BERWICK BANK WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Volume 1, Chapter 3: Project Description

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Prepared by:	**RPS**
Prepared for:	**SSE Renewables**
Checked by:	**Kerr MacKinnon**
Accepted by:	**Ross Hodson**
Approved by:	**Sarah Edwards**

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3. DESCRIPTION OF DEVELOPMENT

3.1. INTRODUCTION

3.1.1. OVERVIEW

1. This chapter of the Offshore Environmental Impact Assessment (EIA) Report provides a description of the offshore components of the Berwick Bank Wind Farm (the Project) with the offshore components seaward of Mean High Water Springs (MHWS) (hereafter referred to as the Proposed Development). This chapter is based on design work undertaken to date and current understanding of the environment associated with the Proposed Development from site-specific survey work. Specifically, this chapter sets out the individual components associated with the Proposed Development and the activities associated with the construction, operation and maintenance, and decommissioning.

2. Berwick Bank Wind Farm is a complex Project subject to various design and engineering tasks, technology choices and market trends in the planning phase. The design and engineering options available are dependent on the specific conditions and environmental factors at the site. Studies to address existing unknowns due to the early stage of development and to refine design parameters will continue beyond the planning phase and into procurement and contracting. At Application, the necessary information on the site conditions and the procurement process is unavailable to inform the final Project design. These include final wind turbine number and size, foundation design, wind farm layout, the exact locations of offshore substations, cable type and cable route. The detailed design will be confirmed once consent has been granted, subject to further site investigation.

3. The Applicant has therefore followed the Project Design Envelope (PDE) approach (also known as the 'Rochdale Envelope') (Scottish Government, 2022). In this chapter, parameters for the Proposed Development are described that include the maximum extents of the design as a basis to determine what the likely worst case effects may be, noting that for some technical topics the worst case might be a combination of parameters, not just the maximum parameter, as explained and assessed in volume 2, chapters 7 to 21. The 'maximum design envelope' presented in this chapter defines the maximum range of design parameters. For the EIA, the Applicant has discerned the maximum impacts that could occur for given receptor groups, selecting these from within the range of the design parameters (maximum design envelope') to define the "maximum design scenario" for that receptor group.

4. As time progresses, and additional information is available from site investigations and commercial availability of technologies, increased certainty can be provided over Project details to inform the final detailed design. This approach is standard for large scale energy projects such as the Project.

3.1.2. PURPOSE OF THIS CHAPTER

5. The purpose of this Offshore EIA Report chapter is:

- to provide the maximum PDE for the Proposed Development which consent is being sought for, comprising information on the site, design, size and other relevant features of the Proposed Development, based on preliminary conceptual design principles (section 3.1.4) and current understanding of the environment;
- to set out the individual components of the Proposed Development, as well as the main activities associated with the construction, operation and maintenance and decommissioning phases; and
- to provide the basis for the assessment of effects included in volume 2, chapters 7 to 21.

3.1.3. PROJECT DESIGN ENVELOPE

6. The PDE approach provides flexibility while ensuring all potential likely significant effects (beneficial or adverse) are assessed within the Offshore EIA process and reported in the Offshore EIA Report. Project parameters presented include a range of potential values up to and including the maximum Project design parameters.

7. The Proposed Development's PDE has been designed to include sufficient flexibility to accommodate further Project refinement during the final design stage. For each of the impacts assessed within the technical assessments (volume 2, chapters 7 to 21), the maximum design scenario has been identified from the range of potential options for each parameter set out in the PDE which is described in this chapter. By employing the maximum design scenario approach, the Applicant retains some flexibility in the final design of the Proposed Development and associated offshore infrastructure, but within certain maximum parameters, which are assessed in this Offshore EIA Report. Based on the PDE, this Project Description chapter provides the maximum scenario, thus anything less than that set out in the Project Description chapter and assessed within the technical assessments will have a lesser impact.

8. This approach is in line with Scottish Government (2013) guidance, which states that 'by applying the principles of an approach commonly known as the 'Rochdale Envelope' it is possible to undertake an environmental assessment which takes account of the need for flexibility in the future evolution of the detailed Project proposal, within clearly defined parameters. In such cases, the level of detail of the proposals must be sufficient to enable a proper assessment of the likely significant environmental effects, and any resultant mitigation measures - if necessary, considering a range of possibilities.' The approach is also compliant with the guidance prepared by Marine Scotland and the Energy Consents Unit in June 2022 for applicants using the design envelope for applications under section 36 of the Electricity Act 1989 (Scottish Government, 2022).

9. The PDE approach applies a "maximum design scenario" that considers a realistic range of Project parameters (or scenarios). The PDE describes a range of parameters that apply to a Project technology design scenario (e.g. largest wind turbine option). For example, wind turbine size and wind turbine number are inherently correlated (e.g. if larger wind turbines are selected), fewer wind turbines are likely to be required. Therefore, each design parameter set out in this chapter are not considered independently. The maximum design scenario developed for each impact pathway has been taken from the PDE to establish the parameters (or combination of parameters) likely to result in the maximum effect (e.g. the maximum adverse scenario), while adhering to the Project technology design scenarios (e.g. infrastructure parameters associated with the largest wind turbine size). However, it does not follow necessarily that the largest parameters set out in this chapter comprise the maximum design scenario for any given receptor group and each of the impacts assessed within the technical assessments (volume 2, chapters 7 to 21).

10. In June 2022, revisions to the Proposed Development site boundary were announced. The revisions comprise a reduction in the Proposed Development array area, including to the north and western areas of the Proposed Development site boundary. This resulted in an approximate reduction in the overall area of the Proposed Development array area of 23% (when compared to the Proposed Development included in the Berwick Bank Wind Farm Offshore Scoping Report submitted in October 2021 (SSER, 2021a). Further detail is included in the Site Selection and Consideration of Alternatives chapter (volume 1, chapter 4), however, in general, the following adjustments have been made to the Proposed Development project description for the Proposed Development:

- revised boundary for Proposed Development array area;
- revised indicative wind turbine layouts;
- revised indicative construction programme;
- removal of open cut trench techniques at landfall;
- removal of the landfall option at Thorntonloch;

- reduction in the number offshore export cables from eight to 12 and refinement of the Proposed Development export cable corridor to account for the array boundary change;
- updated estimates to vessel numbers and movements; and
- revised approach to decommissioning.

11. In light of the revisions to the Proposed Development array area boundary it has been necessary to amend the PDE accordingly. Consequently, the PDE used in this Offshore EIA Report differs from that presented in the Berwick Bank Wind Farm Offshore Scoping Report submitted in October 2021 (SSER, 2021a). The latest PDE parameters for infrastructure seaward of MHWS are included in this Project Description chapter.

12. The derogation provisions within the Habitats Regulations Appraisal (HRA) process may require the Applicant to provide compensatory measures to compensate for the potential adverse effects on the integrity of European sites resulting from the Proposed Development either alone or in combination with other plans and projects. In anticipation of the potential need for compensation measures, the Applicant has undertaken an appraisal of the potential impacts of the compensatory measures proposed (without prejudice to the HRA to be conducted by the Competent Authority). The outcomes of the bespoke EIA and HRA of the compensation options for the Proposed Development are provided alongside the Application.

3.1.4. LOCATION AND SITE INFORMATION

13. The Proposed Development will be located in the central North Sea, approximately 47.6 km offshore of the East Lothian coastline and 37.8 km from the Scottish Borders coastline at St, Abbs. As described in volume 1, chapter 4, the Proposed Development is already the subject of Agreements for Lease (AfL) from Crown Estate Scotland (CES). The Proposed Development's assumed operational lifetime is 35 years, as described in volume 1,chapter 1.

Proposed Development boundary

14. The Proposed Development boundary is illustrated within Figure 3.1 and covers an area of 1,178.1 km^2. This area encompasses the:

- Proposed Development array area (an area of 1,010.2 km^2): this is where the offshore wind farm will be located, which will include the wind turbines, wind turbine foundations, inter-array cables, and a range of offshore substations and offshore interconnector cables; and
- Proposed Development export cable corridor up to MHWS (an area of 167.9 km^2): this is where the offshore electrical infrastructure such as offshore export cables and associated cable protection will be located.

Water depths and seabed within the Proposed Development array area

15. A geophysical survey was undertaken across the Proposed Development array area in 2019, providing geophysical and bathymetric data. The bathymetry of the Proposed Development array area is influenced by the presence of large scale morphological bank features of the 'Marr Bank' and 'Berwick Bank' (Figure 3.1). These two bank features are defined as 'Shelf Banks and Mounds' and are part of the Firth of Forth Banks Complex Marine Protected Area (MPA).

16. A maximum seabed depth is recorded at two locations where deep channels cut into the seabed east and west of the central point of the Proposed Development array area (68.5 m Lowest Astronomical Tide (LAT)). The shallowest area is observed in the west of the Proposed Development array area (33.4 m LAT). The average seabed depth across the Proposed Development array area is 51.7 m below LAT. The shallower areas are coincidental with the two large sand bank features that are present in the Proposed Development site boundary.

17. Further details of the bathymetry and a description of the seabed composition at the Proposed Development array area are presented within volume 2, chapters 7 and 8.

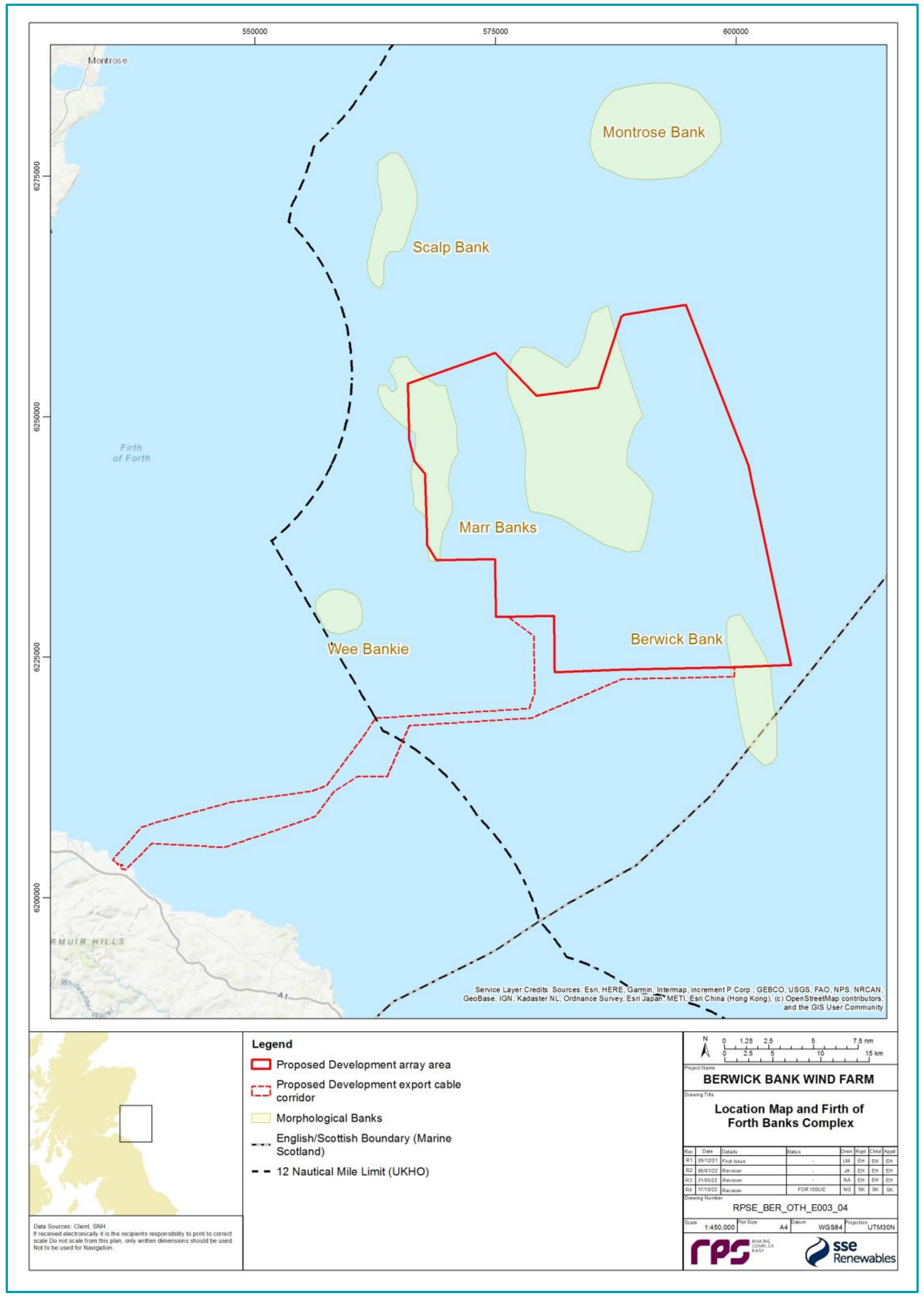

Figure 3.1: Location of the Proposed Development Array Area and Export Cable Corridor and the Firth of Forth Morphological Banks

3.1.5. PROPOSED DEVELOPMENT EXPORT CABLE CORRIDOR

18. The Proposed Development export cable corridor identified commences at the southern/south-western boundary of the Proposed Development array area and makes landfall at Skateraw on the East Lothian coast.

19. The bathymetry along the Proposed Development export cable corridor ranges from the low water mark to a depth of 69.8 m below LAT. Further details of the bathymetry and a description of the seabed composition at the Proposed Development export cable corridor are presented within volume 2, chapters 7 and 8.

3.2. OFFSHORE INFRASTRUCTURE

3.2.1. OVERVIEW

20. The key offshore components of the Proposed Development (seaward of MHWS), as shown in Figure 3.2, will include:

- up to 307 wind turbines (each comprising a tower section, nacelle and three rotor blades) and associated support structures and foundations;
- up to ten Offshore Substation Platforms (OSPs)/Offshore convertor station platforms and associated support structures and foundations to accommodate for a combined High Voltage Alternating Current (HVAC)/High Voltage Direct Current (HVDC) transmission system solution or a HVDC solution;
- estimated scour protection of up to 10,984 m^2 per wind turbine and 11,146 m^2 per OSP/Offshore convertor station platforms;
- a network of inter-array cabling linking the individual wind turbines to each other and to the OSPs/Offshore convertor station platforms plus inter-connections between OSPs/Offshore convertor station platforms (approximately 1,225 km of inter-array cabling and 94 km of interconnector cabling); and
- up to eight offshore export cables connecting the OSPs/Offshore convertor station platforms to landfall at Skateraw. Offshore export cable design includes both HVAC and HVDC solutions.

21. The Applicant is also developing an additional export cable and grid connection to Blyth, Northumberland (hereafter the "Cambois connection"). Applications for the necessary consents (including marine licences) will be applied for separately once further development work has been undertaken on this offshore export corridor. The Cambois connection has been included as a cumulative project for the purposes of the offshore EIA and assessed based on the information presented in the Cambois connection Scoping Report submitted in October 2022 (SSER, 2022e). An EIA and HRA will be prepared to support any relevant consent applications that are required to deliver the Cambois connection which will also consider cumulative effects with the Proposed Development.

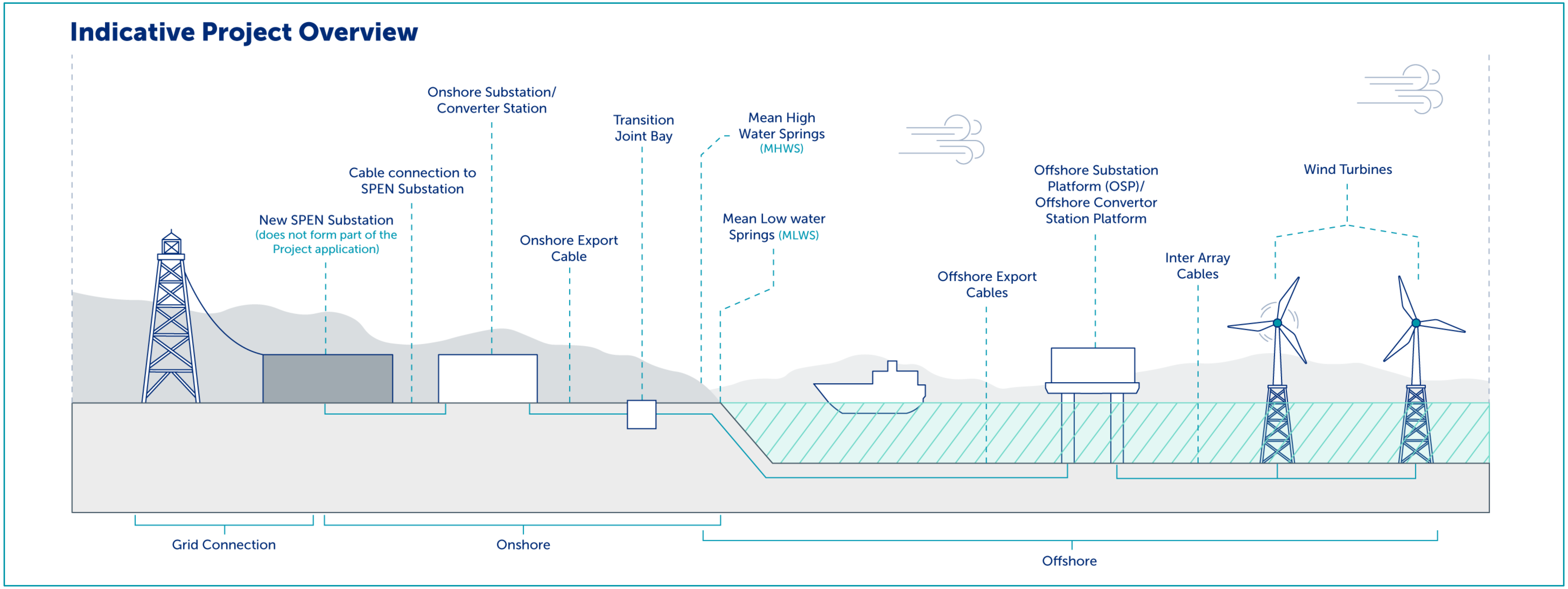

Figure 3.2: Project Overview[1]

[1] Consent is not sought in this Application for SPEN Grid Substation and overhead connections.

