase of this project (which corresponds with the construction phase of the Proposed Development). However, the EIA concluded that the elevated subsea noise levels associated with this would be highly limited in extent and lower than those present in the vicinity of nearby shipping routes. A negligible magnitude of impact was concluded.                                             | Moray West Offshore Windfarm Limited (2018) |

| Project                        | MDS                                                                                                                                                                                                                                                                                                 | Subsea Noise Modelling Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Reference                                                        |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| <b>Pentland Floating OWF</b>   | O&M: this impact was scoped out of the EIA during the O&M phase.                                                                                                                                                                                                                                    | Continuous operational noise was assessed based on 20 MW fixed foundation Wind Turbines. Noise modelling results indicated that there will be negligible risk of injury with both recoverable injury and TTS occurring at < 50 m from the source. Behavioural responses from cable pinging were also expected to be localised, and it was noted that the pinging would be highly unlikely to occur for all Wind Turbines at the same time. Based on these results, and supported by comments from stakeholders, the effects of operational noise on fish and shellfish species was not considered within the EIA for this project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Pentland Floating OWF (2022c)                                    |
| <b>West of Orkney Windfarm</b> | Construction: piling of up to 125 Wind Turbines with monopiles using a maximum hammer energy of 5,000 kJ or jacket foundations with a maximum hammer energy of 3,000 kJ. Included up to five OSP jacket foundations at a 3,000 kJ hammer energy. The MDS also included detonation of up to 22 UXOs. | <p>The subsea noise modelling for mortality and potential injury ranges illustrated that thresholds could be exceeded &lt;100 m from piling activities for moving fish, and thousands of metres for fish modelled as static receptors (although it is unlikely that fish would remain in place for the duration of piling activities). Therefore, spatial overlap between these injury ranges and those associated with the Proposed Development (and the other Tier 2 projects which are far from the West of Orkney Windfarm) is unlikely (see Figure 9.10).</p> <p>TTS and behavioural disturbance ranges were modelled out to tens of thousands of metres for all hearing groups. However, spatial overlap between these disturbance ranges and those from the Proposed Development and other projects would not occur, as the Orkney Islands acted as a barrier, with the mapped noise contours not extending past them (see West of Orkney Windfarm (2023d)).</p> <p>UXO clearance impact ranges were &lt;50 m for low order techniques and out to 630 m for the maximum UXO size under high order detonation conditions. Spatial overlap</p> | West of Orkney Windfarm (2023a), West of Orkney Windfarm (2023d) |

| Project | MDS                                                              | Subsea Noise Modelling Results                                                                             | Reference |
|---------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------|
|         |                                                                  | between these ranges and those associated with the Proposed Development alone are therefore not predicted. |           |
|         | O&M: this impact was scoped out of the EIA during the O&M phase. | N/A                                                                                                        |           |



- 9.12.165 Based on the information provided in Table 9.56, the cumulative impact is predicted to be of local spatial extent, medium duration (over the construction phase), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.166 The sensitivity of the receptor is as defined in Paragraphs 9.10.179 to 9.10.225 above for the alone assessment.

Significance of effect

- 9.12.167 Overall, for the herring IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered, precautionarily, to be high. The cumulative effect will, therefore, be of **Moderate** adverse significance, which is significant in EIA terms.

- 9.12.168 For all other fish and shellfish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.169 For all IEFs except herring, no additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

- 9.12.170 A moderate adverse significance was concluded for the herring IEF due to piling in the construction phase. Therefore, prior to the commencement of piling at the Proposed Development alone, appropriate Additional Mitigation measures will be discussed and agreed with stakeholders. Appropriate mitigation will be secured through the Piling Strategy as a condition of the Marine Licence. It is anticipated that following tailoring of Additional Mitigation measures as described above, the cumulative significance of this impact will be reduced to minor adverse for herring, which is not significant in EIA terms.

*O&M phase*

Magnitude of impact

- 9.12.171 There were six Tier 2 projects with the potential for cumulative impacts associated with subsea noise in the O&M phase of the Proposed Development. The results of subsea noise modelling assessments for these projects are summarised in Table 9.57, although it should be noted that operational noise was not assessed for several projects during this phase. All of the Tier 2 projects will be in their O&M and/or decommissioning phases during the O&M phase of the Proposed Development. This greatly reduces the potential for cumulative effects as the highest potential for impact is associated with piling noise in the

construction phase of an OWF. As detailed for the alone assessment (Paragraphs 9.10.238 to 9.10.239) the risk of effects on fish (either injury or behavioural responses) from operational turbine noise is very low, whether that is from the structure-borne noise regardless of foundation type, and the additional noise generated by movements in the mooring lines. Therefore, it is unlikely that wide-ranging cumulative impacts would occur, given the limited nature of operational noise disturbance to fish and shellfish receptors.

- 9.12.172 Overall, the cumulative impact is predicted to be of local spatial extent, long term duration, continuous (but at very low levels), and low reversibility (although is reversible upon decommissioning). It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

**Table 9.57: Cumulative Subsea Noise Modelling Results for the Tier 2 Projects Overlapping with the O&M Phase of the Proposed Development**

| Project                                             | MDS                                                                                                    | Subsea Noise Modelling Results                                                                                                                                                                                                                                                                                                                                                                                                                            | Reference                                 |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| <b>Offshore Wind Projects and Associated Cables</b> |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                           |
| <b>Beatrice OWF</b>                                 | O&M: up to 277 Wind Turbines, with a capacity of 3.6 MW.                                               | There was no subsea noise modelling undertaken for the O&M phase of this project (which corresponds with the construction phase of the Proposed Development). Operational noise was assessed via a literature review in the EIA, with no significant effects predicted for any fish and shellfish species.                                                                                                                                                | Beatrice OWF Limited (2012b)              |
| <b>Caledonia OWF</b>                                | O&M: operational noise from 140 floating Wind Turbines and four OSPs (including anchor mooring lines). | Subsea noise modelling showed that operational noise from Wind Turbines was below the TTS threshold (based on 186 dB cumulative SEL) for fish and shellfish species and TTS and recoverable injury impact ranges of less than less than 100 m when extrapolated from the Popper <i>et al.</i> (2014) criteria for continuous noise. Individuals would need to be closer than 20 m for 12 hours continuously to have any effect associated with O&M noise. | Caledonia OWF Ltd (2024c)                 |
| <b>Moray East OWF Array</b>                         | O&M: operational noise from 339 fixed foundation Wind Turbines.                                        | There was no subsea noise modelling undertaken for the O&M phase of this project (which corresponds with the construction phase of the Proposed Development). Operational noise was assessed via a literature review in the EIA, with no significant effects predicted for any fish and shellfish species.                                                                                                                                                | Moray Offshore Renewables Limited (2019b) |
|                                                     | Decommissioning: the MDS for this project did not assess subsea noise during the decommissioning phase | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                           |

