BERWICK BANK WIND FARM
REPORT TO INFORM APPROPRIATE ASSESSMENT

PART ONE: INTRODUCTION AND BACKGROUND

Habitats Regulations Appraisal

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HRA Report – Part One
Final

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GLOSSARY

Term	Description
Appropriate Assessment	An assessment to determine the implications of a plan or project on a European site in view of that site's conservation objectives. An Appropriate Assessment forms part of the Habitats Regulations Appraisal (HRA) and is required when a plan or project (either alone or in combination with other plans or projects) is likely to have a significant effect on a European site.
Annex I Habitat	A natural habitat type of community interest, defined in Annex I of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive). The designation of Special Areas of Conservation (SAC) is required in the UK to ensure the conservation of these habitats. The protection afforded to sites designated prior to EU Exit persists in UK law.
Annex II Species	Animal or plant species of community interest, defined in Annex II of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive). The designation of Special Areas of Conservation (SAC) is required in the UK to ensure the conservation of these species. The protection afforded to sites designated prior to EU Exit persists in UK law.
Application	The Applicant is applying for the following consents as part of this Application: a Section 36 consent under the Electricity Act 1989; marine licences under the MCAA 2009; a marine licence under the Marine (Scotland) Act 2010 for the part of the offshore export cables which is within 12 nm of the coast; and planning permission under the Town and Country Planning (Scotland) Act 1997 for all infrastructure located landward of Mean Low Water Springs (MLWS).
Array Area	Area within which offshore wind turbines, inter-array cables and offshore substations platforms/offshore convertor station platforms will occur.
Baseline	The existing conditions as represented by the latest available survey and other data which is used as a benchmark for making comparisons to assess the impact of the Proposed Development.
Berwick Bank Wind Farm	The wind farm which is to be located within the Agreement for Lease area for Berwick Bank Wind Farm (formerly Seagreen 2 Offshore Wind Farm) and the Agreement for Lease area for Marr Bank (formerly Seagreen 3 Offshore Wind Farm) - together now referred to as Berwick Bank Wind Farm.
2020 Berwick Bank	The original proposal for Berwick Bank Wind Farm in respect of which a Scoping Opinion was received from the Scottish Ministers in March 2021.
Competent Authority	The term derives from the Habitats Regulations and relates to the exercise of the functions and duties under those Regulations. Competent authorities are defined in the Habitat Regulations as including "any Minister, government department, public or statutory undertaker, public body of any description or person holding a public office". In the context of a plan or project, the competent authority is the authority with the power or duty to determine whether or not the proposal can proceed (SNH, 2014).
Conversion Factor	The conversion factor is a measure of how much of the hammer energy is converted into received sound
EU Exit	The withdrawal of the United Kingdom from the European Union.
European site	A Special Area of Conservation (SAC), or candidate SAC, (cSAC), a Special Protection Area (SPA), a site listed as a site of community importance (SCI), or, as per Scottish Planning policy (SPP), a possible SAC (pSAC) or potential SPA (pSPA). All Ramsar sites are also Natura 2000 sites (taken as European sites) and a protected under the relevant statutory regimes' (SPP, paragraph 211 (published in 2014 as confirmed by Scottish Government (2019)).
Habitats Directive	The Habitats Directive is the short name for European Union Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora. The Directive led to the establishing of European sites and setting out how they should be protected, it also extends to other topics such as European protected species.
Habitats Regulations	A term that refers to the collective of legislation (three sets of HRA Regulations) that translate the Habitats Directive into specific legal obligations in Scotland, namely: • the Conservation (Natural Habitats, &c.) Regulations 1994; • the Conservation of Habitats and Species Regulations 2017; and • the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended).
Habitat Regulations Appraisal	A process required by the Habitats Regulations of identifying likely significant effects of a plan or project on a European site and (where Likely Significant Effects are predicted or cannot be discounted) carrying out an appropriate assessment to ascertain whether the plan or project will adversely affect the integrity of the European site. If adverse effects on integrity cannot be ruled out, the latter stages of the process require consideration of the derogation provisions in the Habitats Regulations.
In-combination Effect	The combined effect of the Proposed Development in-combination with the effects from a number of different projects on the same feature/receptor.
Landfall	Activities that occur seaward of MHWS to bring the offshore export cables carrying power from the wind farm to the shore and connect the offshore and onshore infrastructure.
Likely Significant Effect	Any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the European site was designated but excluding trivial or inconsequential effects. A likely effect is one that cannot be ruled out on the basis of objective information. A 'significant' effect is a test of whether a plan or project could undermine the site's conservation objectives (SNH, 2014).
Migratory Waterbirds	Species of waders and waterfowl that are ecologically dependant on wetlands and which make regular migrations along the coast of the UK and/or non-breeding individuals that overwinter in the UK.
National Site Network	The National Site Network comprises Special Protection Areas (SPAs) and Special Areas of Conservation (SACs) designated (or proposed) on EU Exit day and which formerly formed part of the Natura 2000 network. The term "national site network" is used in each of the Habitats Regulations and the terms refer to the same network of sites (Scottish Government, 2020).
Natura 2000 Network	A coherent European ecological network of Special Areas of Conservation and Special Protection Areas comprising sites located within European Union Member States.
NatureScot	Scotland's Nature Agency.
Proposed Development	The offshore components of the Project, as described in section 5 and volume 1, chapter 3 of the Offshore EIA Report.
Ramsar Site	Wetlands of international importance, designated under the Ramsar Convention on Wetlands of International Importance.
Seabirds	Birds that spend most of their lives feeding and living on the open ocean, coming ashore only to breed.
Special Area of Conservation (SAC)	Special Areas of Conservation (SACs) are areas designated for the conservation of certain plant and animals species listed in the Habitats Directive.
Site of Community Importance (SCI)	Defined in the Habitats Directive as a site which, in the biogeographical region or regions to which it belongs, contributes significantly to the maintenance or restoration at a favourable conservation status of a natural habitat type in Annex I, or of a species in Annex II, of the Habitats Directive and may also contribute significantly to the coherence of the Natura 2000 network. The site may also contribute significantly to the maintenance of biological diversity within the biogeographic region or regions concerned. For animal species ranging over wide areas, SCIs shall correspond to the places within the natural range of such species which represent the physical or biological factors essential to their life and reproduction.
Special Protection Area (SPA)	Special Protection Areas (SPAs) are sites that are designated to protect rare or vulnerable birds (as listed on Annex I of the Directive 2009/147/EC on the conservation of wild birds), as well as regularly occurring migratory species.