3.2.2. WIND TURBINES

22. The Proposed Development will comprise up to 307 wind turbines, with the final number of wind turbines dependent on the capacity of individual wind turbines used, and also environmental and engineering survey results. The PDE considers a range of wind turbines with parameters reflective of potential generating capacities, allowing for a degree of flexibility to account for any anticipated developments in wind turbine technology while still allowing each of the impacts assessed within the technical assessments (volume 2, chapters 7 to 21), to define the maximum design scenario for the assessment of effects. Consent is therefore sought for the physical parameters of the wind turbines which form the basis of the maximum design scenario such as maximum tip height or rotor diameter, as presented in the PDE rather than actual installed capacity of the wind turbines.

23. A range of wind turbine options have been considered. The parameters in Table 3.1 provide for both the maximum number of wind turbines, as well as the largest wind turbine within the PDE. As set out in paragraph 8, the coupling of these maximum dimensions will not provide a realistic design scenario; as a reduced number of wind turbines will likely be required if an increased rated output of wind turbine model is chosen. Table 3.1 describes the maximum parameters that apply.

24. The wind turbines will comprise a horizontal axis rotor with three blades connected to the nacelle of the wind turbine. Figure 3.3 illustrates a schematic of a typical offshore wind turbine.

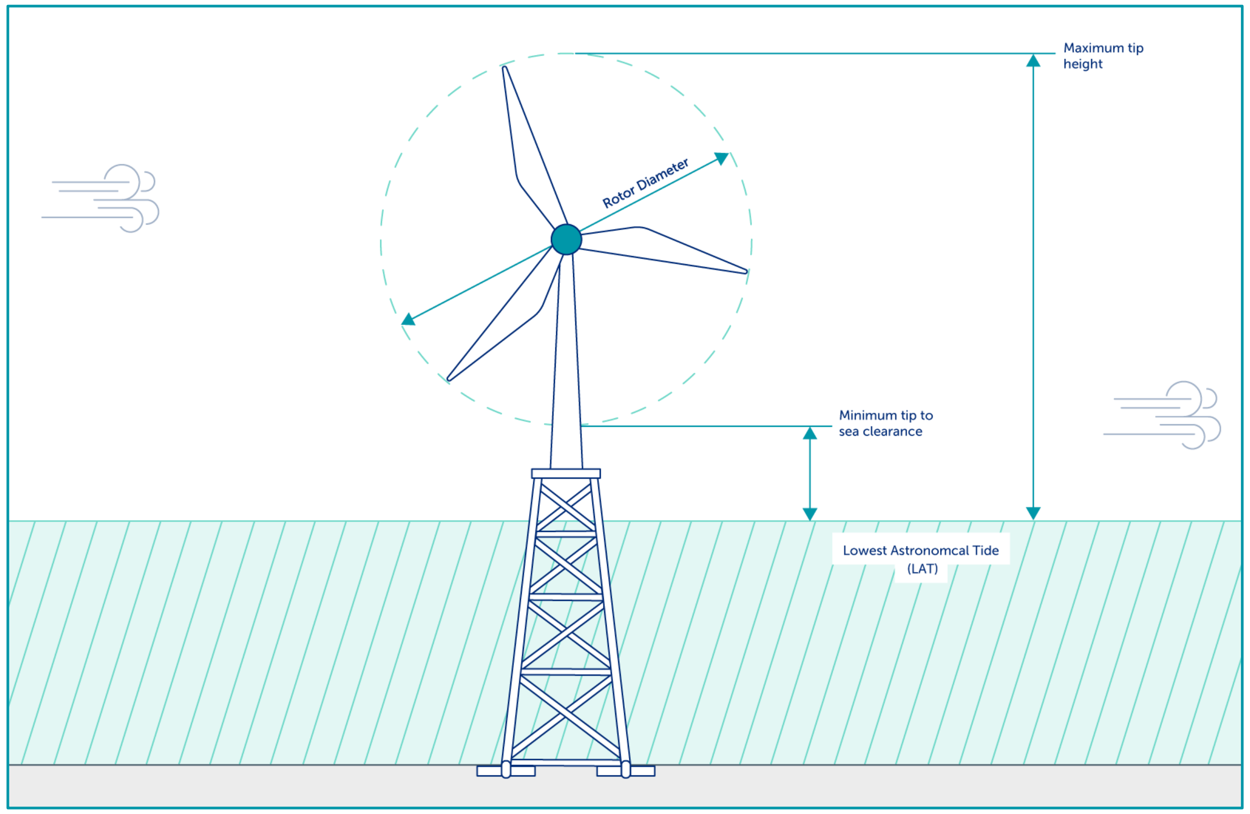

Figure 3.3: Indicative Schematic of an Offshore Wind Turbine on a Jacket Foundation

25. The maximum rotor blade diameter will be no greater than 310 m, with a maximum blade tip height of 355 m above LAT and a minimum lower blade tip height of 37 m above LAT. A scheme for wind turbine lighting and navigation marking will be approved by Scottish Ministers following consultation with appropriate consultees post consent. Outlines plans have been provided with the Application in volume 4 of this Offshore EIA Report.

26. The layout of the wind turbines will be developed to best utilise both the available wind resource, suitability of seabed conditions and wake effects, while seeking to minimise environmental effects and impacts on other marine users (such as fisheries and shipping routes).

27. Figure 3.4 presents an indicative wind farm layout based on the maximum design scenario of 307 wind turbines, while Figure 3.5 displays an indicative wind farm layout should 179 wind turbines were to be installed. The final layout of the wind turbines will be confirmed at the final design stage post consent with details being submitted to Marine Scotland Licensing Team (MS-LOT) for approval.

Table 3.1: Design Envelope: Wind Turbines

Parameter	Maximum Design Envelope [2]
Maximum number of wind turbines	up to 307
Maximum hub height (above LAT) (m)	200
Minimum blade tip height (above LAT) (m)	37
Maximum blade tip height (above LAT) (m)	355
Maximum rotor diameter for smallest wind turbine option (m)	222
Maximum rotor diameter (m)	310
Maximum number of blades	3
Minimum wind turbine spacing (m)	1,000
Maximum wind turbine spacing (m)	4,650

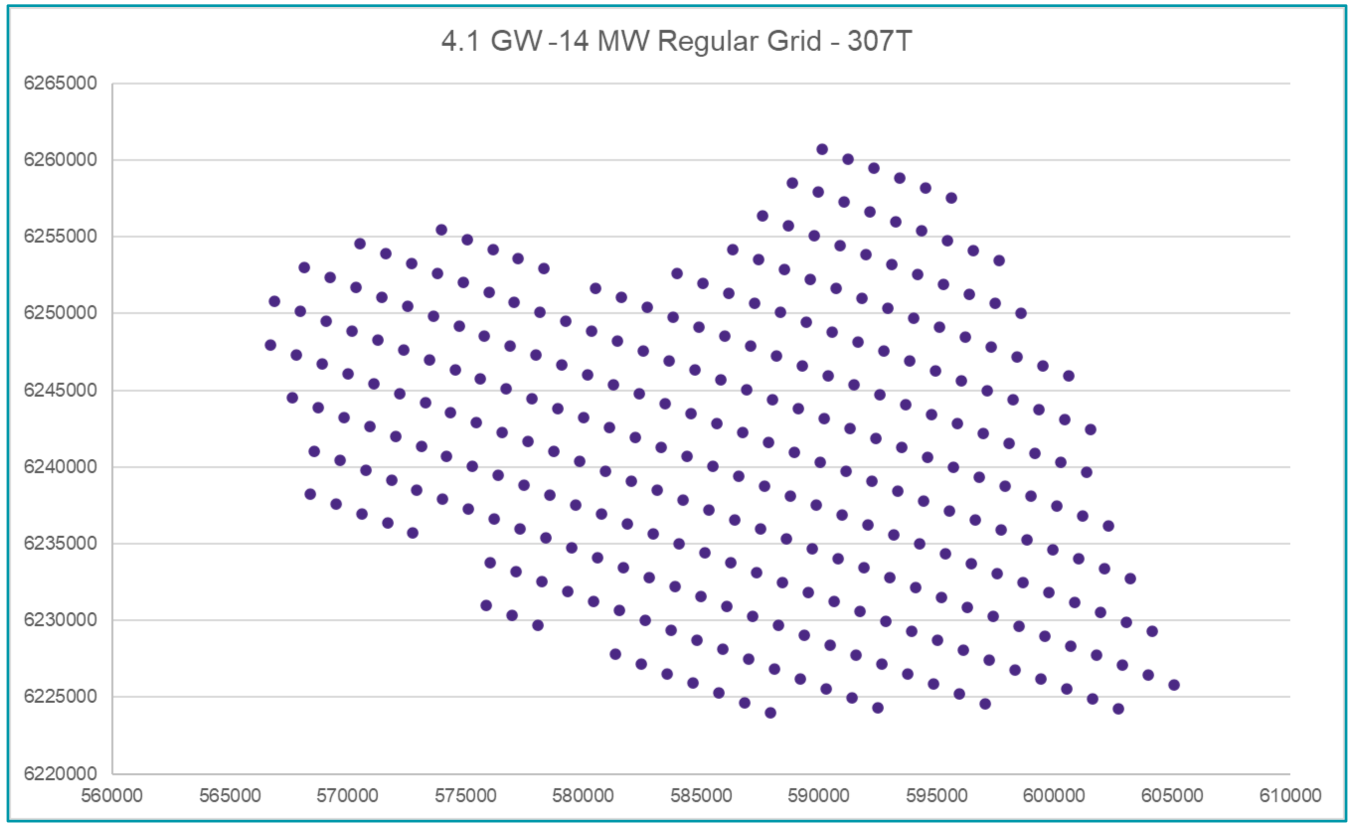

Figure 3.4: Berwick Bank Wind Farm Preliminary Indicative Layout for 307 Wind Turbines Each Square Being 5 km x 5 km)

[2] The maximum design envelope defines the maximum range of design parameters. For the EIA, the Applicant has discerned the maximum impacts that could occur within the range of the design parameters for given receptor groups - referred to as the "maximum design scenario"

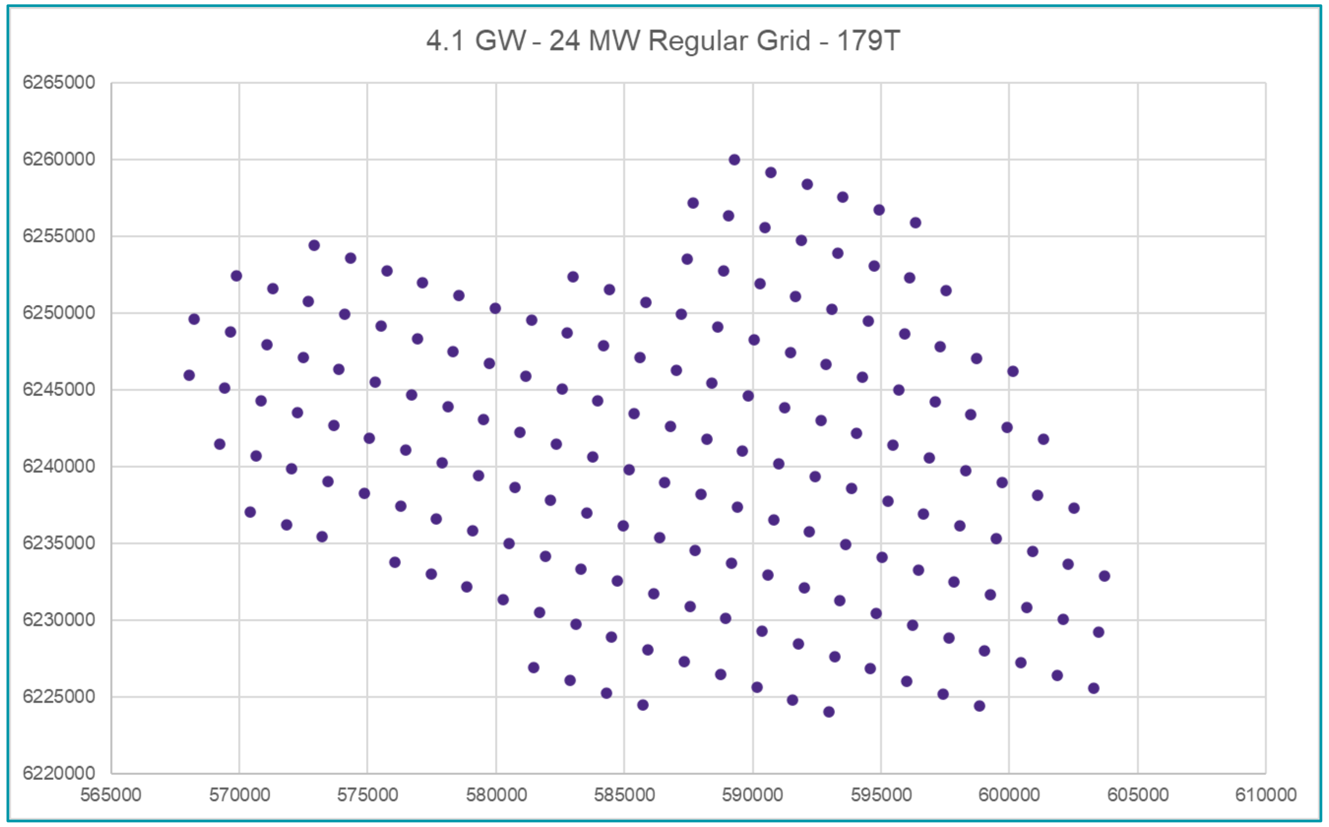

Figure 3.5: Berwick Bank Wind Farm Preliminary Indicative Layout for 179 Wind Turbines Each Square Being 5 km x 5 km)

28. To improve operation, productivity and prevent wear on parts, a number of consumables may be required for the wind turbines. These may include:-

- grease;
- synthetic oil;
- hydraulic oil;
- gear oil;
- lubricants;
- nitrogen;
- water/glycerol;
- transformer silicon/ester oil;
- diesel fuel;
- sulphur hexafluoride SF6; and
- glycol/coolants

29. The quantities required are dependent on the make and model of the wind turbines yet to be selected. Indicative values are provided in the relevant chapters (e.g. volume 2, chapter 19) that enable a precautionary assessment to be undertaken.

Wind turbine foundations and support structures

30. To allow for flexibility in foundation choice, two types of wind turbine support structures and foundations are being considered for the Proposed Development:

- piled jacket; and
- suction caisson jacket.

31. Foundations will be fabricated offsite, stored at a suitable port facility (if required) and transported to site by sea. Specialist vessels will transport and install foundations. Scour protection (typically rock) may be required on the seabed and will be installed before and/or after foundation installation. The following section provides an overview of the foundation types which are being considered for wind turbines - foundation structures for OSPs/Offshore convertor station platforms are discussed in section 3.2.3.

Piled jacket foundation

32. The piled jacket foundations will be transported to site by sea. Once at site, the jacket foundation will be lifted by the installation vessel using a crane and lowered towards the seabed in a controlled manner. Piled jacket foundations are formed of a steel lattice construction (comprising tubular steel members and welded joints) secured to the seabed by driven and/or drilled pin piles attached to the jacket feet (as illustrated in Figure 3.6). The hollow steel pin piles are typically driven or drilled into the seabed, relying on the frictional and end bearing properties of the seabed for support. The PDE for jacket foundations with pin piles is provided in Table 3.2.

Table 3.2: Design Envelope: Wind Turbine Jacket Foundation with Pin Piles

Parameter	Maximum Design Envelope
Maximum number of jacket foundations	307
Maximum number of legs per jacket	4
Maximum diameter of jacket leg (m)	5
Maximum number of pin piles per leg	2
Maximum diameter of pin piles (m)	5.5
Maximum expected pile penetration depth (m)	80
Maximum seabed footprint per jacket foundation (m^2)	190
Maximum seabed footprint for all jacket foundations (m^2)	34,022[3]
Maximum scour protection footprint (per jacket) (m^2)	2,280

[3] based upon 179 x 4 legged jacket foundations required for the largest proposed wind turbines

Parameter	Maximum Design Envelope
Maximum area foundation footprint (per jacket) (m^2) including scour protection	2,470
Maximum hammer energy (kJ) (maximum energy theoretically possible)	4,000
Realistic maximum average hammer energy (kJ) (the maximum average energy predicted over all piling locations)	3,000
Maximum jacket leg spacing (at seabed) (m)	60
Maximum jacket leg spacing (at surface) (m)	35

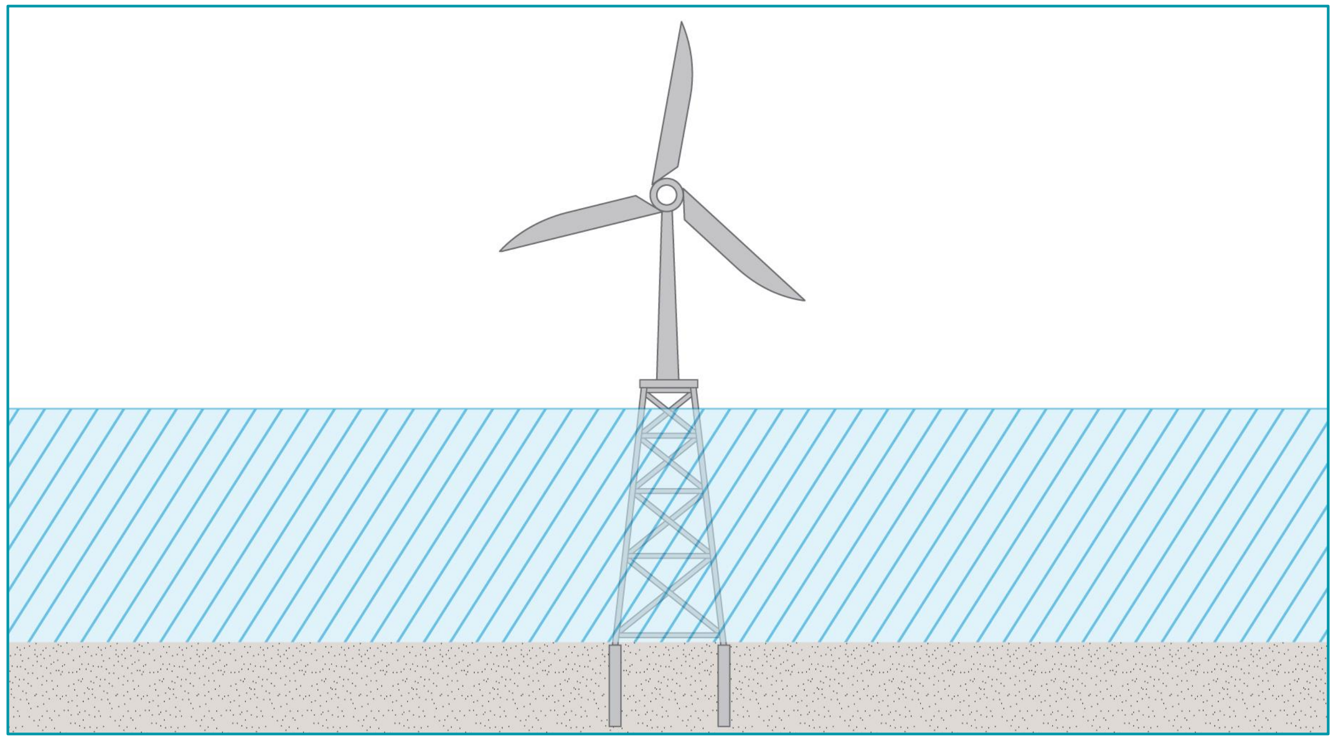

Figure 3.6: Indicative Schematic of a Jacket Foundation with Pin Piles

Suction caisson jacket foundations

33. Suction caisson jacket foundations are formed with a steel lattice construction (comprising tubular steel members and welded joints) fixed to the seabed by suction caissons installed below each leg of the jacket (as per Figure 3.7). The suction caissons are typically hollow steel cylinders, capped at the upper end, which are fitted underneath the legs of the jacket structure. They do not require a hammer or drill for installation.