| Project                      | MDS                                                                                                                                    | Subsea Noise Modelling Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Reference                                   |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| <b>Moray West OWF</b>        | O&M: the MDS for this project considered vessel movements for scheduled and unscheduled maintenance (no maximum values were provided). | There was no subsea noise modelling undertaken for the O&M phase of this project (which corresponds with the construction phase of the Proposed Development). However, the EIA concluded that the elevated subsea noise levels associated with this would be highly limited in extent and lower than those present in the vicinity of nearby shipping routes. A negligible magnitude of impact was concluded.                                                                                                                                                                                                                                                                                             | Moray West Offshore Windfarm Limited (2018) |
|                              | Decommissioning: the MDS for this project considered subsea noise generated by the removal of foundations.                             | There was no subsea noise modelling undertaken for the decommissioning phase of this project (which corresponds with the O&M phase of the Proposed Development). However, the EIA concluded that abrasive cutting, often anticipated for Wind Turbine foundation removal, would not be expected to be significantly higher than general surface vessel noise. Subsea noise resulting from abrasive cutting associated with decommissioning is unlikely to result in any injury, avoidance or significant disturbance of fish and shellfish since noise emissions from these activities are far less than those created during construction (e.g. piling). A negligible magnitude of impact was concluded. |                                             |
| <b>Pentland Floating OWF</b> | O&M: this impact was scoped out of the EIA during the O&M phase.                                                                       | Continuous operational noise was assessed based on 20 MW fixed foundation Wind Turbines. Noise modelling results indicated that there will be negligible risk of injury with both recoverable injury and TTS occurring at < 50 m from the source. Behavioural responses from cable pinging were also                                                                                                                                                                                                                                                                                                                                                                                                      | Pentland Floating OWF (2022c)               |

| Project                        | MDS                                                                         | Subsea Noise Modelling Results                                                                                                                                                                                                                                                                                                 | Reference                       |
|--------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
|                                |                                                                             | expected to be localised, and it was noted that the pinging would be highly unlikely to occur for all Wind Turbines at the same time. Based on these results, and supported by comments from stakeholders, the effects of operational noise on fish and shellfish species were not considered within the EIA for this project. |                                 |
|                                | Decommissioning: this impact was not assessed in the decommissioning phase. | N/A                                                                                                                                                                                                                                                                                                                            |                                 |
| <b>West of Orkney Windfarm</b> | O&M: this impact was scoped out of the EIA during the O&M phase.            | N/A                                                                                                                                                                                                                                                                                                                            | West of Orkney Windfarm (2023a) |

Sensitivity of receptor

- 9.12.173 The sensitivity of the receptor is as defined in Paragraphs 9.10.240 to 9.10.251 above for the alone assessment.

Significance of effect

- 9.12.174 Overall, for the herring IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.175 For all other fish and shellfish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.176 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9 is not significant in EIA terms.

*Decommissioning phase*

Magnitude of impact

- 9.12.177 With the exception of the Caledonia OWF, the Tier 2 projects will have reached their decommissioning phase by the time of the decommissioning of the Proposed Development (Table 9.48), and decommissioning activities are unlikely to overlap. As for the Proposed Development, the Caledonia OWF is likely to submit a Decommissioning Programme to MD-LOT for consultation and approval and specific detail around subsea noise generated during this phase is not currently available. As there will be no piling during the decommissioning phase, which is the source of subsea noise with the highest potential for impact, it has been assumed that the cumulative magnitude of impact in the decommissioning phase is no greater than that defined in Paragraph 9.12.165 for the construction phase.
- 9.12.178 Overall, the cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.179 The sensitivity of the receptor is as defined in Paragraphs 9.10.224 to 9.10.225 above for the alone assessment.

Significance of effect

- 9.12.180 Overall, for the herring IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.

- 9.12.181 For all other fish and shellfish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.182 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9 is not significant in EIA terms.

**Tier 3**

*Construction phase*

Magnitude of impact

- 9.12.183 In addition to the Tier 2 projects, there were five Tier 3 projects with the potential for cumulative impacts associated with subsea noise during the construction phase of the Proposed Development:

- Broadshore Hub OWFs (possibly in its O&M phase);
- Buchan OWF (possibly in its construction phase);
- Marram OWF (possibly in its O&M phase);
- Stromar OWF (possibly in its construction phase); and
- Westray South Tidal Farm (possibly in its construction phase) (Table 9.49).

- 9.12.184 It is possible that the construction phases of these Tier 3 projects may overlap with the construction phase of the Proposed Development, however there are no details in the public domain on the construction programmes available for them. Cumulative effects would be reduced with lower overlap between the construction phases of the Tier 3 projects and the Proposed Development, as subsea noise levels will return to baseline conditions upon completion of individual construction activities (such as piling) for each project.

- 9.12.185 As Tier 3 projects, there are no EIAs available in the public domain and therefore no specific subsea noise modelling results to draw upon. However, in their Scoping Reports, the following indicative Wind Turbine parameters are provided (noting that these are not final and may be subject to change as the projects progress):

- Broadshore Hub OWF: total of up to 72 Wind Turbines and associated OSPs (Broadshore Hub, 2024);
- Buchan OWF: up to 70 floating Wind Turbines and associated OSPs; (Buchan Offshore Wind Limited, 2023);
- Marram OWF: up to 225 floating Wind Turbines with individual capacities of 25 MW and associated OSPs (MarramWind Ltd., 2023); and
- Stromar OWF: up to 71 floating Wind Turbines and associated OSPs (Stromar Offshore Wind Farm, 2024).