ACRONYMS AND ABBREVIATIONS

Acronym	Description
AfL	Agreement for Lease
BBWFL	Berwick Bank Wind Farm Limited
BEIS	Department for Business, Energy and Industrial Strategy
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CJEU	Court of Justice of the European Union
CPT	Cone Penetration Tests
CTV	Crew Transfer Vessel
Defra	Department for Environment, Food and Rural Affairs
DP2	Dynamic Positioning 2
EC	European Commission
EIA	Environmental Impact Assessment
ELC	East Lothian Council
EU	European Union
HDD	Horizontal Directional Drilling
HDPE	High-Density Polyethylene
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IROPI	Imperative reasons of overriding public interest
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LSE	Likely Significant Effects
MBES	Multibeam Echo-Sounder
MCA	Marine and Coastguard Agency
MCAA	Marine and Coastal Access Act 2009
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MS LOT	Marine Scotland Licensing Operations Team
MoD	Ministry of Defence
MSS	Marine Science Scotland
NLB	Northern Lighthouse Board
NtM	Notice to Mariners
NEQ	Net Explosive Quantity
OSP	Offshore Substation Platforms
PDE	Project Design Envelope
QSHE	Quality, Safety, Health & Environment
RIAA	Report to Inform Appropriate Assessment
ROV	Remotely Operated Vehicle
SNH	Scottish Natural Heritage
SOV	Service Operations Vessel
SBES	Single Beam Echo-Sounder
SBP	Sub-bottom Profiling
SPEN	Scottish Power Energy Networks
SPP	Scottish Planning Policy
SWMP	Site Waste Management Plan
SSS	Side Scan Sonar
UHRS	Ultra-High Resolution Seismic
UK	United Kingdom
USV	Unmanned Surface Vessels
UXO	Unexploded Ordnance

UNITS

Unit	Description
%	Percentage
km	Kilometres (distance)
km^2	Square kilometres
m	Metre (distance)
nm	Nautical mile (distance)

1. INTRODUCTION

1.1. BERWICK BANK WIND FARM OVERVIEW

1. Berwick Bank Wind Farm Limited (BBWFL) is a wholly owned subsidiary of SSE Renewables Limited and will hereafter be referred to as the Applicant. The Applicant is developing the Berwick Bank Wind Farm (hereafter referred to as 'the Project').