34. The suction caisson jacket foundations will be transported to site by sea. Once at site, the jacket foundation will be lifted by the installation vessel using a crane and lowered towards the seabed in a controlled manner. When the steel caisson reaches the seabed, a pipe running up through the stem above each caisson will begin to suck water out of each bucket. The buckets are pressed down into the seabed by the resulting suction force. When the bucket has penetrated the seabed to the desired depth, the pump is turned off. A thin layer of grout is then injected under the bucket to fill the air gap and ensure contact between the soil within the bucket, and the top of the bucket itself. The PDE for jacket foundations with suction caissons is provided in Table 3.3.

Table 3.3: Design Envelope: Wind Turbine Jacket Foundation with Suction Caisson

Parameter	Maximum Design Envelope
Maximum number of jacket foundations	307
Maximum number of legs per jacket with suction caisson	4
Maximum diameter of jacket leg (m)	5
Maximum seabed footprint per jacket foundation (m^2)	1,257
Maximum scour protection footprint (per foundation) (m^2)	10,984
Maximum foundation footprint (m^2) including scour protection (per foundation)	12,240
Maximum seabed footprint for suction caisson jacket foundations (m^2)	224,938[4]
Maximum diameter of suction caisson (m)	20
Maximum expected penetration depth (m)	20
Maximum jacket leg spacing (at seabed) (m)	60
Maximum jacket leg spacing (at surface) (m)	35

[4] based upon 179 x 4 legged jacket foundations required for the largest proposed wind turbines

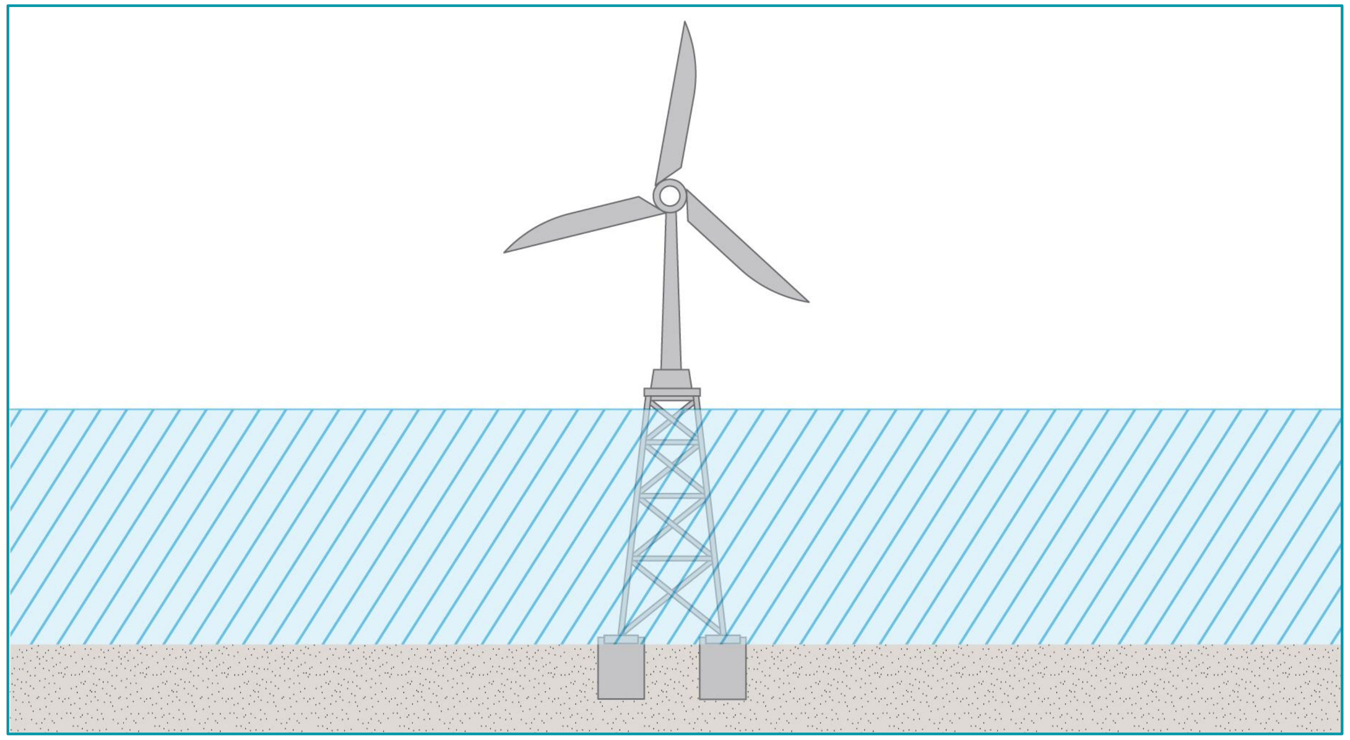

Figure 3.7: Indicative Schematic of a Jacket Foundation with Suction Caissons

3.2.3. OFFSHORE SUBSTATION PLATFORMS AND OFFSHORE CONVERTOR STATION PLATFORMS

35. The Applicant has three signed grid connection agreements with the network operator. Two agreements are for connection at the Branxton substation, with a third additional connection at Blyth, Northumberland (the Cambois connection). The Cambois connection agreement, was confirmed in June 2022 following National Grid's Electricity System Operator (NGESO) Holistic Network Review, and will enable the Project to reach full generating capacity (4.1 GW) by early 2030's.

36. The installation of offshore export cables including landfall methodologies for the Cambois connection is being consented separately to the Proposed Development but has been considered cumulatively as part of this Application.

37. The Project is currently considering HVAC and HVDC solutions for the Offshore Transmission Infrastructure. These solutions include:

- Combined Option A or Combined Option B: a combined HVAC/HVDC solution comprising the following:
  - up to eight HVAC OSPs to facilitate connections to Branxton and two HVDC Offshore convertor station platforms that will be required for the Cambois connection (see Table 3.4); or
  - up to five larger HVAC OSPs to facilitate connections to Branxton and two HVDC Offshore convertor station platforms that will be required for the Cambois connection (see Table 3.5).
- HVDC Option: Up to five HVDC Offshore convertor station platforms, two for the Branxton connection and two for the additional Cambois connection (see Table 3.6) This also includes an offshore interconnector platform.

38. These offshore platforms will be utilised as OSPs/Offshore convertor stations platforms which transform electricity generated by the wind turbines to a higher voltage and thereby allowing the power to be efficiently transmitted to shore. The platforms' topsides size will depend on the final electrical design for the wind farm but maximums could be up to 100 m (length) by 80 m (width) and up to 80 m in height (above LAT), excluding the helideck, antenna structure or lightning protection. The maximum design parameters for OSPs/Offshore convertor station platforms are presented in Table 3.4 and Table 3.5 (Combined Options) and Table 3.6 (HVDC Option). It is proposed that the OSP/Offshore convertor station platform foundations will be painted yellow from the water line up to the topside structure and the topside will be painted light grey.

Table 3.4: Design Envelope: OSP/Offshore Convertor Station Platform (Combined Option A)

Parameter	Maximum Design Envelope	
	HVAC	HVDC
Maximum number of OSPs/Offshore Convertor Station Platforms	8	2
Maximum length of topside (m)	35	100
Maximum width of topside (m)	32	80
Maximum weight of topside (t)	2,500	10,000
Maximum height of topside structure (above LAT) (m)	45	65
Maximum height of lighting protection (above LAT) (m)	55	75
Maximum height of helideck (above LAT) (m)	48	68
Maximum height of crane (above LAT) (m)	65	85
Maximum height of top of antenna structure (above LAT) (m)	65	85

Table 3.5 Design Envelope: OSP/Offshore Convertor Station Platform (Combined Option B)

Parameter	Maximum Design Envelope	
	HVAC	HVDC
Maximum number of OSPs/Offshore Convertor Station Platforms	5	2
Maximum length of topside (m)	60	100
Maximum width of topside (m)	45	80
Maximum weight of topside (t)	6,500	10,000
Maximum height of topside structure (above LAT) (m)	50	65
Maximum height of lighting protection (above LAT) (m)	60	75
Maximum height of helideck (above LAT) (m)	53	68
Maximum height of crane (above LAT) (m)	70	85
Maximum height of top of antenna structure (above LAT) (m)	70	85

Table 3.6: Design Envelope: Offshore Convertor Station Platforms (HVDC Option)

Parameter	Maximum Design Envelope
Maximum number of OSPs/Offshore Convertor Stations	5
Maximum length of topside (m)	100
Maximum width of topside (m)	80
Maximum weight of topside (t)	11,000
Maximum height of topside structure (above LAT) (m)	80
Maximum height of lighting protection (above LAT) (m)	90
Maximum height of helideck (above LAT) (m)	83
Maximum height of crane (above LAT) (m)	100
Maximum height of top of antenna structure (above LAT) (m)	100

39. Table 3.7 presents the consumables which will be required for the OSPs/Offshore convertor station platforms at the Proposed Development. In addition, Uninterruptible Power Supply (UPS) batteries, fire suppression systems, HVAC coolant and SF6 will also be required.

Table 3.7: Design Envelope: Consumables for the Offshore Substation Platforms (per OSP/Offshore Convertor Station Platform)

Parameter	Maximum Design Envelope
Maximum quantity of diesel fuel (m^3)	50
Maximum quantity of transformer coolant oil (litres)	48,000

40. Project design layout has not yet been finalised, however the OSPs/Offshore convertor station platforms will be located within the Proposed Development array area. The offshore platforms will be installed with piled jacket foundations or suction caissons, as described in section 3.2.2. The PDE for offshore platforms piled jacket foundations is shown in Table 3.8 (Combined Option A), Table 3.9 (Combined Option B) and Table 3.10 (HVDC Option). The PDE for offshore platforms suction caissons foundations is shown in Table 3.11 (Combined Option A), Table 3.12 (Combined Option B) and Table 3.13 (HVDC Option).

Table 3.8: Maximum Design Envelope: Jacket Foundation with Pin Piles for OSPs/Offshore Convertor Station Platforms (Combined Option A)

Parameter	Maximum Design Envelope	
	HVAC	HVDC
Maximum number of piled jacket platforms	8	2
Maximum number of legs per jacket	6	8
Maximum number of piles per leg	4	4
Maximum leg diameter (m)	4	5
Maximum number of piles per platform	24	32
Maximum pin pile diameter (m)	3	4
Maximum hammer energy (kJ) (maximum energy theoretically possible)	4,000	4,000
Realistic maximum average hammer energy (kJ) (the maximum average energy predicted over all piling locations)	3,000	3,000

Table 3.9 Maximum Design Envelope: Jacket Foundation with Pin Piles for OSPs/Offshore Convertor Station Platforms (Combined Option B)

Parameter	Maximum Design Envelope	
	HVAC	HVDC
Maximum number of piled jacket platforms	5	2
Maximum number of legs per jacket	8	8
Maximum number of piles per leg	4	4
Maximum leg diameter (m)	4	5
Maximum number of piles per platform	32	32
Maximum pin pile diameter (m)	3.5	4
Maximum hammer energy (kJ) (maximum energy theoretically possible)	4,000	4,000
Realistic maximum average hammer energy (kJ) (the maximum average energy predicted over all piling locations)	3,000	3,000

Table 3.10: Maximum Design Envelope: Jacket Foundation with Pin Piles for OSPs/Offshore Convertor Station Platforms (HVDC Option)

Parameter	Maximum Design Envelope
Maximum number of piled jacket platforms	5
Maximum number of legs per jacket	8
Maximum number of piles per leg	4

Parameter	Maximum Design Envelope
Maximum leg diameter (m)	5
Maximum number of piles per platform	32
Maximum pin pile diameter (m)	4
Maximum hammer energy (kJ) (maximum energy theoretically possible)	4,000
Realistic maximum average hammer energy (kJ) (the maximum average energy predicted over all piling locations)	3,000

Table 3.11: Maximum Design Envelope: Suction Caisson Foundation for OSPs/Offshore Convertor Station Platforms (Combined Option A)

Parameter	Maximum Design Envelope	
	HVAC	HVDC
Maximum number of suction caisson platforms	8	2
Maximum number of legs per jacket	6	8
Maximum diameter of leg (m)	4	5
Maximum suction caisson diameter (m)	15	15
Maximum suction caisson penetration depth (m)	15	15

Table 3.12: Maximum Design Envelope: Suction Caisson Foundation for OSPs/Offshore Convertor Station Platforms (Combined Option B)

Parameter	Maximum Design Envelope	
	HVAC	HVDC
Maximum number of suction caisson platforms	5	2
Maximum number of legs per jacket	8	8
Maximum diameter of leg (m)	4	5
Maximum suction caisson diameter (m)	15	15
Maximum suction caisson penetration depth (m)	15	15

Table 3.13: Maximum Design Envelope: Suction Caisson Foundation for OSPs/Offshore Convertor Station Platforms (HVDC Option)

Parameter	Maximum Design Envelope
Maximum number of suction caisson platforms	5
Maximum number of legs per jacket	8
Maximum diameter of leg (m)	5
Maximum suction caisson diameter (m)	15
Maximum suction caisson penetration depth (m)	15

3.2.4. SCOUR PROTECTION FOR FOUNDATIONS

41. Foundation structures for wind turbines and substations are at risk of seabed erosion and 'scour hole' formation due to natural hydrodynamic and sedimentary processes. The development of scour holes is influenced by the shape of the foundation structure, seabed sedimentology and site-specific metocean conditions such as waves, currents and storms. Scour protection may be employed to mitigate scour around foundations. There are several commonly used scour protection types, including:

- concrete mattresses: several metres wide and long, cast of articulated concrete blocks which are linked by a polypropylene rope lattice which are placed on and/or around structures to stabilise the seabed and inhibit erosion;
- rock placement: either layers of graded stones placed on and/or around structures to inhibit erosion or rock filled mesh fibre bags which adopt the shape of the seabed/structure as they are lowered on to it; or
- artificial fronds: mats typically several metres wide and long, composed of continuous lines of overlapping buoyant polypropylene fronds that create a drag barrier which prevents sediment in their vicinity being transported away. The frond lines are secured to a polyester webbing mesh base that is itself secured to the seabed by a weighted perimeter or anchors pre-attached to the mesh base.

42. The most frequently used scour protection method is 'rock placement', which entails the placement of crushed rock around the base of the foundation structure.

43. The amount of scour protection required will vary for the two foundation types being considered for the Proposed Development. The final choice of scour protection will be made after design of the foundation structure, taking into account a range of aspects including geotechnical data, meteorological and oceanographical data, water depth, foundation type, maintenance strategy and cost. Scour protection PDE parameters for foundations with piled jackets and suction caissons are presented in Table 3.14.

Table 3.14: Scour Protection Parameters – Wind Turbine Foundations and OSP/Offshore Convertor Station Platform

Parameter	Maximum Design Envelope			
	Piled Jacket Foundation	**Jacket Foundation with Suction Caissons**	**OSP/Offshore Convertor Station Platform Foundation (Jacket)**	**OSP/Offshore Convertor Station Platform Foundation (Suction Caisson)**
Type	Concrete mattresses, rock, artificial fronds or other novel solution			
Height (m)	2	2	2	2
Diameter (including pile) (m)	22	80	20	60
Area (per foundation excluding pile) (m^2)	2,280	10,984	4,825	11,146
Volume per foundation (m^3)	4,560	21,967	9,651	22,291
Total volume for wind farm (m^3)	816,240	4,503,286	56,247	126,912

3.2.5. SUBSEA CABLES

44. The type of cable laying vessel that will be used to lay subsea cables on the seabed has not been selected at this time. Therefore, the maximum design envelope accounts for both the use of a Dynamic Positioning (DP) vessel and vessels which require the use of anchor during cable laying activities (see Table 3.15 to Table 3.18).

Inter-array cables

45. Inter-array cables carry the electrical current produced by the wind turbines to an offshore substation platform or an offshore convertor station platform. A small number of wind turbines will typically be grouped together on the same cable 'string' connecting those wind turbines to the substation/convertor platform, and multiple cable 'strings' will connect back to each offshore substation/convertor platform.

46. The inter-array cables will be buried where possible and protected with a hard protective layer (such as rock or concrete mattresses) where adequate burial is not achievable, for example where crossing pre-existing cables, pipelines or exposed bedrock. The requirement for additional protection will be dependent on achieving target burial depths which will be influenced by several factors such as seabed conditions, seabed sedimentology, naturally occurring physical processes and possible interactions with other activities including bottom trawled fishing gear and vessel anchors. There is the potential for seabed preparation to be required prior to cable installation with methods such dredge and deposit of sediments material, use jet trenchers, mechanic trenchers or grapnels currently being considered. The cable installation methodology and potential cable protection measures will be finalised at the final design stage (post-consent). The PDE for inter-array cables is presented in Table 3.15.