- 9.12.186 In addition to piling of Wind Turbine and OSP foundations, UXO clearance is likely to be required, alongside other noise producing activities such as site investigation surveys, vessel use, and cable installation. No specific details are currently available regarding noise-producing parameters, such as maximum piling durations, maximum or realistic hammer energies, however these are likely to be of a similar scale to that of the Proposed Development alone, given the similar scales between the Proposed Development and the Tier 3 OWFs.
- 9.12.187 The Westray South Tidal Farm would involve the installation, operation and decommissioning of around 70 tidal turbine devices at the Westray Firth, Orkney, with a total generating capacity of 170 MW (Orbital Marine Power, 2023). Station-keeping for each device would be via four mooring lines connected to either rock drilled or gravity anchors, therefore subsea noise could be generated via drilling, alongside other construction activities (Orbital Marine Power, 2023). Given that no impact piling is anticipated to occur, the subsea noise associated with construction of this project is not anticipated to have wide ranging effects upon fish and shellfish receptors. Further, given the distance between the Westray South Tidal Farm and the Proposed Development (38.97 km), noise contours are not expected to overlap, and cumulative impacts are not predicted to be significant.
- 9.12.188 Overall, the cumulative impact is predicted to be of local spatial extent, medium duration (over the construction phase), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.
- Sensitivity of receptor
- 9.12.189 The sensitivity of the receptor is as defined in Paragraphs 9.10.179 to 9.10.225 above for the alone assessment.
- Significance of effect
- 9.12.190 Overall, for the herring IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered, precautionary, to be high. The cumulative effect will, therefore, be of **Moderate** adverse significance, which is not significant in EIA terms.
- 9.12.191 For all other fish and shellfish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- Additional Mitigation and residual effect
- 9.12.192 For all IEFs except herring, no Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9 is not significant in EIA terms.

- 9.12.193 A moderate adverse significance was concluded for the herring IEF due to piling in the construction phase. Therefore, prior to the commencement of piling at the Proposed Development alone, appropriate Additional Mitigation measures will be discussed and agreed with stakeholders. Appropriate mitigation will be secured through the Piling Strategy as a condition of the Marine Licence. It is anticipated that following tailoring of Additional Mitigation measures as described above, the cumulative significance of this impact will be reduced to minor adverse for herring, which is not significant in EIA terms.

*O&M phase*

Magnitude of impact

- 9.12.194 In addition to the Tier 2 projects, there were five Tier 3 projects with the potential for cumulative impacts associated with subsea noise during the O&M phase of the Proposed Development:

- Broadshore Hub OWFs (likely in its O&M phase);
- Buchan OWF (likely in its O&M phase);
- Marram OWF (likely in its O&M phase);
- Stromar OWF (likely in its O&M phase); and
- Westray South Tidal Farm (likely in its O&M phase) (Table 9.49).

- 9.12.195 As Tier 3 projects, there are no EIAs available in the public domain and therefore no specific subsea noise modelling results to draw upon. However, as floating OWFs and a floating tidal farm, there is potential for O&M impacts associated with anchor mooring lines similar to those described for the Proposed Development alone. As detailed for the alone assessment (Paragraphs 9.10.238 to 9.10.239) the risk of effects on fish (either injury or behavioural responses) from operational turbine noise is very low, whether that is from the structure-borne noise regardless of foundation type, and the additional noise generated by movements in the mooring lines. Given the distance between the Proposed Development and the Tier 3 projects (Table 9.48), it is unlikely that wide-ranging cumulative impacts would occur, given the limited nature of operational noise disturbance to fish and shellfish receptors.

- 9.12.196 Overall, the cumulative impact is predicted to be of local spatial extent, long term duration, continuous (but at very low levels), and low reversibility (although is reversible upon decommissioning). It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.197 The sensitivity of the receptor is as defined in Paragraphs 9.10.240 to 9.10.251 above for the alone assessment.

Significance of effect

- 9.12.198 Overall, for the herring IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.199 For all other fish and shellfish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.200 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9 is not significant in EIA terms.

*Decommissioning phase*

Magnitude of impact

- 9.12.201 In addition to the Tier 2 projects, there were five Tier 3 projects with the potential for cumulative impacts associated with subsea noise during the decommissioning phase of the Proposed Development:
- Broadshore Hub OWFs (possibly in O&M and/or decommissioning phase);
  - Buchan OWF (possibly in O&M and/or decommissioning phase);
  - Marram OWF (possibly in O&M and/or decommissioning phase);
  - Stromar OWF (possibly in O&M and/or decommissioning phase); and
  - Westray South Tidal Farm (possibly in O&M and/or decommissioning phase) (Table 9.49).
- 9.12.202 It is possible that the O&M and/or decommissioning phases of these Tier 3 projects may overlap with the decommissioning phase of the Proposed Development, however there are no details in the public domain available for them. Cumulative effects would be reduced with lower overlap between the decommissioning phases of the Tier 3 projects and the Proposed Development, as subsea noise levels will return to baseline conditions upon completion of individual activities (such as infrastructure removal) for each project.
- 9.12.203 As per the Proposed Development, it is likely that subsea noise produced by decommissioning activities associated with the Tier 3 projects will be highly limited in extent, with injury and disturbance thresholds not exceeded.
- 9.12.204 Overall, the cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.205 The sensitivity of the receptor is as defined in Paragraphs 9.10.224 to 9.10.225 above for the alone assessment.

Significance of effect

- 9.12.206 Overall, for the herring IEF, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.207 For all other fish and shellfish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.208 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9 is not significant in EIA terms.

**IMPACTS TO FISH AND SHELLFISH DUE TO EMF**

***Tier 2***

*O&M phase*

Magnitude of impact

- 9.12.209 There were several Tier 2 projects with the potential for cumulative EMF impacts during the O&M phase of the Proposed Development (Table 9.58). As for the Proposed Development alone, subsea cables associated with these Tier 2 projects could release EMFs into the marine environment. The maximum cumulative length of subsea cables of the Tier 2 projects together with the Proposed Development is estimated at up to 3,744.15 km, which included up to 24.36 km of dynamic IACs within the water column (Table 9.58).
- 9.12.210 Other cable parameters, such as voltage and burial depth, vary between the Proposed Development and the Tier 2 projects and are not possible to combine into one cumulative value, unlike maximum cable lengths. However, cable burial and/or cable protection measures are outlined within the EIAs for the Tier 2 projects, such as those detailed in Table 9.15 for the Proposed Development.
- 9.12.211 EMFs emitted by subsea cables are influenced by a variety of design and installation factors, including distance between cables, cable sheathing, number of conductors, and internal cable configuration. The intensity of EMF from subsea cables decreases at approximately the inverse square/power of the distance away from the cable (Hutchison *et al.*, 2021). This attenuation is applicable to buried, unburied, and dynamic cables (Hutchison *et al.*, 2021). Therefore, the cumulative magnitude of impact

with the Tier 2 projects is likely to be highly localised to within metres to tens of metres from cables.