Table 3.15: Design Envelope: Inter-Array Cables

Parameter	Maximum Design Envelope
Maximum Voltage (kV)	66
Maximum total cable length (km)	1,225
Maximum external cable diameter (mm)	250
Maximum cable installation methodology	Jet trencher/mechanic trencher/cable plough/deep trenching
Minimum target cable burial depth (m)	0.5
Maximum cable burial depth (m)	3
Maximum width of cable trench (m)	2
Maximum width of seabed affected by installation per cable (m)	15

Interconnector cables

47. Interconnector cables will be required to connect the OSPs/Offshore convertor station platforms to each other in order to provide redundancy in the case of failures within the electrical transmission system. The cables are likely to consist of a cross-linked polyethylene (XLPE) insulated aluminium or copper conductor cores.

48. These cables will be either HVDC or a combination of HVDC and HVAC. Table 3.16 provides the maximum design scenario for interconnector cables.

49. The interconnector cables will have a minimum target burial depth of 0.5 m. If burial is not possible due to ground conditions or target burial depths not being achievable, then cable protection techniques will be employed (paragraph 55). The total length of interconnector cables will not exceed 94 km. There is the potential for seabed preparation to be required prior to cable installation with methods such dredge and deposit of sediments material, use jet trenchers, mechanic trenchers or grapnels currently being considered.

Table 3.16: Design Envelope: Interconnector Cables

Parameter	Maximum Design Envelope
Maximum total cable length (km)	94
Maximum external cable diameter (mm)	260
Cable installation methodology – burial technique	Jet trencher/mechanic trencher/cable plough/cable plough (potential for pre-pre-sweeping/dredging in some areas)
Target Minimum cable burial depth (m)	0.5
Maximum cable burial depth (m)	3
Maximum width of cable trench (m)	2

Parameter	Maximum Design Envelope
Maximum width of seabed affected by installation per cable (m)	15
Maximum anchor footprint for wind farm (m^2)[5]	18,800
Maximum number of anchors and anchor repositions per km of cable	One every 500 m

Offshore export cables

50. Offshore export cables are used for the transfer of power from the OSPs/Offshore convertor station platforms to the transition join bay at landfall where they become onshore export cables. Up to eight offshore export cables will be required (applicable to both Combined and HVDC Options).

51. The offshore export cables will have a maximum total length of 872 km, comprised of up to eight cables connecting the OSPs/Offshore convertor station platforms to landfall at Skateraw. Each of these offshore export cables will be installed in a trench up to 2 m wide with a target burial depth of between 0.5 m and 3 m per cable.

52. Although the Proposed Development export cable corridor has been identified, the exact route of the offshore export cables is yet to be determined and will be based upon geophysical and geotechnical survey information. This information will also support the decision on requirements for any additional cable protection. Flexibility is required in the location, depth of burial and protection measures for the offshore export cables to ensure physical and technical constraints, changes in available technology and Project economics can be accommodated within the final design.

53. The proposed method for the installation of the offshore export cables through the intertidal zone at landfall at Skateraw is by using a trenchless technique burial method (Figure 3.9). Following punch out of offshore export cables, onwards installation to the wind farm will be completed by using jetting, trenching and ploughing as summarised in Table 3.17, noting pre-sweeping/dredging may be required in some areas.

[5] Maximum anchor footprint for the wind farm is calculated using the anchor footprint times the number of anchor drops likely to be required across the while wind farm.

Table 3.17: Design Envelope: Offshore Export Cable Method of Installation

Method of Installation	Example
Jet trencher including deep jet trenchers	Jet trenching tools use water jets to fluidise the seabed which allows the cable to sink into the seabed under its own weight. Jet trenching tools are most effective in soft, fine grained sediments (e.g. sands and soft clays). Jet trenching machines can be towed, free swimming or tracked.
Mechanical trencher	Mechanical trenchers are usually mounted on tracked vehicles and use chainsaw or wheeled arms with teeth or chisels to cut a defined trench. They are suitable for a range of sediments including hard/coarse seabed, although they are less effective in glacial tills or boulder clays as the boulders can damage the teeth.
Cable ploughs	Cable ploughs are usually towed either from a vessel or vehicle on the seabed. There are two types of plough: displacement plough which creates a V shaped trench into which the cable can be laid; or the non-displacement plough which brings the cable into the soil. Cable ploughs can used for a range of sediments.
Trenchless technique	For example Horizontal Directional Drilling (HDD) will be used at landfall to bring cables ashore under the intertidal area.

54. The maximum design scenario for the offshore export cables is described in Table 3.18.

Table 3.18: Design Envelope: Offshore Export Cables

Parameter	Maximum Design Envelope
Maximum number of cables	8
Maximum total cable length (km)	872
Maximum cable diameter (mm)	260
Cable installation methodologies – seaward of MLWS	Jet trencher/mechanic trencher/cable plough/deep trencher
Cable installation methodologies – landward of MLWS	Trenchless installation
Minimum target cable burial depth (m)	0.5
Maximum target cable burial depth (m)	3
Maximum width of cable trench (per circuit) (m)	2
Maximum width of seabed disturbed by cable installation (per cable (m))	15
Maximum area of seabed disturbed for offshore export cable route (km^2) (cable installation)	12.43

Parameter	Maximum Design Envelope
Maximum anchor footprint for offshore export cable route (m^2)	174,400
Maximum number of anchors and anchor reposition per km of cable	One every 500 m

Cable protection

55. Cable protection will be used to prevent movement or exposure of the cables over the lifetime of the Proposed Development when target cable burial depth is not achieved due to seabed conditions. This will protect cables from other activities such as fishing or anchor placement, dropped objects, and limit the effects of heat and/or induced magnetic fields. Cable protection may comprise sleeving, cast iron shells, concrete mattressing or rock placement. The preferred solution for protection will depend on seabed conditions along the route and the need to protect cables from other activities which may occur in that area.

56. The maximum design scenario for inter-array, interconnector and offshore export cables, are presented in Table 3.19.

Table 3.19: Design Envelope: Cable Protection Parameters

Parameter	Maximum Design Envelope		
	Inter-Array Cables	Interconnector Cables	Offshore Export Cables
Type	Cable protection systems including concrete mattressing, rock placement, rock bags, cast iron shells and sleeving	Cable protection systems including concrete mattressing, rock placement, rock bags, cast iron shells and sleeving	Cable protection systems including concrete mattressing, rock placement, rock bags, cast iron shells and sleeving
Maximum cable protection height (m)	3	3	3
Maximum cable protection width (m)	20	20	20
Maximum percentage of cables that may require cable protection (%)	15	15	15
Maximum total cable protection footprint area for cables (m^2)	2,572,500	282,000	2,616,000
Maximum total cable protection volume for wind farm (m^3)	7,717,500	846,000	7,848,000

Concrete mattressing

57. Concrete mattresses are constructed using high strength concrete blocks and U.V. stabilised polypropylene rope. They are supplied in standard 6 m x 3 m x 0.3 m units of standard density, however modifications to size, density, and shape (tapered edges for high current environments, or denser concrete) can be engineered bespoke to the locality.

58. The mattresses can be installed above the cables with a standard multicat type DP vessel and free-swimming installation frame. The mattresses are lowered to the seabed and once the correct position is confirmed, a frame release mechanism is triggered and the mattress is deployed on the seabed. This single mattress installation is repeated for the length of cable that requires protection. The mattresses may be gradually layered in a stepped formation on top of each other dependant on expected scour. Concrete mattressing can be used for cable protection and at cable crossings (see paragraph 62).

Rock placement

59. Rock placement on top of cables to provide additional protection is carried out either by creating a berm or by the use of rock bags (see Figure 3.8).

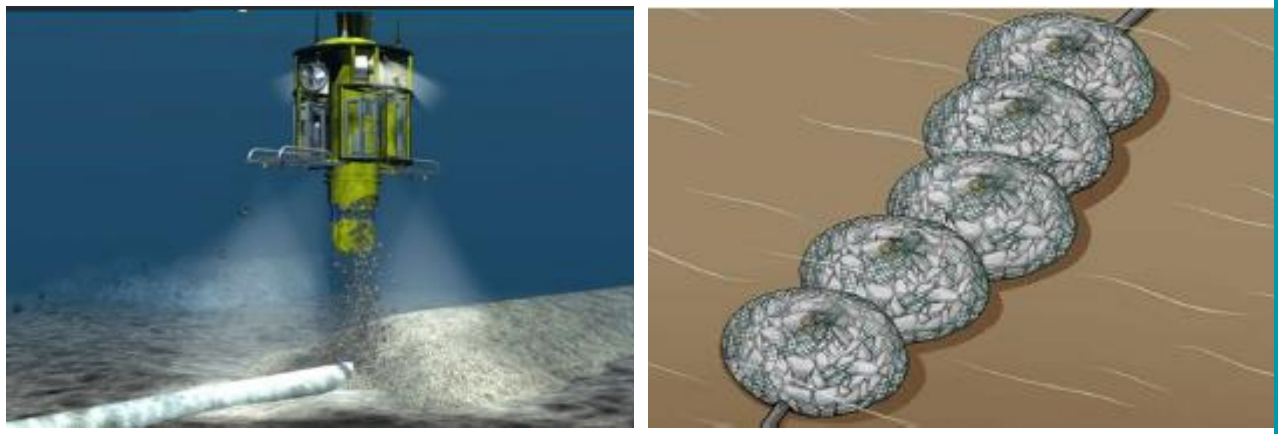

Figure 3.8: Rock Cable Protection Methods (Left: Rock Placement; Right: Rock Bags)

60. Rock placement is achieved using a vessel with equipment such as a ‘fall pipe’ which allows installation of rock close to the seabed. The rock protection design for the Proposed Development will be within a maximum height of 3 m and 20 m width (see Table 3.19), with an approximate slope of 1:3 both sides of the cable. This shape is designed to provide protection from anchor strike and anchor dragging, and to allow over trawl by fishing vessels. The cross-section of the berm may vary dependent on expected scour. The length of the berm is dependent on the length of the cable which requires protection.

61. Alternatively, pre-filled rock bags can be placed above the cables with specialist installation beams. Rock bags consist of various sized rocks contained within a rope or wire net. Similar to the installation of the concrete mattresses, they are lowered to the seabed and when in the correct position, are deployed on to the seabed. Typically, each rock bag is 0.7 m in height and has a diameter of 3 m. Rock placement can be used for cable protection and at cable crossings (see paragraph 62). The number of rock bags required is dependent on the length of cable which requires protection.

Cable crossing

62. Up to 16 cable crossings may be required for the offshore export cables. The offshore export cables will cross each of the Neart na Gaoithe cables and will avoid crossing each other. This will be facilitated by the installation of standard cable crossing designs, likely to be comprised of ducting, concrete mattresses or rock as described above. Offshore export cables will avoid crossing interconnector cables. The maximum design scenario for cable crossing is presented in Table 3.19. Further description of the crossing methodology is described in section 3.4.1.

63. It is also possible that up to 78 inter-array cable crossings will be required. Additional cable protection will be required at these crossings, and these crossings and the required protection are accounted for in Table 3.19. The design will look to minimise cable crossings with up to 78 inter-array crossings predicted in total.

Table 3.20: Design Envelope: Cable Crossing Parameters (Inter-Array Cables and Offshore Export Cables)

Parameter	Maximum Design Envelope
Inter-Array Cables	
Maximum number of crossings	78
Crossing material/method	Concrete mattressing, rock placement, rock bags, cast iron shells and sleeving
Maximum height of crossing (m)	3.5
Maximum width of crossing (m)	21
Maximum length of each crossing (m)	30
Maximum total area of crossings (m^2)	49,140
Maximum volume of material (per crossing) (m^3)	2,205
Maximum total volume of crossing protection across the wind farm (m^3)	171,990
Offshore Export Cables	
Maximum number of crossings	16
Crossing material/method	Concrete mattressing, rock placement, rock bags, cast iron shells, CPS systems
Maximum height of crossing (m)	3.5
Maximum width of crossing (m)	21
Maximum length of each crossing (m)	40
Maximum total area of crossings (m^2)	13,440
Maximum volume of material (per crossing) (m^3)	2,940
Maximum total volume of crossing protection across the wind farm (m^3)	47,040

3.3. SITE PREPARATION ACTIVITIES

64. A number of site preparation activities will be required in the Proposed Development array area and Proposed Development export cable corridor. Site preparatory works are assumed to begin prior to the first activities within the Proposed Development array area and continue as required throughout the construction programme. As such, site preparation activities may happen at any point during the construction phase.

65. An overview of these activities is provided below.

3.3.1. PRE-CONSTRUCTION SURVEYS

66. A number of pre-construction surveys will be undertaken to identify in detail:

- seabed conditions and morphology;
- presence/absence of any potential obstructions or hazards; and
- to inform detailed project design work.

67. These geophysical and geotechnical surveys will be conducted across the Proposed Development array area and Proposed Development export cable corridor and are expected to have a duration of three months. Geophysical surveys will comprise techniques such as Side Scan Sonar (SSS), Sub-bottom Profiling (SBP), Multibeam Echo-Sounder (MBES), Single Beam Echo-Sounder (SBES), high-density magnetometer surveys and Ultra High Resolution Seismic (UHRS). Geotechnical surveys will comprise techniques such as boreholes, Cone Penetration Tests (CPTs) and vibrocores.

68. Geotechnical surveys will be conducted at specific locations within the footprint of the Proposed Development export cable corridor and the Proposed Development array area.

69. Geophysical survey works will be carried out to provide details of Unexploded Ordnance (UXO), bedform and boulder mapping, detailed bathymetry, a topographical overview of the seabed and an indication of sub-surface layers. These will be carried out within the whole Proposed Development array area and Proposed Development export cable corridor, utilising mutilsensor towed arrays and sonar.

3.3.2. CLEARANCE OF UNEXPLODED ORDNANCE

70. It is possible that UXO originating from World War I or World War II may be encountered during the construction or installation of offshore infrastructure. This poses a health and safety risk where it coincides with the planned location of infrastructure and associated vessel activity, and therefore it is necessary to survey for and carefully manage UXO.

71. The following methodologies are considered for UXO avoidance/clearance:

- avoid and leave *in situ*;
- micrositing to avoid UXO;
- relocation of UXO to avoid detonation;
- low order (e.g. deflagration); and
- high order detonation (with associated mitigation measures).

72. Where it is not possible to avoid or relocate a UXO, the preferred method for UXO clearance is for a low order technique (subsonic combustion) with a single donor charge of up to 80 g Net Explosive Quantity (NEQ) for each clearance event. Due to the intensity of the surveys required to accurately identify UXO, this work cannot be conducted before detailed design work has confirmed the planned location of infrastructure. Based on existing knowledge of the area (Seagreen 1), it has been assumed that there may be up to 14 UXO which require clearance by a low order technique (such as deflagration). However, due

to risk of unintended high order detonation, it has been assumed that 10% of all clearance events may result in high order detonation (see volume 2, chapter 10).

73. The maximum design scenario for UXO clearance is provided in Table 3.21.

Table 3.21: Design Envelope: Unexploded Ordnance Parameters

Parameter	Maximum Design Envelope
Maximum weight expected to be encountered (kg)	300
Maximum realistic number of UXO identified	70
Maximum realistic number of UXO to be cleared	14
Maximum number of UXO cleared per 24 hours	2
Maximum total duration of UXO clearance activities (days)	70

3.3.3. SAND WAVE CLEARANCE

74. In some areas within the Proposed Development array area and along the Proposed Development export cable corridor, existing sand waves and similar bedforms may need to be removed prior to the installation of cables. This is carried out mainly for two reasons, although others may arise:

- many of the cable installation tools require a relatively flat seabed surface in order to work effectively. Installing cables on up or down a slope over a certain angle, or where the installation tool is working on a camber may reduce the ability to meet target burial depths; and
- the cable must be installed to a depth where it may be expected to stay buried for the duration of the Proposed Development operational lifetime (35 years). Sand waves are generally mobile in nature therefore the cable must be buried beneath the level where natural sand wave movement could uncover it. Sometimes this can only be achieved by removing the mobile sediments before installation takes place.

75. Sand wave clearance may take place throughout the construction phase. If required, sand wave clearance will be completed in areas within the Proposed Development array area along the inter-array cables, OSP/Offshore convertor station platform interconnector cables and the Proposed Development export cable corridor. Seabed features clearance will involve removal of the peaks of the seabed features by techniques such as dredging, with material replaced in the troughs, thereby levelling the seabed. A specialist dredging vessel may be required to complete the seabed features clearance.

76. Sand wave clearance may also be undertaken using other methodologies including pre-installation ploughing tools to flatten sand waves, pushing sediment from wave crests into adjacent troughs and levelling the seabed.

77. The maximum design scenario for sand wave clearance in the Proposed Development array area and Proposed Development export cable corridor is summarised in Table 3.22. Final values for sand wave clearance will be refined following completion of a geophysical survey campaign prior to construction.

78. In addition to sand wave clearance, boulder clearance and pre-lay grapnel run may be required to prepare the site for cable installation.

Table 3.22: Design Envelope: Sand Wave Clearance Parameters

Parameter	Maximum Design Envelope
Inter-Array/OSP-Offshore Convertor Station Platform Interconnector Cables	
Maximum width of sand wave clearance along inter-array cables (m)	25
Maximum area of sand wave clearance along inter-array/interconnector cables (m^2)	9,892,500
Maximum volume of sand wave clearance along inter-array/interconnector cables (m^3)	12,860,250
Offshore Export Cables	
Maximum width of sand wave clearance (m)	25
Maximum area of sand wave clearance (m^2)	4,360,000
Maximum volume of sand wave clearance (m^3)	21,800,000

3.3.4. BOULDER CLEARANCE

79. Boulder clearance is commonly required during offshore wind farm site preparation. A boulder is typically defined as being over 200 mm in diameter/length. It is expected that the boulder clearance campaign will be carried out with the use of a DP vessel.

80. Boulder clearance may be required along the inter-array cables, OSP/Offshore convertor station platform interconnector cables and the Proposed Development export cable corridor. Boulder clearance is required to reduce the risk of shallow cable burial resulting in the need for further cables burial works and/or cable protection, as well minimising risk of damage to cables during installation. It may also be required in the vicinity of the foundation locations (including within the jack-up vessel zone around the foundation locations), in order to avoid disruption to installation activities and to ensure stability for the jack-up vessel. Table 3.23 provides the maximum design scenario for boulder clearance in the Proposed Development array area and Proposed Development export cable corridor.

81. Cable routes may be pre-ploughed to remove boulders or, alternatively clearance may be undertaken using a boulder grab. The method to be deployed will be informed by geophysical and pre construction surveys and will be dependent on the size, density and location of boulders, and more than one method of boulder removal may be deployed across the Proposed Development.

Table 3.23: Design Envelope: Boulder Clearance Parameters

Parameter	Maximum Design Envelope
Maximum width of boulder clearance along inter-array/interconnector cables (m)	25
Maximum area of boulder clearance along inter-array/interconnector cables (m^2)	6,595,000
Maximum width of boulder clearance along offshore export cables (m)	25

Parameter	Maximum Design Envelope
Maximum area of boulder clearance along offshore export cables (m^2)	4,360,000

3.3.5. VESSELS FOR SITE PREPARATION ACTIVITIES

82. Table 3.24 includes all vessels to be used during site preparation activities.

Table 3.24: Design Envelope: Vessels for Site Preparation Activities

Parameter	Maximum Design Envelope	
	Maximum Total Number of Vessels on Site at any One Time	**Total Movements (Return Trips Across Site Preparation Activities)**
Boulder clearance vessel	9	316
Geophysical/geotechnical survey vessel	2	70
UXO clearance vessel	7	30
Sand wave clearance vessel	3	104
Total	**21**	**520**

3.4. CONSTRUCTION PHASE

3.4.1. METHODOLOGY

83. The Proposed Development is likely to be constructed according to the general sequence below, although the final sequence may vary from this:

- step 1 – offshore export cables – landfall installation;
- step 2 – foundation installation and scour protection installation;
- step 3 – OSP/Offshore convertor station platform topside installation/commissioning;
- step 4 – inter-array and interconnector cable installation and cable protection installation;
- step 5 – offshore export cables – offshore installation and cable protection installation; and
- step 6 – wind turbine installation/commissioning.

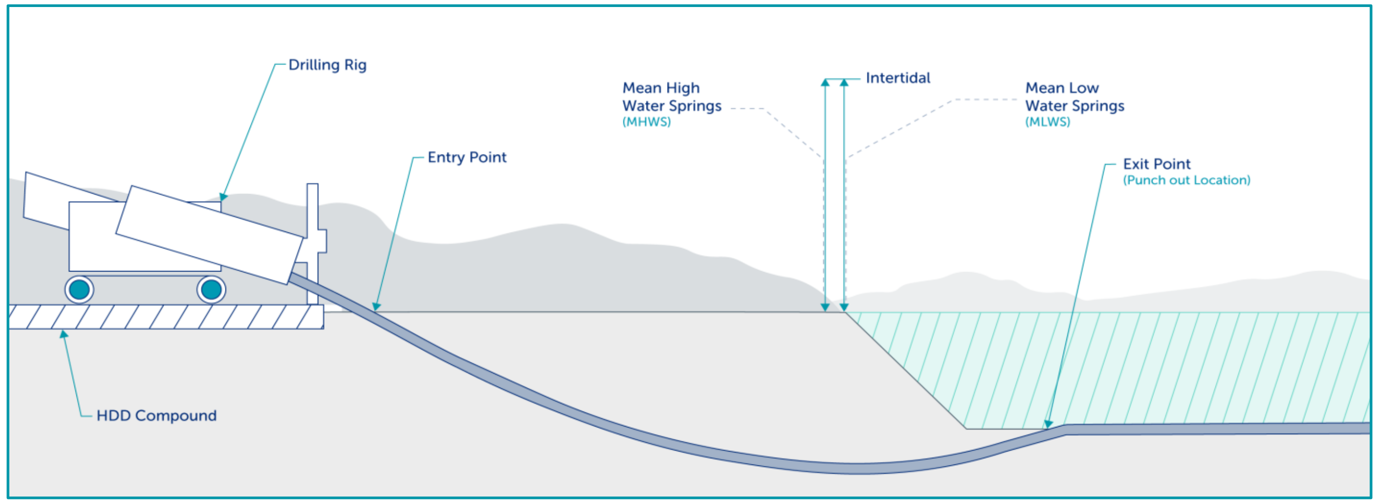

Figure 3.9: Typical Long Section of Trenchless Technique Method

84. Each stage is outlined in further detail in the following sections.

Step 1 – Offshore export cables – landfall installation

85. Figure 3.10 shows the Proposed Development export cable corridor as it reaches landfall at Skateraw.

86. Offshore export cables landfall installation parameters are presented in Table 3.25. Works landward of MHWS are described and assessed in the Berwick Bank Wind Farm Onshore EIA Report (SSER. 2022a), although those works are assessed cumulatively with the Proposed Development in this Offshore EIA Report.

87. It is proposed that the cables are installed through the intertidal zone using trenchless technology (Figure 3.9), such as HDD. HDD involves drilling a hole (or holes) along an underground pathway from one point to another, through which the offshore export cables are installed, without the need to excavate an open trench. To achieve this a drill rig is located onshore, landward of MHWS. A working area will be established containing the drill rig, electrical generator, water tank, mud recycling unit and temporary site office. The drilling installation will commence from above the MHWS, with the HDD exit point (punch out location) located seaward of MLWS between 488 m and 1,500 m below MWHS. As such, no works are planned to take place in the intertidal zone.

88. A drilling fluid, such as Bentonite, is pumped into the drilling head during the drilling process to stabilise the hole and retrieve the drilled material. Once the drilling is complete, cable ducts may be installed from land and pushed out, or towed into position by a vessel offshore and pulled in. The offshore export cables are then pulled through the pre-installed ducts by land-based winches.

89. The HDD punch out may also require the excavation of HDD exit punches out.

90. The HDD works comprise the following main stages:

a. A pilot hole will be drilled from onshore to offshore.
b. Once the pilot hole has been completed, the reaming process will commence, increasing the diameter of the pilot hole to accommodate the safe installation of HDD duct. The reaming process will continue back and forth for a number of passes to achieve a minimum bore diameter. During the drilling procedure,

drilling fluid is continuously pumped to the drill head to act as a lubricant. Solids are removed from the returning fluid, and the spoil is transported off site or into the mud pit (landward of the MHWS) to settle.

c. A jack-up vessel or dredger will be used at the at the HDD exit point to create a HDD exit punch out.
d. The last forward HDD reamer exits the seabed at the HDD exit punch out.
e. The HDD reamer is then disconnected from the drill pipe and recovered.
f. The High-Density Polyethylene (HDPE) liner pipe will be pre-assembled and then floated in, connected to the drill pipe, and pulled onshore from the offshore end through the pre-drilled bore into position.
g. Steps a to f are then repeated for all the 220 kV (or 275 kV) offshore export cable circuits.
h. Trenches are then excavated from the HDD entry points above the MHWS to the transition joint bay and ducts installed and backfilled; (covered as part of the onshore submission).
i. HDD construction equipment and plant is then demobilised from site.
j. The ducts are then proved ready for cable pull in and messenger wires are installed.
k. Cables will then be installed in the ducts by pulling onshore through the ducts from the offshore delivery vessel to the transition joint bays.

91. Once commenced, the HDD drilling activities may be required to operate continuously over a 24-hour period until each bore is complete. Subject to further construction planning and availability of drilling rigs, drilling may be carried out concurrently to accelerate the construction works programme.

92. There are typically two pulls in techniques considered for the HDD landfall installation. The first being direct pull in, where the cable vessel will sit a short stand-off distance from the HDD exit point, where the cable is pulled directly and unreeled from the vessel. The second being floated pull in, where the vessel will stand-off at a suitable water depth for its safe operation and float the cable toward the duct, with a second vessel assisting located above the HDD exit point to guide the cable through the duct.

93. Bentonite comprises 95% water and 5% bentonite clay which is a non-toxic, natural substance. Bentonite drilling fluid is non-toxic and can be commonly used in farming practices. Every endeavour will be made to avoid a breakout (loss of drilling fluid to the surface). A typical procedure for managing a breakout under water would include:

- stop drilling immediately;
- pump lost circulation material (mica), which will swell and plug any fissures;
- check and monitor mud volumes and pressures as the works recommence; and
- repeat process as necessary until the breakout has been sealed.

94. As part of the detailed design work required to inform the final landfall methodology, the potential risks relating to cable exposure due to coastal recession and beach lowering will be considered in greater detail including the effects to climate change over the operational and maintenance phase of the Proposed Development. Indicative trenchless burial depths are provided in Table 3.25 but this is subject to further refinement post consent.

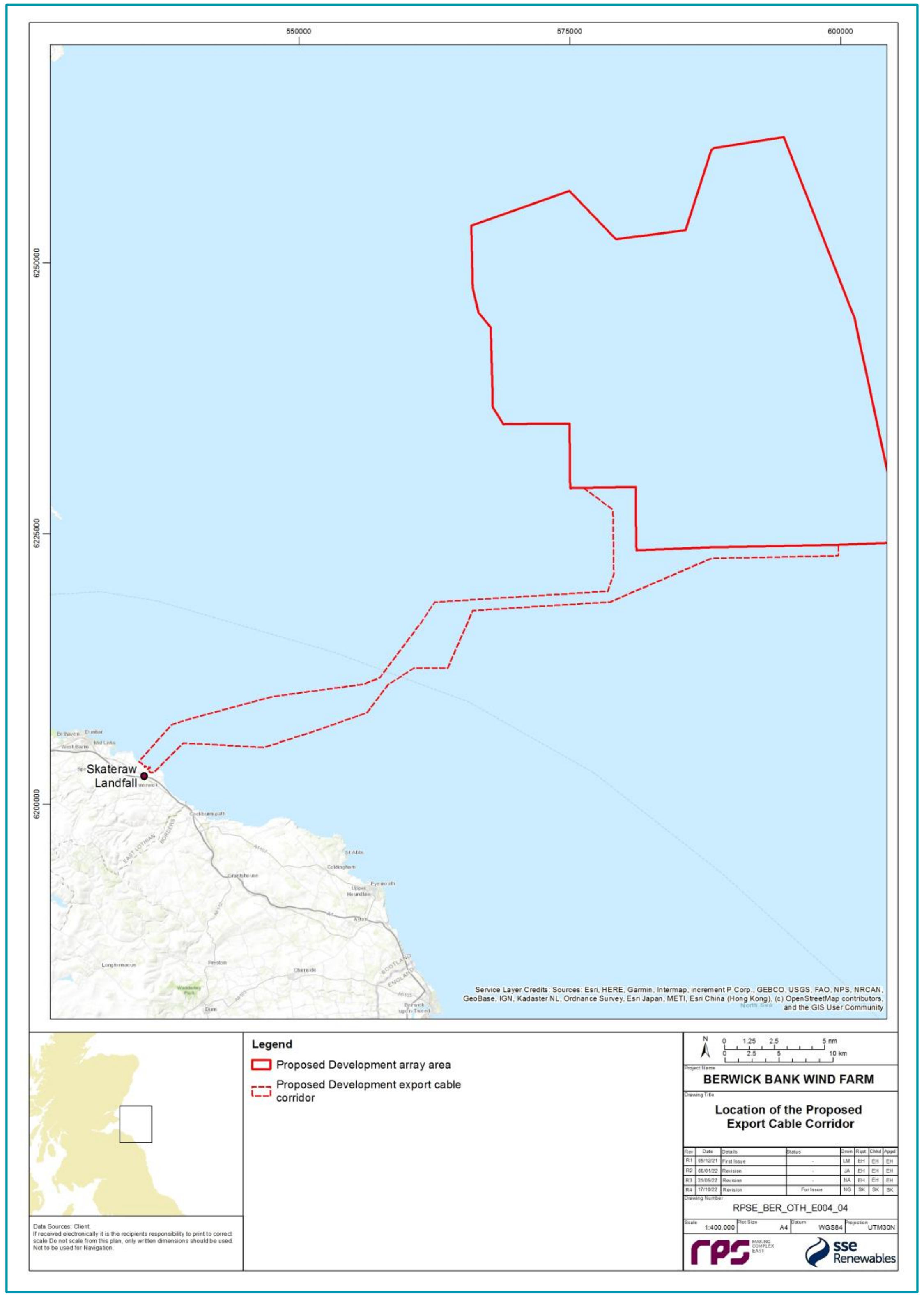

Figure 3.10: Location of the Proposed Development Export Cable Corridor

Table 3.25: Design Envelope: Offshore Export Cables (Seaward of MHWS)

Parameter	Maximum Design Envelope
Maximum number of offshore export cables within Proposed Development export cable corridor	8
Maximum number of transition joint pits	8
Maximum number of trenchless cable ducts	8
Maximum diameter of cable ducts (m)	2.5
Maximum length from OSP/Offshore convertor station platform to MWHS (km) (single cable)	109
Maximum total length of offshore export cables (km)	872
Burial technique	Trenchless technique (e.g. HDD)
Estimated trenchless burial depth (m) (intertidal)	30
Minimum trenchless burial depth (m) (intertidal)	0.5
Maximum trench width (m) (per cable)	2
Dimension of exits punches out (m) (subtidal)	20 x 5

Step 2 – Foundation installation and scour protection installation

Jacket foundations

95. Wind turbines and OSP/Offshore convertor station platform foundations will be transported to the Proposed Development array area by vessel from the fabrication site or port facility (see section 3.4.2 for further detail on vessels to be used at the Proposed Development).

96. Jacket foundations could use either piles or suction caissons. Information on the methodology to be followed during suction caissons installation is provided in paragraphs 33 and 34. The piled jacket foundation will be installed into the seabed by either piling or drilling techniques, or a combination of both (drive-drill-drive), depending on seabed conditions. Typically, piles will be piled into the seabed using a vibro/hydraulic hammer until any hard ground is encountered, with drilling techniques deployed to install the remaining length of pile, if required.

97. Piling characteristics are presented in Table 3.26. In order to complete the piling, the pile is usually lowered to the seabed with the help of a crane while kept in position using a pile gripper. A pile installation frame will be temporarily placed on the seabed to facilitate pile placement and spacing. The frame will be removed and moved to the next location once the piles are installed. The impact of the temporary placement of the frame on the seabed is bound by the maximum design scenario of disturbance caused by placement of scour protection. The hydraulic hammer is then positioned onto the pile and driven to target depth. Although a hammer energy of 4,000 kJ is considered as the maximum design scenario for the purposes of assessment, the realistic maximum average energy used when piling will be lower for the majority of the time (3,000 kJ). It is worth noting that the piles are likely to be pre-piled in advance with the jackets then installed on top at a later date.

98. Piling will commence with a lower hammer energy of 600 kJ, with a slow ramp up of energy up to a realistic 3,000 kJ over a period of 20 minutes. If necessary, this will be followed by a gradual increase to the maximum required installation energy (if higher than 3,000 kJ, but not to exceed the maximum energy of 4,000 kJ) during the piling of the final metres of pile, which is typically significantly less than the maximum hammer energy. The PDE includes for up two piling events occurring simultaneously at wind turbines (or wind turbine and OSPs/Offshore convertor station platform locations), with no concurrent piling of OSPs/Offshore convertor station platforms proposed. Table 3.26 provides the maximum deign scenario for the jacket piling.

Table 3.26: Design Envelope: Jacket Piling Characteristics

Parameter	Maximum Design Envelope	
	Wind Turbine Foundation (Piled Jacket)	**OSP/Offshore Convertor Station Platform Foundation (Piled Jacket)**
Maximum number of piles requiring piling	1,432[6]	256
Maximum hammer energy (kJ)	4,000	4,000
Realistic maximum average hammer energy (kJ)	3,000	3,000
Soft start energy (% of maximum hammer energy)	15%	15%
Duration		
Maximum soft start duration (minutes)	20	20
Maximum duration of piling (per pile) (hours)	10	8
Maximum number of piles installed over 24 hours	5	3
Maximum duration of piling per day over construction phase (hours)	24	20
Average duration of piling per day over construction phase (hours)	18	16
Maximum total number of days when piling may occur over construction phase	298	75
Concurrent Piling		
Maximum number of concurrent piling events	2	1

[6] Note: up to two pins may be required for the larger wind turbine specifications (e.g. 24 MW). In the event these wind turbines are selected, fewer would be required. Accordingly, this calculation accounts for up to 179 larger specification wind turbines (requiring a maximum of two pins per leg).

Parameter	Maximum Design Envelope	
Minimum distance between concurrent piling events (m)	900	n/a
Maximum distance between concurrent piling events (km)	49.43	n/a

99. Drilling characteristics are presented in Table 3.27. If drilling is required (i.e. in the event that pile driving may not be suitable due to hard ground), a sacrificial caisson may need to be installed to support surficial soils during the drilling activities. The caisson would be driven and left in place. The pile would then be lowered into the drilled bore and grouted in place, with the voids (annuli) between the pile and the rock, and between the pile and the caisson, filled with inert grout. The grout would fill the voids by being pumped from a vessel into the bottom of the drilled hole. The process would be carefully controlled and monitored to ensure minimal spillage to the marine environment.

100. Drilling will result in the release of seabed material, which will be deposited adjacent to each drilled foundation location.

Table 3.27: Design Envelope: Jacket Drilling Characteristics

Parameter	Maximum Design Envelope	
	Wind Turbine Foundation (Piled Jacket)	**OSP/Offshore Convertor Station Platform (Piled Foundation)**
Maximum number of piles requiring drilling (per foundation)	8	4
Maximum (%) of all piles requiring drilling over the wind farm	10	10
Maximum drilling rate (m/hour)	0.5	0.5
Maximum drilling depth (m)	16	12
Maximum drilling duration (per pile) (hours)	32	29
Maximum drilling duration for wind farm (days)	191	39
Maximum volume of drill arisings per pile (m^3)	380	151
Maximum volume of drill arisings for wind farm (m^3)	54,442	6,636
Maximum number of concurrent drilling events	2	1

Step 3 – OSP/Offshore convertor station platform topside installation/commissioning

101. The OSP/Offshore convertor station platform topsides will be transported to the Proposed Development by vessel either from the fabrication yard or the pre-assembly harbour, after the foundations are installed. The OSP/Offshore convertor station platform will be transported by the installation vessel or on a barge towed by a tug. Once on site, the OSP/Offshore convertor station platform will be rigged up, seafastening cut, lifted and installed onto the foundation. The OSP/Offshore convertor station platform will then be welded or bolted to the foundation. The installation vessel will mobilise with all the required equipment including rigging, welding and bolting equipment.