**Table 9.58: Cumulative Potential Sources of EMFs for the Tier 2 Projects within the O&M Phase of the Proposed Development**

| <b>Project</b>                                      | <b>MDS</b>                                                                                                          | <b>Source of EMFs</b>                                                      | <b>Reference</b>                                                  |
|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------|
| <b>Proposed Development</b>                         | 605 km (includes up to 12 km of dynamic IACs).                                                                      | See Table 9.15                                                             | N/A                                                               |
| <b>Offshore Wind Projects and Associated Cables</b> |                                                                                                                     |                                                                            |                                                                   |
| <b>Beatrice OWF</b>                                 | O&M: 350 km of IAC.                                                                                                 | IACs.                                                                      | Beatrice OWF Limited (2012b)                                      |
| <b>Beatrice OWF Export Cable Route</b>              | O&M: 70 km of export cables.                                                                                        | Export cables.                                                             | Beatrice OWF Limited (2025)                                       |
| <b>Caledonia OWF</b>                                | O&M: 655 km of IAC (6,864 m dynamic), 60 km of interconnector cables, and 330 km of export cables (1,045 km total). | Export cables, IACS (including dynamic cables), and interconnector cables. | Caledonia OWF Ltd (2024c), Caledonia OWF Ltd (2024d)              |
| <b>Moray East OWF Array</b>                         | O&M: 572 km of IACs.                                                                                                | IACs.                                                                      | Moray Offshore Renewables Limited (2019b)                         |
| <b>Moray East OWF Transmission</b>                  | O&M: 105 km of export cables.                                                                                       | Export cables.                                                             | Moray Offshore Renewables Limited (2019d)                         |
| <b>Moray West OWF</b>                               | O&M: 275 km of IACs, 15 km of interconnectors and 130 km of export cables (420 km total).                           | Export cables, IACS, and interconnector cables.                            | Moray West OWF Limited (2018)                                     |
| <b>Pentland Floating OWF</b>                        | O&M: 25 km of export cable and 20 km of IACs. In addition, up to 5,500 m of dynamic cables (50.5 km total).         | Export cables and IACs (including dynamic cables).                         | Pentland Floating OWF (2022b)                                     |
| <b>Cable Projects</b>                               |                                                                                                                     |                                                                            |                                                                   |
| <b>Shefa-2 Seg 8</b>                                | O&M: 98.99 km within the 50 km CEA buffer.                                                                          | Telecommunications cables.                                                 | Calculated in house, using Geographical Information Systems (GIS) |
| <b>Shefa-2 Seg 9</b>                                | O&M: 89.63 km within the 50 km buffer.                                                                              |                                                                            |                                                                   |

| Project                                                                           | MDS                                                               | Source of EMFs | Reference                                                                         |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------|----------------|-----------------------------------------------------------------------------------|
| <b>Shetland HVDC</b>                                                              | O&M: 253 km in total, with 146.75 km within the 50 km CEA buffer. |                | Scottish South and Southern Energy Networks (SSE, 2021) and calculated using GIS. |
| <b>R100 projects (telecommunication cables between islands in eastern Orkney)</b> | O&M: 19.28 km within the 50 km CEA buffer.                        |                | Calculated in house, using GIS                                                    |
| <b>Spittal to Peterhead Subsea Cable Link</b>                                     | O&M: 172 km                                                       | Power cables   | SSENT (2025)                                                                      |
| <b>Total cable length (Proposed Development and Tier 2 projects)</b>              | <b>3,744.15 km (including 24.36 km of dynamic IACs)</b>           |                |                                                                                   |



- 9.12.212 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous, and high reversibility (as cables will be removed and/or de-powered during the decommissioning phase). It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.213 The sensitivity of the receptor is as defined in Paragraphs 9.10.273 to 9.10.294 above for the alone assessment.

Significance of effect

- 9.12.214 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.215 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

**Tier 3**

*O&M phase*

Magnitude of impact

- 9.12.216 In addition to the Tier 2 projects, the only Tier 3 projects identified with a potential for cumulative impact were the Stromar OWF and the Westray South Tidal Farm (both in their O&M phases) (Table 9.49). As Tier 3 projects, there were no specific cable parameters publicly available for Stromar OWF or the Westray South Tidal Farm (e.g. lengths of cables, burial depths, cable protection). However, cable burial and/or cable protection measures are likely to be included within these projects as industry standard, such as detailed in Table 9.15 for the Proposed Development.
- 9.12.217 EMFs emitted by subsea cables are influenced by a variety of design and installation factors, including distance between cables, cable sheathing, number of conductors, and internal cable configuration. The intensity of EMF from subsea cables decreases at approximately the inverse square/power of the distance away from the cable (Hutchison *et al.*, 2021). This attenuation is applicable to buried, unburied, and dynamic cables (Hutchison *et al.*, 2021). Therefore, the cumulative magnitude of impact with the Tier 3 projects is likely to be highly localised to within metres to tens of metres from cables.
- 9.12.218 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous, and high reversibility (as cables will be removed and/or de-powered during the decommissioning phase). It is predicted

that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.219 The sensitivity of the receptor is as defined in Paragraphs 9.10.273 to 9.10.294 above for the alone assessment.

Significance of effect

- 9.12.220 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.221 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

**Tier 4**

*O&M phase*

Magnitude of impact

- 9.12.222 In addition to the Tier 2 and 3 projects, the only Tier 4 projects identified with a potential for cumulative impact was Orkney Connection cable (in its O&M phases) (Table 9.49). As a Tier 4 project, there were no specific cable parameters publicly available (e.g. lengths of cables, burial depths, cable protection). However, cable burial and/or cable protection measures are likely to be included within these projects as industry standard, such as detailed in Table 9.15 for the Proposed Development.
- 9.12.223 EMFs emitted by subsea cables are influenced by a variety of design and installation factors, including distance between cables, cable sheathing, number of conductors, and internal cable configuration. The intensity of EMF from subsea cables decreases at approximately the inverse square/power of the distance away from the cable (Hutchison *et al.*, 2021). This attenuation is applicable to buried, unburied, and dynamic cables (Hutchison *et al.*, 2021). Therefore, the cumulative magnitude of impact with the Tier 4 project is likely to be highly localised to within metres to tens of metres from cables.
- 9.12.224 The cumulative impact is predicted to be of local spatial extent, long term duration, continuous, and high reversibility (as cables will be removed and/or de-powered during the decommissioning phase). It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.225 The sensitivity of the receptor is as defined in Paragraphs 9.10.273 to 9.10.294 above for the alone assessment.