102. All necessary cable connecting and commissioning works are expected to be carried out with the assistance of a jack-up or DP vessel, with assisting support and supply vessels as required. Crew Transfer Vessels (CTVs) likely will be used to transfer personnel to and from the installation vessel.

Step 4 – Inter-array and interconnector cable installation and cable protection installation

103. A range of possible cable installation options may be required in order bury cables to the required target burial depths. While the nature of the seabed sediments within the Proposed Development array area may tend to installation of inter-array and interconnector cables being largely carried out using jetting tools any, or a combination of the options highlighted in Table 3.17 may be required.

104. The same installation and cable protection methodologies apply as described for the offshore export cables in paragraphs 105 to 109. Cable crossing required for the inter-array and interconnector cables are discussed in paragraph 63.

Step 5 – Offshore export cables – offshore installation and cable protection installation

Offshore export cables installation

105. A range of possible cable installation options may be required in order bury cables to the required target burial depths. There are various types of installation tools that may be used to install the offshore export cables, including:

- jet trenching, which injects water at high pressure in the area surrounding the cable using a jetting tool. allowing the cable to sink to the required burial depth;
- deep jet trenching;
- mechanical trenching, which excavates a trench in the seabed in which the cable is layed; and
- cable ploughs, which opens a narrow trench in the seabed using a towed plough, inserting the cable simultaneously.

106. Pre-sweeping and/or dredging may be required in some areas. This will allow for the selected cable installation method to be used. Trenchless techniques will also be used at landfall as explained in Table 3.25.

Cable protection installation

107. Cable protection will be used where minimum target burial depths are not achieved during installation and at cable crossings (see section 3.2.5). Cable protection systems are also to be used as cables approach and enter the wind turbines and OSPs/Offshore convertor station platforms (see section 3.2.5).

108. It is proposed that cable protection will consist of the following cable protection systems:

- rock placement;
- rock bags;
- concrete mattresses
- cast iron shells; and;
- sleeving.

109. Further information is provided in paragraphs 55 to 61.

Cable crossing installation

110. As explained in paragraph 62, up to 16 cable crossings may be required for the offshore export cables. The crossings would be protected using one of the protection technologies described in Table 3.19. A crossing angle close to 90 degrees relative to the existing cable is the preferred option, however this might differ depending on the final design and protection technology used.

Step 6 – Wind turbine installation/commissioning

111. The wind turbines will be transported to the Proposed Development array area by vessel from the pre-assembly port where sub-assemblies (nacelle, rotor blades and towers), assembly parts, tools and equipment will be loaded onto an installation or support vessel.

112. At the installation location, the wind turbine towers will be lifted onto the pre-installed foundation and transition piece by the crane on the installation vessel. The nacelle and rotor blades will then be lifted into position. The exact methodology for the assembly will be dependent on the installation contractor and wind turbine type.

113. Following installation of the wind turbine, commissioning activities will take place including mechanical completion, electrical completion, HV commissioning and HV energisation.

114. Following energisation, the HV commissioning activities will be completed and the wind turbines will undergo performance and reliability testing.

3.4.2. INSTALLATION VESSELS AND HELICOPTERS

115. A range of installation vessels will be used for the construction of the Proposed Development. This includes main installation vessels (e.g. jack-up or DP vessels with heavy lifting equipment), support vessels (including Service Operation Vessels (SOVs), tugs and anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels and scour/cable protection installation vessels. In addition, it is possible that helicopters will be used for crew transfers.

116. Installation vessel and helicopter parameters are presented in Table 3.28 for activities associated with the construction of the Proposed Development. The table provides an overview of the number of vessels/helicopters (and return trips) for construction of the Proposed Development including within the array area and along the Proposed Development export cable corridor (including landfall) at any one time during the entire construction phase. The number of vessels required seabed preparation activities are also provided separately in Table 3.24. It should be noted that the numbers presented are an estimated maximum adverse scenario for assessment purposes and in reality, vessel and helicopter numbers are anticipated to be less than this. The maximum number of vessels is 155 on site at any one time with up to 11,484 return trips.

Table 3.28: Design Envelope: Infrastructure Installation (Proposed Development Array Area and Export Cable (including landfall)) - Vessels and Helicopters

Parameter	Maximum Design Envelope	
	Maximum Total Number of Vessels on Site at any One Time	**Total Movements (Return Trips Across Construction Phase)**
Main installation vessels (jack-up barge/DP vessel)	9	297
Cargo barge	14	194
Support vessels (including SOVs)	9	714
Tug/anchor handlers	22	794
Cable installation vessels	6	36
Guard vessels	22	1488
Survey vessels	8	464
Crew transfer vessels	14	3342
Scour/cable protection installation vessels	10	3390
Resupply vessels	20	245
Helicopters	13	3214
Boulder clearance vessel	9	316
Geophysical/geotechnical survey vessel	2	70
UXO clearance vessel	7	30
Sand wave clearance vessel	3	104
Total	**168**	**14,698**
Total (excluding helicopters)	**155**	**11,484**

117. Jack-up vessels/barges make contact with the seabed when their jack-up spud cans (base structure of each leg) are lowered into place. For the purposes of the Offshore EIA Report, jack-up vessel parameters are presented in Table 3.29.

Table 3.29: Design Envelope: Jack-up Vessels

Parameter	Maximum Design Envelope
Maximum number of legs per vessel	6
Maximum individual leg diameter (m)	8.6
Maximum area of spud cans (m^2)	250
Maximum individual leg area (m^2)	25

Parameter	Maximum Design Envelope
Maximum seabed footprint (m^2)	1,000

3.4.3. CONSTRUCTION PORTS

118. It is likely that the Proposed Development components will be fabricated at a number of manufacturing sites across Scotland, the UK and Europe, while the substructures could be fabricated in the Middle East or Far East. Components may be transported directly to the Proposed Development from where they are manufactured or may be delivered to a port where they are stored in line with the day to day practice of that port before onward transport to the Proposed Development. This will be determined as part of competitive tendering processes whilst aiming to maximise UK and Scottish content, in line with Supply Chain Plan commitments.

119. All components are anticipated to be transported via sea transport to the Proposed Development for installation via vessels and associated equipment. Therefore, there is not anticipated to be a requirement for large components (e.g. wind turbine blades) to be transported via road.

120. The construction port for the storage, fabrication, pre-assembly and delivery of Proposed Development infrastructure has not yet been confirmed at the time of writing this Offshore EIA Report., however the majority of large infrastructure will go to site via vessel. Suitable ports will be selected based on the presence of appropriate facilities to handle and process offshore wind farm components. It is anticipated that all activities carried out within port will fall under established port licences and operational controls. For the purposes of this Offshore EIA Report and in order to assess a maximum design scenario, the assessments consider a maximum number of vessels and vessel movements to/from site, where relevant.

121. Construction personnel will transit to the location of the Proposed Development on the installation vessels or other vessels listed in Table 3.28. Crew transfers may also take place between the construction port and the site of the Proposed Development via Crew Transfer Vessels (CTVs), Service Operation Vessels (SOVs), or by helicopter operating from a licenced airfield. Crew transfers during construction, operation and decommissioning will launch from existing port sites.

3.4.4. CONSTRUCTION PROGRAMME

122. An outline of the programme for construction of the Proposed Development is provided below. The indicative commencement and completion dates, together with estimated durations of key construction activities, have been used to inform the assessment of construction impacts. Further detail on specific timeframes, durations and sequencing of activities is provided in the maximum design scenario tables that are included in each of the technical chapters.

123. Due to its scale, the Proposed Development will be built out over a period of up to eight years including site preparation works and snagging activities following installation of the wind turbines prior to final commissioning. The majority of activities will occur over various campaigns targeted at the relevant assets. Most activities will have a maximum duration of five years or less. Although construction activities will typically occur sequentially there are expected to be periods where certain construction activities occur concurrently. For example, substructure installation and inter-array cables installation, or commencement of wind turbine installation while foundation installation is being completed.

124. Indicative outline construction programme includes the following:

- commencement of offshore construction (site preparation and landfall activities) expected Q1 2025;
- completion of construction (including snagging) expected Q1 2033;
- key construction activity and estimated durations:
  - site preparation works – will occur for the duration of the construction phase but will not be continuous;
  - landfall installation – up to approximately 15 months;
  - wind turbine substructure installation – up to four years and six months across two installation campaigns;
  - OSPs/Offshore convertor station platforms installation – up to three years across two installation campaigns;
  - Inter-array cables installation - up to five years across two installation campaigns;
  - offshore export cables installation – up to two years and one month;
  - wind turbine installation – up to three years across two installation campaigns; and
  - completion and snagging – up to five years across two campaigns periods.

3.4.5. RECOMMENDED SAFE PASSING DISTANCES AND AIDS TO NAVIGATION

Safety zones, recommended safe passing distances and Notice to Mariners

125. It is standard practice during the construction and operation of an offshore development to communicate with other mariners of safe clearance distances around construction, installation, maintenance and decommissioning activities.

Statutory safety zones

126. The legal mechanism for establishing statutory safety zones is discussed in volume 1, chapter 2. The following safety zones will be recommended for the Proposed Development:

- temporary (or rolling) 500 m safety zones surrounding the location of all fixed (surface piercing) structures where work is being undertaken by a construction vessel;
- 50 m safety zones around all surface structures until commissioning where construction work is not active; and
- 500 m around any structure where major maintenance is ongoing (major maintenance- works are defined within the Electricity (Offshore Generating Stations)(Safety Zones) (Application Procedures and Controls of Access) Regulations 2007.

127. Statutory decommissioning safety zones will be applied for during the decommissioning phase as appropriate and are not expected to exceed the standard 500 m.

Recommended safe passing distances

128. Recommended safe passing distances may also be used during the construction, operation and maintenance and decommissioning phases to ensure the safety of third party vessels. These will be communicated via Notice to Mariners (NtMs) during all phases of the Proposed Development.

Aids to navigation

129. The lighting and marking of wind turbines and OSPs/Offshore convertor station platforms to aid navigation will be defined post consent in consultation with the Northern Lighthouse Board (NLB), Marine and Coastguard Agency (MCA), the Civil Aviation Authority (CAA) and the Ministry of Defence (MoD).

130. Throughout the lifetime of the Proposed Development, marine aids to navigation will be provided in accordance with the requirements of the NLB, MCA and adherence to Civil Aviation Publication (CAP) 393 Article 223 (Civil Aviation Authority (CAA), 2016), unless otherwise agreed. All navigational aids associated with the Proposed Development will be suitably monitored and maintained to ensure the relevant CAA availability targets are met.

3.5. OPERATION AND MAINTENANCE PHASE

3.5.1. METHODOLOGY

131. The overall operation and maintenance strategy will be finalised once the operation and maintenance base location and technical specification of the Proposed Development are known, including wind turbine type, electrical export option and final project layout.

132. This section, therefore, provides a description of the reasonably foreseeable planned and unplanned maintenance activities at the Proposed Development.

133. Table 3.30 provides a list of all operation and maintenance activities planned for the Proposed Development.

134. The offshore operation and maintenance will be both preventative and corrective. The operation and maintenance strategy will include an onshore (harbour based) operation and maintenance base, supported by a SOV and/or Crew Transfer Vessel (CTV) logistics strategy. This will be developed at a later stage once further detail is confirmed for the Proposed Development

Table 3.30: Design Envelope: Operation and Maintenance Activities

Parameter	Maximum Design Envelope		
Foundations (Wind Turbines)	**Description**	**Expected Method and Vessel Types**	**Expected Frequency**
Routine Inspections	Inspections of foundations, including Transition Pieces and ancillary structures (e.g. J-tubes), above and below sea level.	Small team/drone access by CTV/SOV	Routine maintenance - Estimated every six months for first two years and annually thereafter = estimated 37 across the 35 year life cycle of the Project.
Geophysical surveys	Survey of seabed and assets.	Survey vessel or Unmanned Surface Vessels (USVs) (Xocean)	Estimated every six months for first two years and annually thereafter plus ad hoc (e.g. jack-up vessels). = estimated 37 across the 35 year life cycle of the Project.
Repairs and replacements of navigational equipment	Repairs and replacements of electrical equipment such as lighting, fog horns, navigation lights and transponders.	Small team access by CTV/SOV	Unscheduled maintenance - Estimated once every two years for nav lights with a maximum of 26 across the life cycle of the Project.
Removal of marine growth and bird guano	Removal of marine growth and bird guano from foundations, transition pieces, or access ladders (e.g. boat landings or other secondary structures). Removal of bird guano.	Ad hoc pressure washer from CTV/SOV	Unscheduled maintenance - Estimated removal occurring on every wind turbine twice over the lifecycle of the project = 614 times (based on 307 wind turbines).
Replacement of corrosion protection anodes	Remove and replace anodes required for corrosion protection.	Dependant on cathodic protection. Divers or Remotely Operated Vehicle (ROV) usually deployed from a Dynamic positioning 2 (DP2) vessel	Estimated four every three years = 47 over the lifecycle.
Painting	Application of paint or other coatings to protect the foundations from corrosion (internal/external), including surface preparation.	Small team access by CTV/SOV	Unscheduled maintenance - Carried out during other works. Likely 10% of foundations a year.
Replacement of access ladders and boat landings	Removal and replacement of ancillary structures (e.g. access ladders and boat landings).	Unknown at this time	Estimated at one per five years plus possible ad hoc requirements = ten over the lifecycle of the Project.
Modifications to/replacement of J-tubes	Modifications to/replacement of J-tubes (e.g. during inter-array cable repair works).	Divers or ROV usually deployed from a DP2 vessel.	Estimated at one per five years = ten over the lifecycle of the Project.
Wind Turbines	**Description**	**Expected Method and Vessel Types**	**Expected Frequency**
Routine inspections	Inspections within the wind turbines on the exterior of the wind turbine (e.g. blade inspections).	Drone campaign accessed by CTV/SOV	Rolling campaign of approx.25% of site/year. Undertaken from SOV which is essentially permanently on site.
Replacement of consumables	Replacement of consumables within the wind turbine (e.g. filters, oils, lubricants)	Small team access by CTV/SOV	Oils/filters annually. Gearbox oil min five yearly.
Minor repairs and replacements within the wind turbine	Minor repairs and replacements (like-for-like) within the wind turbine (e.g. motors, pumps, small electric equipment, circuit breakers, fuses).	Small team access by CTV/SOV	One every two years per wind turbine plus consideration of additional ad hoc repairs and replacements = 7,373 over 35 years.
Major component replacement	Replacement of blades, gearboxes, transformers or generators.	Jack up barge	Approximately 70 replacements over ten years, 245 over the 35 year lifetime.
Painting or other coatings	Paint or other coatings applied (internal/external). Coatings on the blades and minor paint repairs to tower and nacelle.	Small team access by CTV/SOV	Minor touch up campaign each year on transition piece on all wind turbines. Undertaken as part of routine maintenance. Likely 10% of wind turbines a year. Occur alongside foundation campaign.

Parameter	Maximum Design Envelope		
Foundations (OSP/Offshore Convertor Station Platform)	**Description**	**Expected Method and Vessel Types**	**Expected Frequency**
Routine inspections	Inspections within the OSP/Offshore convertor station platforms on the exterior of the wind turbine (e.g. blade inspections).	Drone campaign accessed by CTV/SOV	Included in the routine inspections for wind turbines foundations.
Geophysical surveys	Survey of seabed and assets.	Survey vessel or USV (Xocean)	Included in the geophysical surveys for wind turbines foundations.
Removal of marine growth and bird guano	Removal of marine growth and bird guano from foundations or access ladders.	Ad hoc pressure washer from CTV/SOV	Estimated removal occurring on every OSP/Offshore convertor station platform twice over the lifecycle of the Project = 20 times (based on ten OSP/Offshore convertor station platform).
Replacement of corrosion protection anodes	Remove and replace anodes required for corrosion protection.	Divers or ROV usually deployed from a DP2 vessel	One every three years = 12 over the lifecycle.
Painting	Application of paint or other coatings to protect the foundations from corrosion (internal/external), including surface preparation.	Small team access by CTV/SOV	Carried out during other works. Assumed 10% of OSPs/Offshore convertor station platforms a year.
Replacement of access ladders and boat landings	Removal and replacement of ancillary structures (e.g. access ladders and boat landings).	Unknown at this time	Estimated at one per five years = seven trips over the lifecycle of the Project.
Modifications to/replacement of J-tubes	Modifications to/replacement of J-tubes (e.g. during inter-array or offshore export cables repair works).	Divers or ROV usually deployed from a DP vessel	Estimated at one per five years = seven trips over the lifecycle of the Project.
Topside (OSP/Offshore Convertor Station Platform)	**Description**	**Expected Method and Vessel Types**	**Expected Frequency**
Routine inspections	Inspections within the OSP/Offshore convertor station platform on the exterior of the OSP/Offshore convertor station platform.	Small team access by CTV/SOV	Monthly visual inspection - one day per structure.
Removal of marine growth and bird guano	Removal of marine growth and bird guano	Ad hoc pressure washer from CTV/SOV	Estimated removal occurring on every OSP/Offshore convertor station platform twice over the lifecycle of the Project = 20 times (based on ten OSP/Offshore convertor station platform).
Replacement of consumables and minor components.	Replacement of consumables (e.g. oils, lubricants) and minor components within the OSP/Offshore convertor station platform.	Small team access by CTV/SOV	When found during monthly inspection done at the time.
Major component replacement	Replacement of transformers, switchgear etc.	Jack up barge	One to two every ten years.
Painting or other coatings	Paint or other coatings applied (internal/external).	Small team access by CTV/SOV	Assumed 10% of OSPs/Offshore convertor station platforms a year. Completed in same campaign as foundations.
Inter-Array Cables	**Description**	**Expected Method and Vessel Types**	**Expected Frequency**
Routine inspections	Inspections of the cable and any cable protection, including at their entry into J-tubes on offshore structures.	Survey vessel or USV (Xocean). ROV. Non-invasive	10% of inter-array cable length inspected each year.
Geophysical surveys	Survey of seabed and cable protection (if present).	Survey vessel or USV (Xocean)	10% of inter-array = length inspected each year, more if issues are identified.
Inter-array cable repair	Repair and replacement of inter-array cable section/whole inter-array cable.	Cable vessel	Ten inter-array cable repair events of up to 3,000 m each (length of whole inter-array cable), over the lifetime of the project. Conducted from cable installation vessel.