Significance of effect

- 9.12.226 Overall, for all fish and shellfish IEFs, the cumulative magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.227 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

**IMPACTS TO FISH AND SHELLFISH DUE TO ENTANGLEMENT**

***Tier 2***

*O&M phase*

Magnitude of impact

- 9.12.228 There were two Tier 2 projects identified with the potential to have a cumulative risk of entanglement with the Proposed Development during their O&M phases: Caledonia OWF and Pentland Floating OWF (Table 9.49). The maximum cumulative length of mooring lines and dynamic cables within the water column of the Tier 2 projects together with the Proposed Development is estimated at up to 415.26 km<sup>2</sup> (Table 9.59).
- 9.12.229 As described in Section 9.9, as a part of the Embedded Mitigation, mooring lines and dynamic IACs will undergo regular inspections during the O&M phase, employing a risk-based adaptive management approach. In addition, the Caledonia OWF has the development of and adherence to an Entanglement Management Plan to reduce the potential risk of entanglement to marine life as an Embedded Mitigation measure (Caledonia OWF Ltd, 2024d). Similarly, the Pentland Floating OWF has the removal of debris from mooring lines and dynamic cables as an Embedded Mitigation measure (Pentland Floating OWF, 2022c). The EIA for Pentland Floating OWF states that mooring line and cable inspections are expected to occur at a higher frequency initially and then reduce in frequency over a number of years, with changes to inspection periods based on evidence of risk garnered from the inspections (Pentland Floating OWF, 2022c). Additionally, a small number of floating substructures associated with the Pentland Floating OWF will be equipped with sensors monitoring tension and inclination on mooring lines. This will detect any larger debris and anomalies. Any inspected or detected debris on the floating lines and cables will be recovered, based on a risk assessment which considers the

impact on the environment, risk to asset integrity, and cost of intervention (Pentland Floating OWF, 2022c).

- 9.12.230 The risk of entanglement for fish and shellfish receptors is not fully understood but the commitment to monitor and manage the risks will reduce any potential contribution to cumulative effects. There are no published standard industry measures at the time of writing. However, as the Tier 2 projects have adopted a similar 'monitor and manage' approach as the Proposed Development, it is likely that the potential for cumulative effects would be further reduced.

**Table 9.59: Cumulative Potential Sources of Entanglement for the Tier 2 Projects within the O&M Phase of the Proposed Development**

| Project                                                 | MDS                                                                                                  | Potential Source of Entanglement  | Reference                                                    |
|---------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------|--------------------------------------------------------------|
| <b>Proposed Development</b>                             | 135.82 km                                                                                            | See Table 9.15                    | N/A                                                          |
| <b>Offshore Wind Projects and Associated Cables</b>     |                                                                                                      |                                   |                                                              |
| <b>Caledonia OWF</b>                                    | O&M: 234 km of mooring lines and 6,864 m of dynamic IACs (total of 240.86 km).                       | Mooring lines and dynamic cables. | Caledonia OWF Ltd (2024d)                                    |
| <b>Pentland Floating OWF</b>                            | O&M: 33,075 m of semi-taut mooring lines, and 5,500 m of export cable and IACs. (total of 38.58 km). | Mooring lines and dynamic cables. | Pentland Floating OWF (2022b), Pentland Floating OWF (2022c) |
| <b>Total (Proposed Development and Tier 2 projects)</b> | 415.26 km                                                                                            |                                   |                                                              |

- 9.12.231 Overall, the cumulative impact is predicted to be of local spatial extent (in the context of the geographic frame of reference), long term duration, continuous, and low reversibility (if it occurs). It is predicted that the impact will affect the receptor directly in the case of both (rare) primary entanglement and secondary entanglement, however the risk of secondary entanglement is sufficiently reduced with the application of the Embedded Mitigation, and any population-level effects are highly unlikely. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.232 The sensitivity of the receptor is as defined in Paragraphs 9.10.305 to 9.10.320 above for the alone assessment.

Significance of effect

- 9.12.233 Overall, for all marine fish and diadromous fish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.234 For the squid and octopi IEF, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.235 For the remaining shellfish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.236 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

**Tier 3**

*O&M phase*

Magnitude of impact

- 9.12.237 In addition to the Tier 2 projects, there were two Tier 3 projects identified with the potential to have a cumulative risk of entanglement with the Proposed Development during their O&M phases: Stromar OWF and the Westray South Tidal Farm (Table 9.49). As Tier 3 projects, there were no specific parameters publicly available for them (e.g. lengths of cables and mooring lines in the water column). Therefore, a qualitative assessment has been provided.
- 9.12.238 The risk of entanglement for fish and shellfish receptors is not fully understood but the commitment to monitor and manage the risks will reduce any potential contribution to cumulative effects. There are no published standard industry measures at the time of writing. However, if other OWF projects (such as those identified in Tier 2) adopt a similar 'monitor and manage' approach (see Paragraph 9.12.229), it is likely that the potential for cumulative effects from the Tier 3 projects would be further reduced. Considering the implementation of these Embedded Mitigation measures during the O&M phase of the Proposed Development, the potential for cumulative effects associated with the Tier 3 projects resulting from entanglement is considered very unlikely.
- 9.12.239 Overall, the cumulative impact is predicted to be of local spatial extent (in the context of the geographic frame of reference), long term duration, continuous, and low reversibility (if it occurs). It is predicted that the

impact will affect the receptor directly in the case of both (rare) primary entanglement and secondary entanglement, however the risk of secondary entanglement is sufficiently reduced with the application of the Embedded Mitigation, and any population-level effects are highly unlikely. The magnitude of impact is therefore, considered to be low.

Sensitivity of receptor

- 9.12.240 The sensitivity of the receptor is as defined in Paragraphs 9.10.305 to 9.10.320 above for the alone assessment.