Parameter			Maximum Design Envelope
Inter-array cable reburial	Reburial of exposed inter-array cable section.	Cable vessel/support vessel	Ten inter-array cable reburial events of up to 1,000 m each (length of whole inter-array cable), over the lifetime of the Project. Conducted from cable installation vessel.
Modifications to/replacement of J-tubes	Modifications to/replacement of J-tubes (e.g. during inter-array cable repair works).	DP2 with Divers or ROV	Not anticipated.
Offshore Export Cables	**Description**	**Expected Method and Vessel Types**	**Expected Frequency**
Routine inspections	Inspections of the cable and any cable protection, including at their entry into J-tubes on offshore structures.	Survey vessel or USV (Xocean). ROV	Annually.
Geophysical surveys	Survey of seabed and cable protection (if present).	Survey vessel or USV (Xocean)	Annually.
Offshore export cable repair (subtidal)	Repair and replacement of offshore export cable section.	Shallow barges or amphibious solutions	Four offshore export cable repair events of up to 1,000 m each, over the lifetime of the Project. Conducted from cable installation vessel.
Offshore export cable reburial (subtidal)	Reburial of exposed offshore export cable section.	Shallow barges, offshore support vessel or amphibious solutions	Four offshore export cable reburial events of up to 1,000 m each, over the lifetime of the Project. Conducted from cable installation vessel.
Offshore export cable repair (intertidal)	Repair and replacement of offshore export cable section.	Shallow barges or amphibious solutions	Included in above number.
Offshore export cable reburial (intertidal)	Reburial of exposed offshore export cable section.	Shallow barges or amphibious solutions	Included in above number.

3.5.2. OPERATION AND MAINTENANCE VESSELS

135. The maximum design scenario for operation and maintenance vessel requirements for the Proposed Development are presented in Table 3.31.

Table 3.31: Design Envelope: Vessels Required During the Operation and Maintenance Activities

Parameter	Maximum Design Envelope	
	Expected Maximum Total Numbers of Vessels on Site at any One Time	**Expected Total Movements (Return Trips Across Operation and Maintenance Period)**
CTVs	4	832 per year
Jack-up vessels	1	2 per year
Cable repair vessels	1	5 times in lifetime
SOVs	2	26 per year
SOV daughter craft	2	2 to 4 movements around the Proposed Development array area per day
Cable survey vessel	1	1 vessel conducting a 4 week survey per year
Excavators or backhoe dredger	1	5 times over lifetime
Drones (used for blade inspections)	1	12 times over the lifetime of the project (approx. 1 every 3 years)

3.6. HEALTH AND SAFETY

136. All elements of the Proposed Development will be risk assessed according to the relevant government guidance as well as the Applicant's internal best practice. These risk assessments will then form the basis of the methods and safety mitigations put in place across the life of the Proposed Development.

137. The Applicant has a focus on employee safety and its QHSE policy ensures that the Applicant's wind farms are safe by design and that the processes and procedures are adhered to. There is a clearly defined safety culture in place in order to avoid incidents and accidents.

138. There will be constant controls to ensure that the safety measures are observed and followed and the Applicant has built a safe workplace for its employees and contractors.

139. The focus on QHSE is intended to ensure that everyone feels safe, in a highly controlled and safety-driven environment. This is the Applicant's first priority for the Proposed Development. It is done by closely monitoring all matters relating to health and safety on all wind farms operated by the Applicant.

3.7. WASTE MANAGEMENT

140. Waste will be generated as a result of the Proposed Development, with most of the waste expected to be generated during the construction and decommissioning phases.

141. Procedures for handling waste materials will be described in a Site Waste Management Plan (SWMP). The SWMP will describe and quantifies the waste types arising from the Proposed Development activities and how these will be managed (dispose, reuse, recycle or recover). The SWMP will also provide information on the management arrangements for the identified waste types and management facilities in the vicinity of the Proposed Development.

142. The SWMP will be provided prior to construction when further detailed design information becomes available.

3.8. DECOMMISSIONING PHASE

143. Under Section 105 of the Energy Act 2004 (as amended), developers of offshore renewable energy projects are required to prepare a decommissioning programme for approval by Scottish Ministers. A Section 105 notice is issued to developers by the regulator after consent or marine licence has been issued for the given development. Developers are then required to submit a detailed plan for the decommissioning works, including anticipated costs and financial securities. The plan will consider industry practice, guidance and legislation relating to decommissioning at that time. The plan will be consulted on with relevant stakeholders and will be made publicly available. MS-LOT will further consult on the plan, the costs and financial securities prior to seeking ministerial approval. The decommissioning plan and programme will be updated during the Proposed Development's lifespan to take account of changing practice and new technologies.

144. At the end of the operational lifetime of the Proposed Development, it is anticipated that all structures above the seabed or ground level will be completely removed were this be feasible and practicable. This will be kept under review depending on current legislation and guidance requirements, best practice and other options may be required including cutting structures below the seabed. A similar approach will be taken for cables and associated infrastructure with the aim for removal subject to existing guidance, best practice and consideration of environmental conditions and sensitivities. However, there is also potential for repowering, as explained in section 3.9.

145. The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. The CES AfLs for the Proposed Development require that the Project is decommissioned at the end of its lifetime.

3.8.1. OFFSHORE DECOMMISIONING

Wind turbines

146. Wind turbines will be removed by reversing the methods used to install them.

Foundations

147. Piled foundations are likely to be cut at an agreed depth below the seabed using pile cutting devices, depending on seabed mobility, and removed. Suction caisson foundations will be fully removed.

148. As the decommissioning programme will be updated during the Project lifespan, it may be decided, closer to the time of decommissioning, that removal will result in greater environmental impacts than leaving components *in situ*.

Scour protection

149. Draft decommissioning guidance (Scottish Government, 2019) assumes a default requirement for full removal of installations, including scour protection and offshore cables. It also states, "*Exceptions will be considered on a case by case basis and the case must be put forward as part of the decommissioning programme, taking on board environmental conditions, the balance of risk, cost and technological capabilities at that time*".

150. It is proposed that scour protection will be removed where possible and appropriate to do so, noting this will depend on the type of scour protection used and condition of said protection at the time of removal. As explained in paragraph 148, this approach will be reviewed at the time of decommissioning following the most up to date and best available guidance. For the purpose of this Offshore EIA Report, the most adverse scenario has been assessed for each topic.

Offshore export cables

151. It is proposed that offshore export cables will be removed where possible and appropriate to do so. This approach will be reviewed at the time of decommissioning following the most up to date and best available guidance. For the purpose of this Offshore EIA Report, the most adverse scenario has been assessed for each topic.

3.9. REPOWERING

152. Removal of all structures on the seabed as part of offshore decommissioning is standard procedure for a sector such as oil and gas where a non-renewable resource is being exploited. However, for offshore renewables, consideration may be given to repowering as an alternative – particularly as it is unlikely that the need for the power generated will disappear at the time of decommissioning.

153. Although CES leases for the Proposed Development will be for 50 years, the operational life of the Proposed Development is likely to be 35 years. During this time, there will be a requirement for upkeep and maintenance of the Project. Such maintenance is discussed in section 3.5.

154. If there are changes in technology, it may be desirable to 'repower' the Proposed Development at or near the end of its design life (i.e. reconstruct and replace wind turbines and/or foundations with those of a different specification or design). If the specifications and designs of the new wind turbines and/or foundations fell outside of the maximum design scenario or if the impacts of constructing, operation and maintenance and decommissioning the wind turbines and/or foundations were to fall outside those considered by this Offshore EIA Report, repowering would require further consent (and potentially an EIA) and is therefore outside of the scope of this document. At this time, it is not expected that repowering would require any removal of existing or installation of new offshore cables.

3.10. DESIGNED IN MEASURES

155. The PDE includes a number of designed in measures which have been included in the Proposed Development and are committed to be delivered by the Applicant as part of the Proposed Development.

156. Table 3.32 describes the designed in measures included for the Proposed Development. These measures are integrated into the description of the Proposed Development and have therefore been considered in the assessments presented in volume 2, chapters 7 to 21.

Table 3.32: Designed In Measures for the Proposed Development

Designed In Measures	Justification
Physical Processes	
Scour protection.	There is the potential for scouring of seabed sediments to occur due to interactions between metocean regime (wave, sand and currents) and foundations or other seabed structures. This scouring can develop into depressions around the structure. The use of scour protection around offshore structures and foundations will be employed, as described in detail in section 3.2.4. The scour protection has been included in the modelled scenarios used within the assessment of effects.
Cable burial depth.	There is a potential for cable exposure to occur due to interactions between metocean regime (wave, sand and currents). The sediment transport can lead to exposure of cables and infrastructure. The use of a cable burial depth alongside the cable installation strategy should provide sufficient depth to avoid exposure.
Benthic Subtidal and Intertidal Ecology	
An Environmental Management Plan (EMP) (volume 4, appendix 22) will be prepared and implemented during the construction, operation and maintenance and decommissioning phases of the Project.	Measures will be adopted to ensure that the potential for release of pollutants from construction, operation and maintenance and decommissioning plant is reduced as 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 takes containing hazardous substances, and storage of these substances in impenetrable bunds.
Code of Construction Practice (CoCP).	These measures have been identified during the design of the onshore and intertidal elements of the Proposed Development as part of the EIA process. They include strategies, control measures and monitoring procedures for managing the potential environmental impacts of constructing the Project and limiting disturbance from construction activities as far as reasonably practicable.
Decommissioning Plan.	The aim of this plan is to adhere to the existing UK and international legislation and guidance, with decommissioning industry practice applied. Overall, this will ensure the legacy of the Proposed Development will reduce the amount of long-term disturbance to the environment so far as reasonably practicable.
An Invasive Non-Native Species (INNS) Management Plan (INNSMP) will be implemented and is included in the EMP (see volume 4, appendix 22, annex B). The plan outlines measures to ensure vessels comply with the International Maritime Organisation (IMO) ballast water management guidelines. It will consider the origin of vessels and contain standard housekeeping measures for such vessels as well as measures to be adopted in the event that a high alert species is recorded.	To manage and reduce the risk of potential introduction and spread of INNS so far as reasonably practicable.
Marine Pollution Contingency Plan (MPCP).	Measures will be adopted to ensure that the potential for release of pollutants from construction, operation and decommissioning plant is minimised. These will likely include: designated areas for refuelling where spillages can be easily contained; only using chemicals included on the approved Centre for Environment, Fisheries and Aquaculture Science (Cefas) list under the Offshore Chemical Regulations 2002; storage of these 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. In this manner, the potential for release of contaminants from rigs and supply/service vessels will be strictly controlled, thus providing protection for marine life across all phases of the offshore wind farm development.
Suitable implementation and monitoring of cables including those installed by burial, or those protected by external protection, and where target burial depths as identified via risk assessment have not been met.	The mobile nature of sedimentary environments found in the Proposed Development benthic subtidal and intertidal ecology study area could result in the exposure of previously buried infrastructure such as inter-array, OSP/Offshore convertor station platform interconnector and offshore export cables. Monitoring these features ensures that repair and reburial are done efficiently so that no more than the assessed amount of new hard substrate habitat is created, and this infrastructure does not cause unnecessary damage to the environment. Approval would be sought to implement these repairs and reburial events as well as for deployment of cable protection in line with what has been assessed.
A pre-construction Annex I reef survey to determine the location, extent and composition of any biogenic/geogenic reefs within the Proposed Development. Should such reef features be identified during pre-construction surveys, appropriate measures (e.g. micro-siting) will be discussed with statutory consultees and agreed with MS-LOT to avoid direct impacts to these features, where reasonably practicable, and on the basis of the extent of these features at the time of construction.	Rocky and stony reef was recorded within the Proposed Development export cable corridor and a localised patch of low potential *Sabellaria spinulosa* reef was recorded within the Proposed Development array area. This designed in measure will ensure that direct impacts (e.g. habitat loss) to ecologically sensitive biogenic or geogenic reefs will be avoided or minimised where possible and reasonably practicable.
Only drilling fluids that are on the Poses Little or No Risk (PLONOR) to the environment list. The list is controlled and maintained by Cefas to be used.	Due to the direction of the trenchless cable landfall being constructed from onshore to offshore, there will be a potential interface between the sea and the drill fluids during physical punch out of the exit punches out and potentially at break outs associated with the selected trenchless technique (e.g. HDD). Small quantities of drill fluids may be released. To limit potential environmental damage only PLONOR listed drilling fluid will be used.
Fish and Shellfish Ecology	
Implementation of piling soft start and ramp up measures. During piling operations, soft starts will be used, involving the implementation of lower hammer energies (i.e.	This measure will minimise the risk of injury to fish species in the immediate vicinity of piling operations, allowing individuals to flee the area before noise levels reach a level at which injury may occur.

Designed In Measures	Justification
approximately 15% of the maximum hammer energy) at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	
Low order disposal of UXOs.	Low order techniques will be adopted wherever practicable (e.g. deflagration and clearance shots) as mitigation to minimise noise levels and thereby injury and disturbance to fish and shellfish receptors. However, there is a small risk that low order could unintentionally arise in a high order detonation and therefore this scenario has also been considered in the assessment of effects.
Development of, and adherence to, an EMP, including MPCP.	To reduce the potential for release of pollutants from construction, operation and maintenance, and decommissioning plant as 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 takes containing hazardous substances, and storage of these substances in impenetrable bunds. The MPCP will require, in the unlikely event that a pollution even occurs, that plans are in place to respond quickly and effectively to ensure any spillage is reduced as far as reasonably practicable and effects on the environment are ideally avoided or reduced as far as reasonably practicable. Implementation of these measures will reduce the accidental release of contaminants from vessels as far as reasonably practicable, thus providing protection for marine life across all phases of the Project Development.
Development of, and adherence to, an appropriate CoCP.	These measures have been identified during the design of the offshore and intertidal elements of the Project as part of the EIA process. They include strategies, control measures and monitoring procedures for managing the potential environmental impacts of constructing the Project and limiting disturbance from construction activities as far as reasonably practicable.
Preparation and implementation of a Cable Plan (CaP), including a cable burial risk assessment (CBRA) to inform cable burial depth.	A CaP will be prepared prior to the construction phase and will include a detailed cable laying plan, including geotechnical data, cable laying techniques and a CBRA which will include details on target and minimum burial depths. While the sediments in which cables are buried will not reduce the strength of Electromagnetic Fields (EMFs), the burial of cables does increase the distance between cables and fish and shellfish Important Ecological Features (IEFs), with greater attenuation of EMFs with greater distance from the cable, thereby potentially reducing the effect of EMFs on those IEFs.
Development of, and adherence to, a Decommissioning Plan.	The aim of this plan is to adhere to the existing UK and international legislation and guidance, with decommissioning industry practice applied. Overall, this will reduce the amount of long-term disturbance to the environment as far as reasonably practicable. While this measure has been committed to as part of the Proposed Development, the maximum design scenario for the decommissioning phase has been considered in each of the assessments of effects.
Marine Mammals	
An outline Marine Mammal Mitigation Protocol (MMMP) (volume 4, appendix 23) will be consulted on with NatureScot and/or Marine Scotland Science (MSS), approved by MS-LOT and implemented prior to construction. For the purpose of developing the MMMP, a mitigation zone will be defined based on the maximum predicted injury range from the dual metric noise modelling for any of the modelled scenarios (4,000 kJ for concurrent piling of wind turbines and 4,000 kJ for single piling OSPs/Offshore convertor station platforms) and across all marine mammal species. The MMMP will set out the designed-in measures to apply in advance of and during piling activity. A MMMP will also include geophysical surveys to ensure that appropriate measures are followed in line with JNCC guidance (JNCC, 2017).	The implementation of an approved MMMP will mitigate for the risk of physical or permanent auditory injury to marine mammals within a 'mitigation zone'. The potential to mitigate for injury was considered with respect to the largest potential injury zone across all species (2,319 m based on predictions of injury for minke whale using the 4% reducing to 0.5% conversion factor). The use of an approved MMMP will also minimise the potential for collision risk, or potential injury to, marine mammals. Measures such as visual and acoustic monitoring will be applied. The measures outlined in JNCC guidelines (JNCC, 2017) are designed to reduce the risk of injury to marine mammals during geophysical survey activities.
Implementation of piling soft start and ramp up measures. During piling operations, soft starts will be used. This will involve the implementation of lower hammer energies (i.e. approximately 15% of the maximum hammer energy) at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	This measure will minimise the risk of injury to marine mammal and fish species in the immediate vicinity of piling operations, allowing individuals to flee the area before noise levels reach a level at which injury may occur. It is considered that compliance with these guidelines will, in most cases, reduce the risk of injury to marine mammals to negligible levels.
Detonation of UXO using low order techniques.	Low order techniques will be adopted where practicable. Given the small risk that a low order could unintentionally arise in a high order detonation (approximately 10% of the total number of UXOs could result in high order detonation), the MMMP (volume 4, appendix 23) will also include mitigation to reduce the risk of injury from UXO clearance. Measures such as visual and acoustic monitoring will be applied.
Code of Conduct will be issued to all Project vessel operators, requiring them to: • not deliberately approach marine mammals; • keep vessel speed to a minimum; and • avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride. Code of Conduct will be adhered to at all times.	To minimise the potential for collision risk, or potential injury to, marine mammals and megafauna.