Significance of effect

- 9.12.241 Overall, for all marine fish and diadromous fish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.242 For the squid and octopi IEF, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The cumulative effect will therefore be of **Minor** adverse significance, which is not significant in EIA terms.
- 9.12.243 For the remaining shellfish IEFs, the cumulative magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. The cumulative effect will therefore be of negligible to minor adverse significance. As a precaution, **Minor** adverse significance has been concluded, which is not significant in EIA terms.

Additional Mitigation and residual effect

- 9.12.244 No Additional Mitigation is considered necessary because the likely effect in the absence of Additional Mitigation (beyond the Embedded Mitigation measures outlined in Section 9.9) is not significant in EIA terms.

## 9.13 Proposed Monitoring

- 9.13.1 This section outlines the proposed monitoring applicable to the identified potential significant adverse impacts related to fish and shelf Proposed monitoring measures are outlined in Table 9.60 below.

**Table 9.60: Proposed Monitoring and the Method of Implementation for Fish and Shellfish Ecology**

| Potential Environmental Effect       | Monitoring Commitment                                                                                                    | Means of Implementation |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Various effects upon diadromous fish | Development of and adherence to a PEMP post-consent to include details of any agreed surveys or monitoring requirements. | The PEMP                |

## 9.14 Transboundary Effects

- 9.14.1 A screening of transboundary effects has been carried out (see Volume 3, Technical Appendix 4.5: Transboundary Impacts Screening) and has identified that there were no likely significant transboundary effects with regard to fish and shellfish ecology from the Proposed Development upon the interests of EEA states.

## 9.15 Summary of Impacts, Mitigation, Likely Significant Environmental Effects and Monitoring

- 9.15.1 Information on fish and shellfish ecology within the Fish and Shellfish Ecology Study Area was collected through a detailed desktop review and the results of site-specific surveys. This information is summarised in Table 9.8 and Table 9.9.
- 9.15.2 Table 9.61 presents a summary of the assessment of significance in respect to Fish and Shellfish Ecology. Overall, it is concluded that there will be no likely significant environmental effects arising from the Proposed Development during the construction, O&M or decommissioning phases. Although a likely significant effect (moderate adverse) has been concluded for the herring IEF resulting from piling during the construction phase. Appropriate Additional Mitigation measures will be discussed and agreed with stakeholders prior to commencement of works. These will be detailed and secured through the Piling Strategy developed post-consent. Measures included in the Piling Strategy will be dependent on the final design of the Proposed Development. Mitigation measures within the Piling Strategy will be agreed as part of a stepped strategy post consent and will follow the mitigation hierarchy – avoid, reduce, mitigate. It is expected that the measures secured within the Piling Strategy will reduce the significance of this impact to minor adverse for herring, which is not significant in EIA terms.



- 9.15.3 Table 9.62 presents a summary of the CEA on fish and shellfish ecology in EIA terms. Overall, it is concluded that there will be no likely significant cumulative effects from the Proposed Development alongside other projects/plans. As detailed in Paragraph 9.15.3, appropriate Additional Mitigation measures will be discussed and agreed with stakeholders to reduce the significance of the cumulative impact of subsea piling noise on herring to minor adverse, which is not significant in EIA terms.
- 9.15.4 No likely significant transboundary effects have been identified in regard to effects of the Proposed Development.

Table 9.61: Summary of Assessment of Significance

| Description of Impact                                                                    | Embedded Mitigation                                                                   | Magnitude of Impact | Sensitivity of Receptor                                                                                           | Significance of Effect                                                                         | Additional Mitigation                                                                       | Significance Residual Effect                                  | Proposed Monitoring |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------|---------------------|
| <b>Construction Phase</b>                                                                |                                                                                       |                     |                                                                                                                   |                                                                                                |                                                                                             |                                                               |                     |
| <b>Temporary habitat loss and/or disturbance</b>                                         | N/A                                                                                   | Low                 | <ul style="list-style-type: none"> <li>Sandeel – Medium</li> <li>All other IEFs – Low</li> </ul>                  | All IEFs – Minor adverse                                                                       | None required.                                                                              | N/A                                                           | None.               |
| <b>Long term habitat loss and/or disturbance</b>                                         | N/A                                                                                   | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs – Low</li> </ul> | All IEFs – Minor adverse                                                                       | None required.                                                                              | N/A                                                           | None.               |
| <b>Introduction of artificial habitat and subsequent colonisation of hard structures</b> | N/A                                                                                   | Low                 | All IEFs – Low                                                                                                    | All IEFs – Minor adverse                                                                       | None required.                                                                              | N/A                                                           | None.               |
| <b>Increased SSCs and associated deposition</b>                                          | Development of, and adherence to, a CSIP post consent.                                | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs – Low</li> </ul> | All IEFs – Minor adverse                                                                       | None required.                                                                              | N/A                                                           | None.               |
| <b>Subsea noise impacting fish and shellfish receptors</b>                               | <ul style="list-style-type: none"> <li>Piling soft starts and/or ADDs; and</li> </ul> | Low                 | <ul style="list-style-type: none"> <li>Herring – High</li> <li>All other IEFs – Low</li> </ul>                    | <ul style="list-style-type: none"> <li>Herring – Moderate adverse (for piling only)</li> </ul> | Appropriate Additional Mitigation measures to be discussed and agreed with stakeholders and | Herring IEF – Minor adverse (after application of appropriate | None.               |

| Description of Impact                                              | Embedded Mitigation                                                                           | Magnitude of Impact | Sensitivity of Receptor                                                                                           | Significance of Effect                                                                                                     | Additional Mitigation                                                                                                                                                                 | Significance Residual Effect | Proposed Monitoring |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------|
|                                                                    | <ul style="list-style-type: none"> <li>Low order disposal of UXOs, where possible.</li> </ul> |                     |                                                                                                                   | <ul style="list-style-type: none"> <li>All other IEFs (and herring for all other noise sources) – Minor adverse</li> </ul> | secured as part of a Piling Strategy post consent to reduce the significance of the impact of subsea piling noise on herring to minor adverse, which is not significant in EIA terms. | Additional Mitigation)       |                     |
| <b>Accidental pollution impacting fish and shellfish receptors</b> | Various measures, see Table 9.22 for full details                                             | Negligible          | All IEFs - Medium                                                                                                 | All IEFs – Negligible adverse                                                                                              | None required.                                                                                                                                                                        | N/A                          | None.               |
| <b>O&amp;M Phase</b>                                               |                                                                                               |                     |                                                                                                                   |                                                                                                                            |                                                                                                                                                                                       |                              |                     |
| <b>Temporary habitat loss and/or disturbance</b>                   | N/A                                                                                           | Low                 | <ul style="list-style-type: none"> <li>Sandeel – Medium</li> <li>All other IEFs - Low</li> </ul>                  | All IEFs – Minor adverse                                                                                                   | None required.                                                                                                                                                                        | N/A                          | None.               |
| <b>Long term habitat loss and/or disturbance</b>                   | N/A                                                                                           | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs - Low</li> </ul> | All IEFs – Minor adverse                                                                                                   | None required.                                                                                                                                                                        | N/A                          | None.               |
| <b>Introduction of artificial habitat and</b>                      | N/A                                                                                           | Low                 | All IEFs - Low                                                                                                    | All IEFs – Minor adverse                                                                                                   | None required.                                                                                                                                                                        | N/A                          | None.               |

| Description of Impact                                              | Embedded Mitigation                                                                                                                 | Magnitude of Impact | Sensitivity of Receptor                                                                                                                 | Significance of Effect                                                                                                                     | Additional Mitigation | Significance Residual Effect | Proposed Monitoring |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------------------------------|---------------------|
| <b>subsequent colonisation</b>                                     |                                                                                                                                     |                     |                                                                                                                                         |                                                                                                                                            |                       |                              |                     |
| <b>Increased SSCs and associated deposition</b>                    | N/A                                                                                                                                 | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs – Low</li> </ul>                       | All IEFs – Minor adverse                                                                                                                   | None required.        | N/A                          | None.               |
| <b>Subsea noise impacting fish and shellfish receptors</b>         | N/A                                                                                                                                 | Low                 | <ul style="list-style-type: none"> <li>All Fish IEFs – Medium</li> <li>All Shellfish IEFs – Negligible</li> </ul>                       | All IEFs – Minor adverse                                                                                                                   | None required.        | N/A                          | None.               |
| <b>Impacts to fish and shellfish receptors due to EMF</b>          | <ul style="list-style-type: none"> <li>Development of, and adherence to, a CSIP post consent; and</li> <li>CBRA and CBA.</li> </ul> | Low                 | All IEFs – Low                                                                                                                          | All IEFs – Minor adverse                                                                                                                   | None required.        | N/A                          | None.               |
| <b>Impacts to fish and shellfish receptors due to entanglement</b> | Development and adherence to an Entanglement Management Plan, or equivalent.                                                        | Low                 | <ul style="list-style-type: none"> <li>All marine fish and diadromous fish IEFs – Medium</li> <li>Squid and octopi IEF – Low</li> </ul> | <ul style="list-style-type: none"> <li>All marine fish and diadromous fish IEFs – Minor adverse</li> <li>Squid and octopi IEF –</li> </ul> | None required.        | N/A                          | None.               |

| Description of Impact                                                 | Embedded Mitigation                                         | Magnitude of Impact | Sensitivity of Receptor                                                                                           | Significance of Effect                                                                                      | Additional Mitigation | Significance Residual Effect | Proposed Monitoring |
|-----------------------------------------------------------------------|-------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-----------------------|------------------------------|---------------------|
|                                                                       |                                                             |                     | <ul style="list-style-type: none"> <li>All other shellfish IEFs – Negligible to minor</li> </ul>                  | Minor adverse<br><ul style="list-style-type: none"> <li>All other shellfish IEFs – Minor adverse</li> </ul> |                       |                              |                     |
| <b>Accidental pollution impacting fish and shellfish receptors</b>    | Various measures, see Table 9.22 for full details           | Negligible          | <ul style="list-style-type: none"> <li>All IEFs - Medium</li> </ul>                                               | <ul style="list-style-type: none"> <li>All IEFs – Negligible adverse</li> </ul>                             | None required.        | N/A                          | None.               |
| <b>Decommissioning Phase</b>                                          |                                                             |                     |                                                                                                                   |                                                                                                             |                       |                              |                     |
| <b>Temporary habitat loss and/or disturbance</b>                      | Drafting and implementation of a decommissioning programme. | Low                 | <ul style="list-style-type: none"> <li>Sandeel – Medium</li> <li>All other IEFs - Low</li> </ul>                  | All IEFs – Minor adverse                                                                                    | None required.        | N/A                          | None.               |
| <b>Long term habitat loss and/or disturbance</b>                      | Drafting and implementation of a decommissioning programme. | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs - Low</li> </ul> | All IEFs – Minor adverse                                                                                    | None required.        | N/A                          | None.               |
| <b>Introduction of artificial habitat and subsequent colonisation</b> | Drafting and implementation of a decommissioning programme. | Low                 | All IEFs - Low                                                                                                    | All IEFs – Minor adverse                                                                                    | None required.        | N/A                          | None.               |

| Description of Impact                                              | Embedded Mitigation                                         | Magnitude of Impact | Sensitivity of Receptor                                                                                           | Significance of Effect        | Additional Mitigation | Significance Residual Effect | Proposed Monitoring |
|--------------------------------------------------------------------|-------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------|-----------------------|------------------------------|---------------------|
| <b>Increased SSCs and associated deposition</b>                    | N/A                                                         | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs – Low</li> </ul> | All IEFs – Minor adverse      | None required.        | N/A                          | None.               |
| <b>Subsea noise impacting fish and shellfish receptors</b>         | Drafting and implementation of a decommissioning programme. | Low                 | All IEFs - Low                                                                                                    | All IEFs – Minor adverse      | None required.        | N/A                          | None.               |
| <b>Accidental pollution impacting fish and shellfish receptors</b> | Various measures, see Table 9.22 for full details           | Negligible          | All IEFs - Medium                                                                                                 | All IEFs – Negligible adverse | None required.        | N/A                          | None.               |