Designed In Measures	Justification
Development of, and adherence to, an EMP, including MPCP.	To ensure that the potential for release of pollutants during construction, operation and maintenance, and decommissioning phases are minimised. 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 takes containing hazardous substances, and storage of these substances in impenetrable bunds. The MPCP will ensure that in the unlikely event that a pollution even occurs, that plans are in place to respond quickly and effectively to ensure any spillage is minimised and effects on the environment are ideally avoided or minimised. Implementation of these measures will ensure that accidental release of contaminants from vessels will be avoided or minimised, thus providing protection for marine life across all phases of the Proposed Development.
Development of, and adherence to, an appropriate CoCP.	Measures within the CoCP have been identified during the design of the onshore and intertidal elements of the Proposed Development as part of the EIA process. They include strategies, control measures and monitoring procedures for managing the potential environmental impacts of constructing the Proposed Development and limiting disturbance from construction activities as far as reasonably practicable.
Development of, and adherence to, a Decommissioning Plan.	The aim of this plan is to adhere to the existing UK and international legislation and guidance. Overall, this will ensure the legacy of the Proposed Development will result in the minimum amount of long-term disturbance to the environment. While this measure has been committed to as part of the Proposed Development, the maximum adverse scenario for the decommissioning phase has been considered in each of the assessments of effects.
Offshore Ornithology	
Increased air gap between the lower tip height and sea surface.	By raising the air gap to a minimum of 37 m above Lowest Astronomical Tide (LAT) as a designed in measure the risk of collision impacts is significantly reduced as an increasing proportion of birds fly below the rotor height.
Avoidance of relatively high densities of seabirds.	Based on existing baseline data the Project selected a site boundary that avoided areas recognised to have relatively high densities of seabirds. Subsequently, the boundary has been further refined to reduce the potential impacts on birds.
Site boundary moved 2 km away from boundary of Outer Firth of Forth and St Andrews Bay Complex SPA.	During the refinement of the site boundary, a decision was made to move it 2 km from the boundary of this SPA in order to reduce the possibility of any displacement effects on birds within the SPA.
Commercial Fisheries	
Appointment of a Fisheries Liaison Officer (FLO).	Provides a project specific point of contact to liaise and engage with the fishing industry.
Participation in the Forth and Tay Commercial Fisheries Working Group (FTCFWG).	Provides a forum for information sharing and discussion of key issues with fisheries stakeholders and other developers in the region.
A Navigational Safety Plan and Vessel Management Plan (NSPVMP) (volume 4, appendix 25) will provide the details of the vessel management and navigational safety of the Proposed Development and mitigate the impact of project vessels and the navigational risk to other legitimate users of the sea. Under the NSPVMP, the Applicant will ensure that details of the Proposed Development are promulgated in the Kingfisher fortnightly bulletins, as soon as reasonably practicable prior to the commencement of construction of the Proposed Development. These bulletins will inform the commercial fishing industry of vessels routes, timing and locations of construction works, and relevant details of the construction activities. Record hazards such as subsea cables.	Facilitates awareness and helps minimising disturbance to fishing activities. timely and efficient distribution of NtM, Kingfisher notifications and other navigational warnings of the position and nature of works associated with the Proposed Development.
Compliance of all Project vessels with international marine regulations as adopted by the Flag State, notably the International Regulations for Preventing Collisions at Sea (COLREG) and International Convention for the Safety of Life at Sea (SOLAS).	Minimises the risk introduced due to the presence of Project vessels.
Lighting and marking of the Proposed Development array area in agreement with the NLB and in line with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) G1162 (IALA, 2021).	Maximises awareness of the Proposed Development both in day and night conditions including in restricted visibility and assists with Search and Rescue (SAR) operations.
Appropriate marking of structures (both within the Proposed Development array area and export cable corridor) on United Kingdom Hydrographic Office (UKHO) Admiralty Charts.	Maximises awareness of the Proposed Development allowing vessels to passage plan in advance.
Adherence to appropriate guidance with regards to fisheries liaison and mitigation (i.e. Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW) guidance).	Facilitates the establishment of productive relationships with fisheries stakeholders and the implementation of an evidence-based approach to mitigation.
Use of guard vessels and Offshore Fisheries Liaison Officers (OFLOs) where required and appropriate.	Facilitates engagement with fisheries stakeholders during specific Project works and minimises potential for conflict between the Proposed Development and fishing activities.

Designed In Measures	Justification
Development of a Fisheries Management and Mitigation Strategy (FMMS) (volume 4, appendix 24) for MS-LOT approval and in consultation with fisheries stakeholders.	Details the Applicant's proposed approach to fisheries liaison and to facilitating co-existence, including details on the measures which are proposed to be implemented to minimise impacts on commercial fishing.
Outline NSVMP will be provided at Application (volume 4, appendix 25).	Details the Applicants proposed approach to navigation safety and vessel management to maximise safety considerations.
Cables will be buried to a minimum depth of 0.5 m where reasonably practicable. Where cable burial target depths are not met cable protection will be used.	Minimises potential interactions between fishing gear and cables.
The location, extent and nature of the cable protection measures used will be communicated to the fishing industry.	Prevents potential damage to and from fishing gear and associated safety risks.
Where rock placement is used for cable protection consideration will be given to designs that minimise potential gear snagging risk (i.e. used of graded rock and 1:3 profile berms).	Facilitates co-existence and minimises potential damage to and from fishing gear and associated safety risks.
Undertaking of post-lay and burial inspection surveys and, where appropriate and practicable, undertaking of rectification works.	Facilitates co-existence and prevents potential damage to and from fishing gear and minimises potential safety risks.
Undertaking of assessments to determine cable burial status (including cable protection) and identify potential changes to seabed conditions. Findings would be shared with the fishing industry to discuss requirements for any further surveys.	Facilitates co-existence and prevents potential damage to and from fishing gear and minimises potential safety risks.
Anticipated vessel transit routes and shelter/holding areas for construction vessels will be identified in the VMP.	Facilitates co-existence and minimises potential adverse interactions between Proposed Development vessels and fishing activities.
Development of a Code of Good Practice for contracted vessels.	Facilitates co-existence between vessels undertaking works for the Proposed Development and fishing vessels and helps minimise potential adverse interactions.
Development of suitable procedures to allow claims for loss or damage to gear.	Facilitates co-existence and minimises potential adverse interactions between Proposed Development vessels and fishing activities.
Shipping and Navigation	
Application for Safety Zones up to 500 m around structures where vessels are undertaking construction work during construction and periods of major maintenance and 50 m around partially completed or completed but not yet fully commissioned surface piercing structures during construction.	Protects third-party vessels from Project vessels involved in construction and major maintenance activities which may be Restricted in their Ability to Manoeuvre (RAM).
Deployment of a buoyed construction area in agreement with the NLB.	Protects third-party vessels from Project vessels involved in construction and major maintenance activities which may be RAM.
Suitable implementation and monitoring of cable protection (via burial, or external protection where adequate burial depth as identified via risk assessment is not feasible) with any damage, destruction or decay of cables notified to the MCA, NLB, Kingfisher and UKHO no later than 24 hours after discovered.	Minimises the risks of underwater allision with cable protection, anchor or fishing gear interaction with subsea cables and interference with magnetic position fixing equipment.
Compliance with Marine Guidance Note (MGN) 654 and its annexes (in particular SAR annex 5 (MCA, 2021) and completion of a SAR checklist) where applicable.	Ensures the final array layout is suitable for SAR operations and that reductions in under keel clearance are acceptable.
Use of guard vessel(s) as required by risk assessment.	Maximises awareness of temporary hazards.
Layout finalised through the Development Specification and Layout Plan (DSLP) via consultation with the MCA and NLB.	Ensures the final array layout is suitable for both surface and air based (for SAR purposes) navigation.
Lighting and marking of the Proposed Development array area in agreement with the NLB and in line with IALA G1162 (IALA, 2021).	Maximises awareness of the Proposed Development in both day and night conditions including in restricted visibility and assists with SAR operations.
Marine coordination and communication to manage project vessel movements.	Ensures project vessels are suitably managed to minimise the likelihood of involvement in incidents and maximise the ability to assist in the event of a third-party incident.
Creation and implementation of a MPCP.	Minimises the environmental effects in the event of an incident involving pollution.
Appropriate marking of structures (both within the Proposed Development array area and export cable corridor) on UKHO Admiralty Charts.	Maximises awareness of the Proposed Development allowing vessels to passage plan in advance.
Minimum blade clearance of 22 m above MHWS (in line with Royal Yachting Association (RYA) policy (RYA, 2019).	Minimises the risk of blade allision particularly for sailing vessels with a mast, noting that the minimum blade clearance will be 37 m above LAT.

Designed In Measures	Justification
Compliance of all project vessels with international marine regulations as adopted by the Flag State, notably the COLREGs (IMO, 1972/77) and SOLAS (IMO, 1974).	Minimises the risk introduced due to the presence of project vessels.
Promulgation of information for vessel routes, timings and locations, Safety Zones and advisory safe passing distances as required via Kingfisher Bulletins.	Maximises awareness of the Proposed Development allowing vessels to passage plan in advance.
Aviation, Military and Communications	
Adherence to Civil Aviation Authority (CAA) (2016). *CAP 393, Air Navigation: The Order and the Regulations (2016)*. This will require approval and implementation of a Lighting and Marking Plan (LMP) (volume 4, appendix 27) which will set out specific requirements in terms of aviation lighting to be installed on the wind turbines. The LMP will be prepared in consultation with the CAA, Ministry of Defence (MoD) and MCA and will take into account requirements for aviation lighting as specified in Article 223 of the UK Air Navigation Order (ANO), 2016 and changes to International Civil Aviation Organization (ICAO) Annex 14 Volume 2, Chapter 6, paragraph 6.2.4 promulgated in November 2016.	To comply with CAA (2016). *CAP 393, Air Navigation: The Order and the Regulations (2016)* which sets out the mandatory requirements for the lighting of offshore wind turbines, and to ensure appropriate lighting is in place to facilitate aeronautical safety. An outline LMP is provided with the Application (see volume 4, appendix 22).
All structures of more than 91.4 m in height will be charted on aeronautical charts and reported to the Defence Geographic Centre (DGC) which maintains the UK's database of tall structures (Digital Vertical Obstruction File) at least ten weeks prior to construction. Furthermore, any temporary obstacles associated with wind farms which are of more than 91.4 m in height (e.g. construction infrastructure such as cranes and/or meteorological masts) are to be alerted to aircrews by means of the Notice to Airmen (NOTAM) system.	An object which is more than 91.4 m in height is considered to have significance for the en route operations of aircraft in UK airspace.
CAA will be informed of the locations, heights and lighting status of the wind turbines, including estimated and actual dates of construction and the maximum heights of any construction equipment to be used, prior to the start of construction, to allow inclusion on aviation charts and in the UK Integrated Aeronautical Information Package (IAIP).	To comply with CAA (2016): *CAP 764 - CAA Policy and Guidelines on Wind Turbines (Version 6, February 2016*) which requires the CAA to be notified of the construction and location of wind turbines.
Infrastructure and Other Users	
Application and use of Safety Zones during construction, operation and maintenance, and decommissioning activities associated with wind turbines and offshore platforms. In the interests of safety to infrastructure and other users receptors.	In the interests of safety to infrastructure and other users receptors.
Timely and efficient distribution of NtM, Kingfisher notifications and other navigational warnings of the position and nature of works associated with the Proposed Development.	In the interests of safety to infrastructure and other users receptors.
Promulgation of information and implementation of Safety Zones and advisory safety distances regarding the displacement of recreational marine vessels	The construction of infrastructure and implementation of safety distances around construction vessels may displace recreation vessels. Likewise, maintenance and decommissioning activities may also displace recreation vessels.
Crossing or laying of cables over or adjacent to known or future cables will be subject to crossing and/or proximity agreements.	In the interests of safety to infrastructure and other users receptors and to potential maintenance works being undertaken (e.g. Neart Na Gaoithe (NnG) offshore export cables).
Promulgation of information and implementation of Safety Zones and advisory safety distances regarding the displacement of recreational marine fishing and other marine activities not related to utilising watercraft.	The construction of infrastructure and implementation of safety distances around the landfall location may prevent access to the area for recreation users. Likewise, maintenance and decommissioning activities may also restrict access.
Promulgation of information and crossing and/or proximity agreements regarding restricted access to NnG infrastructure.	The construction of offshore export cables and implementation of safety distances around vessels may affect or restrict access to existing cables. Likewise, maintenance and decommissioning activities may also restrict access.
Presence of 500 m construction safety zones around structures undergoing installation, 500 m operational safety zones for major maintenance activities and 50 m advisory safety zones around all structures until the point of commissioning. Advisory clearance distances of up to 500 m in radius around installation vessels. Advisory clearance distances along vulnerable sections of cables (i.e. cables waiting burial or protection).	In the interests of safety to infrastructure and other users receptors.
Creation of a database of known users (including local yacht clubs, local dive clubs and local recreational activity centres) to act as a mailing list for direct issue of NtMs.	To ensure that as many interested parties as possible are aware of Proposed Development activities.

Designed In Measures	Justification
Marine Archaeology	
An outline Written Scheme of Investigation (WSI) has been provided with this application (volume 4, appendix 22, annex D). The WSI will be updated for submission prior to construction and submitted to MS-LOT for approval.	To identify possible features of marine archaeological importance and agree mitigation to avoid and/or mitigate potential impacts.
Implementation of Archaeological Exclusion Zones (AEZs) around sites identified as having high and medium archaeological potential. Final wind turbine locations to avoid any known archaeological constraints identified in pre-construction surveys through micro-siting.	To avoid direct impacts on sites of identified archaeological significance
Retained Archaeologist (RA) to provide input into specifications for further geophysical surveys and archaeological analysis of the outputs from any further pre-construction geophysical surveys.	To avoid impacts on sites of archaeological importance.
Should material of archaeological interest be encountered during works these will be reported through the agreed Protocol for Archaeological Discoveries (PAD). The PAD will be based on the Offshore Renewables Protocol for Archaeological Discoveries (Crown Estate, 2014) for unexpected archaeological discoveries made during the Proposed Development.	To protect and record sites/objects of archaeological significance affected by the Proposed Development.
Cultural Heritage and Seascape, Landscape and Visual Impact	
The Proposed Development array area has been sited 37.8 km offshore from closest part of the Proposed Development array area to the closest section of coast. The eastern edge of the Proposed Development array area is generally located at distances over 60 km from the coast. The siting of the Proposed Development at long distance offshore forms the key designed in measure which minimises potential for significant cultural heritage effects relating to setting.	The siting of the Proposed Development at long distance offshore forms the key designed in measure which minimises potential for significant cultural heritage effects relating to setting.
Maximum blade tip height is 355 m from lowest astronomical tide (LAT) and maximum rotor diameter of 310 m. The height of the Proposed Development will not exceed the maximum blade top height.	The height of the Proposed Development will not exceed the maximum blade top height.
The colour of the wind turbine tower and blades will be agreed with relevant stakeholders and will likely be RAL 7035 (light grey) above the interface level. The jacket foundation (including foundation piece) will likely be painted RAL 1023 (traffic yellow) up to the interface level at approximately +30 m above LAT. The light grey (RAL 7035) colour of the Proposed Development wind turbines provides standard mitigation as a recessive colour in the seascape/sky backdrop. The brighter yellow jacket foundation will be limited to the jacket foundation (including transition piece) up to the interface level which is low lying and less visible in distant views from low lying areas.	The light grey (RAL 7035) colour of the Proposed Development wind turbines provides standard mitigation as a recessive colour in the seascape/sky backdrop. The brighter yellow jacket foundation will be limited to the jacket foundation (including transition piece) up to the interface level which is low lying and less visible in distant views from low lying areas.
Socio-Economic and Tourism	
Local Recruitment Plan: setting out initiatives to ensure local residents are aware of and given opportunity to access employment opportunities.	This will include a Local Skills Plan setting out opportunities and actions for engagement to enable local residents and training providers to prepare for anticipated employment opportunities
Supply Chain Engagement Plan: setting out initiatives to enhance opportunities for procurement from local and Scottish suppliers and to drive the investment in new facilities associated with the development, manufacturing and supply, and construction/installation supply chain	This looks to act on the opportunity presented by a more reliable pipeline of offshore wind sector activity and tackle the historic lack of investment in supply chain capacity – this is observed by Scottish Offshore Wind Energy Council (SOWEC) and aligns with the Scottish Government's commitment to deliver on the ambitions of Scotland's offshore wind programme. This pipeline of activity can create market certainty for investors to facilitate the establishment of new and increased supply chain capabilities in Scotland – as pointed out by Highlands and Islands Enterprise and Scottish Enterprise during consultation.
A Berwick Bank Community Benefit Fund would be established in partnership with local stakeholders to ensure that local communities help set the priorities for the fund, as well as decide on what gets funded. The details of the Community Benefit Fund would be established after a consent determination has been made.	Ahead of establishing any formal Fund, the Project team are keen to support local initiatives where possible and have invited local stakeholders to discuss opportunities directly with the Project team. To date the Project has supported various local organisations and initiatives such as the North Berwick Fringe By The Sea Festival, the Scottish Seabird Centre and the National Merlin Rocket Yachting Championship, held in East Lothian. In addition to this the Project team are working alongside local education partners to explore a variety of Science, Technology, Engineering and Mathematics (STEM) benefits that the Project can bring to the East Lothian area. The Project team are members of the East Lothian Industry and Education Partnership and are also members of the Mid and East Lothian Chamber of Commerce.

3.11. RESIDUES, EMISSIONS AND WASTE

157. The EIA Regulations require a description of the anticipated residues and emissions and wastes arising from the Proposed Development and a description of the likely significant effects resulting from the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste. Table 3.33 outlines these requirements and where these are addressed in the Offshore EIA Report.

Table 3.33: Residues and Emissions

EIA Report Requirement	How and Where is Considered in the Offshore EIA Report
Description of expected residues and emissions and the production of waste, where relevant; and A description of the likely significant effects of the project on the environment resulting from, the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste	The potential impacts associated with the emission of noise and vibration and associated nuisances are assessed in: • volume 2, chapter 8; • volume 2, chapter 9; • volume 2, chapter 10; • volume 2, chapter 15; • volume 3, appendix 10.1; and • volume 3, appendix 20.1. The potential impacts associated with electromagnetic fields are assessed in: • volume 2, chapter 9; and • volume 2, chapter 10. The disposal and recovery of waste is considered in: • volume 4, appendix 22.

3.12. NATURAL RESOURCES

158. Similarly, the EIA Regulations require a description of the anticipated likely significant effects resulting from the use of natural resources. Table 3.34 outlines these requirements and where these are addressed in the Offshore EIA Report.

Table 3.34: Natural Resources

EIA Report Requirement	How and Where is Considered in the Offshore EIA Report
A description of the likely significant effects of the Project on the environment resulting from, the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources	The use of natural resources is outlined in this chapter. Seabed disturbance (land and soil) is assessed in: • volume 2, chapter 7; • volume 2, chapter 8; • volume 2, chapter 9; and • volume 2, chapter 10. Use of rocks are assessed in: • volume 2, chapter 8; • volume 2, chapter 12; and • volume 2, chapter 13.

3.13. RISK OF MAJOR ACCIDENTS AND NATURAL DISASTERS

159. The risk of major accidents and natural disasters which could arise from the Proposed Development activities has been assessed within volume 2, chapter 21 of this Offshore EIA Report.

3.14. REFERENCES

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