Table 9.62: Summary of CEA

| Description of Impact                                                 | Cumulative Effects Assessment Tier | Magnitude of Impact | Sensitivity of Receptor                                                                                           | Significance of Effect                                                                         | Additional Mitigation                                          | Significance Residual Effect                                  | Proposed Monitoring |
|-----------------------------------------------------------------------|------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------------|---------------------|
| <b>Construction Phase</b>                                             |                                    |                     |                                                                                                                   |                                                                                                |                                                                |                                                               |                     |
| <b>Temporary habitat loss and/or disturbance</b>                      | Tiers 2 to 4                       | Low                 | <ul style="list-style-type: none"> <li>Sandeel – Medium</li> <li>All other IEFs – Low</li> </ul>                  | All IEFs – Minor adverse                                                                       | None required.                                                 | N/A                                                           | None.               |
| <b>Long term habitat loss and/or disturbance</b>                      | Tiers 2 to 4                       | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs – Low</li> </ul> | All IEFs – Minor adverse                                                                       | None required.                                                 | N/A                                                           | None.               |
| <b>Introduction of artificial habitat and subsequent colonisation</b> | Tiers 2 to 4                       | Low                 | All IEFs – Low                                                                                                    | All IEFs – Minor adverse                                                                       | None required.                                                 | N/A                                                           | None.               |
| <b>Increased SSCs and associated deposition</b>                       | Tiers 2 to 4                       | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs – Low</li> </ul> | All IEFs – Minor adverse                                                                       | None required.                                                 | N/A                                                           | None.               |
| <b>Subsea noise impacting fish and shellfish receptors</b>            | Tiers 2 and 3                      | Low                 | <ul style="list-style-type: none"> <li>Herring – High</li> </ul>                                                  | <ul style="list-style-type: none"> <li>Herring – Moderate adverse (for piling only)</li> </ul> | Appropriate Additional Mitigation measures to be discussed and | Herring IEF – Minor adverse (after application of appropriate | None.               |



| Description of Impact                            | Cumulative Effects Assessment Tier | Magnitude of Impact | Sensitivity of Receptor                                                                                           | Significance of Effect                                                                                                     | Additional Mitigation                                                                                                                                                                                                         | Significance Residual Effect | Proposed Monitoring |
|--------------------------------------------------|------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------|
|                                                  |                                    |                     | <ul style="list-style-type: none"> <li>All other IEFs - Low</li> </ul>                                            | <ul style="list-style-type: none"> <li>All other IEFs (and herring for all other noise sources) – Minor adverse</li> </ul> | agreed with stakeholders and secured as part of a Piling Strategy post consent to reduce the significance of the cumulative impact of subsea piling noise on herring to minor adverse, which is not significant in EIA terms. | Additional Mitigation)       |                     |
| <b>O&amp;M Phase</b>                             |                                    |                     |                                                                                                                   |                                                                                                                            |                                                                                                                                                                                                                               |                              |                     |
| <b>Temporary habitat loss and/or disturbance</b> | Tiers 2 to 4                       | Low                 | <ul style="list-style-type: none"> <li>Sandeel – Medium</li> <li>All other IEFs - Low</li> </ul>                  | All IEFs – Minor adverse                                                                                                   | None required.                                                                                                                                                                                                                | N/A                          | None.               |
| <b>Long term habitat loss and/or disturbance</b> | Tiers 2 to 4                       | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs - Low</li> </ul> | All IEFs – Minor adverse                                                                                                   | None required.                                                                                                                                                                                                                | N/A                          | None.               |
| <b>Introduction of artificial</b>                | Tiers 2 to 4                       | Low                 | All IEFs - Low                                                                                                    | All IEFs – Minor adverse                                                                                                   | None required.                                                                                                                                                                                                                | N/A                          | None.               |

| Description of Impact                                       | Cumulative Effects Assessment Tier | Magnitude of Impact | Sensitivity of Receptor                                                                                                                                                                         | Significance of Effect                                                                                                                                                                                     | Additional Mitigation | Significance Residual Effect | Proposed Monitoring |
|-------------------------------------------------------------|------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------------------------------|---------------------|
| habitat and subsequent colonisation                         |                                    |                     |                                                                                                                                                                                                 |                                                                                                                                                                                                            |                       |                              |                     |
| Subsea noise impacting fish and shellfish receptors         | Tiers 2 and 3                      | Low                 | <ul style="list-style-type: none"> <li>All Fish IEFs – Medium</li> <li>All Shellfish IEFs – Negligible</li> </ul>                                                                               | All IEFs – Minor adverse                                                                                                                                                                                   | None required.        | N/A                          | None.               |
| Impacts to fish and shellfish receptors due to EMF          | Tiers 2 to 4                       | Low                 | All IEFs - Low                                                                                                                                                                                  | All IEFs – Minor adverse                                                                                                                                                                                   | None required.        | N/A                          | None.               |
| Impacts to fish and shellfish receptors due to entanglement | Tiers 2 and 3                      | Low                 | <ul style="list-style-type: none"> <li>All marine fish and diadromous fish IEFs – Medium</li> <li>Squid and octopi IEF – Low</li> <li>All other shellfish IEFs – Negligible to minor</li> </ul> | <ul style="list-style-type: none"> <li>All marine fish and diadromous fish IEFs – Minor adverse</li> <li>Squid and octopi IEF – Minor adverse</li> <li>All other shellfish IEFs – Minor adverse</li> </ul> | None required.        | N/A                          | None.               |

| Description of Impact                                                 | Cumulative Effects Assessment Tier | Magnitude of Impact | Sensitivity of Receptor                                                                                           | Significance of Effect   | Additional Mitigation | Significance Residual Effect | Proposed Monitoring |
|-----------------------------------------------------------------------|------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|------------------------------|---------------------|
| <b>Decommissioning Phase</b>                                          |                                    |                     |                                                                                                                   |                          |                       |                              |                     |
| <b>Temporary habitat loss and/or disturbance</b>                      | Tiers 2 to 4                       | Low                 | <ul style="list-style-type: none"> <li>Sandeel – Medium</li> <li>All other IEFs - Low</li> </ul>                  | All IEFs – Minor adverse | None required.        | N/A                          | None.               |
| <b>Long term habitat loss and/or disturbance</b>                      | Tiers 2 to 4                       | Low                 | <ul style="list-style-type: none"> <li>Herring and sandeel IEFs – Medium</li> <li>All other IEFs - Low</li> </ul> | All IEFs – Minor adverse | None required.        | N/A                          | None.               |
| <b>Introduction of artificial habitat and subsequent colonisation</b> | Tiers 2 to 4                       | Low                 | All IEFs - Low                                                                                                    | All IEFs – Minor adverse | None required.        | N/A                          | None.               |
| <b>Subsea noise impacting fish and shellfish receptors</b>            | Tiers 2 and 3                      | Low                 | All IEFs - Low                                                                                                    | All IEFs – Minor adverse | None required.        | N/A                          | None.               |

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