2. The Project is a proposed offshore wind farm located in the outer Firth of Forth and Firth of Tay, approximately 37.8 km east of the Scottish Borders coastline (St. Abb's Head) and 47.6 km from the East Lothian coastline (see Figure 1.1). The Project comprises the offshore components of the Project (hereafter referred to as the 'Proposed Development') and onshore infrastructure required to generate and transmit electricity from the Proposed Development array area to a Scottish Power Energy Networks (SPEN) 400kV Grid Substation located at Branxton, southwest of Torness Power station. The offshore export cables will make landfall on the East Lothian coast, at Skateraw.

3. This report focuses on the offshore components of the Proposed Development which includes the offshore wind farm (the wind turbines, their foundations and associated inter-array cabling), together with associated infrastructure including Offshore Substation Platforms (OSPs)/Offshore Converter Station Platforms, their foundations and the offshore export cables and cable protection.

4. The Applicant has prepared separate Applications for consents, licences and permissions for the offshore (seaward of mean high water springs (MHWS)) and onshore (landward of mean low water springs (MLWS)) infrastructure of the Project. The consents, licences and permissions that will be sought by the Applicant for the Proposed Development include:

- a Section 36 consent under the Electricity Act 1989 for project infrastructure in the Scottish offshore region (12-200 nm) where generating capacity exceeds 50 megawatts (MW);
- Marine Licences under the Marine (Scotland) Act 2010 (0 to 12 nm) and the Marine and Coastal Access Act (MCAA) 2009 (Scottish waters beyond 12 nm) for the following:
  - Generating station (wind turbines, wind turbine foundations and inter array-cables);
  - Transmission infrastructure (OSPs/convertor station platforms, inter-array cables and offshore export cables); and
- planning permission under the Town and Country Planning (Scotland) Act 2010 for Project infrastructure landward of MLWS.

5. In July 2022, National Grid Electricity Systems Operator (NGESO) announced as part of its Holistic Network Review, that the Applicant has signed an agreement for an additional grid connection at Blyth, Northumberland (referred to as the Cambois connection). Necessary consents for the Cambois connection (including marine licences) will be applied for separately once further development work has been undertaken on this export cable corridor route and landfall. These Applications will be supported by an Environment Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA). The Cambois connection has also been included as an in-combination project for the purposes of this Offshore HRA and assessed based on the information available at the point of assessment.

6. The Project is an amalgamation of two previously proposed and separate wind farms – Berwick Bank (hereafter '2020 Berwick Bank') and Marr Bank, which were initially to be located next to each other in the Firth of Forth Zone. Up to July 2021, the Applicant progressed the EIA and HRA processes for these separate offshore wind farms. In July 2021, the Applicant made several changes to the consenting strategies for the projects, including the decision to combine the two separate projects into a single Project – Berwick Bank Wind Farm.

7. In October 2020, the Applicant consulted on a HRA Screening Report for the 2020 Berwick Bank proposal (SSER, 2020) which was to be located approximately 43km east of the East Lothian and 33.5 km east of Scottish Borders coastline from the nearest boundary with an array area of approximately 775 km^2. Advice on Likely Significant Effects (LSE) Screening (as it pertained to the 2020 Berwick Bank proposal) was received by the Applicant on 11 May 2021. Following the receipt of the 2020 Berwick Bank Screening Report Response, the Applicant submitted a Berwick Bank Wind Farm Offshore HRA Screening Report to the Marine Scotland Licensing Operations Team (MS-LOT) for the Proposed Development (hereafter, the HRA Stage One Screening Report) in October 2021 (SSER, 2021b). LSE screening advice was received in February 2022 together with EIA Scoping advice (MS-LOT, 2022). In supporting the HRA for the Proposed Development, consideration has been given to the responses from Scottish Ministers to the HRA Stage One Screening Report for the Proposed Development. As far as responses provided in relation to 2020 Berwick Bank are relevant to the Proposed Development, or the Applicant has been directed to refer to them, the Applicant has relied on these responses to guide the scope of the HRA. Such responses are categorised within the term "relevant consultation undertaken to date".

8. The boundary of the Proposed Development is a reduction of the combined boundaries of 2020 Berwick Bank and Marr Bank Wind Farm (which previously covered up to 1,314 km^2). In May 2022, the Berwick Bank Wind Farm boundary was revised again, and the Proposed Development array area was reduced by approximately 20%. The area covered by the Proposed Development has been reduced to 1,010.2 km^2. No significant changes have been made to the Proposed Development export cable corridor or landfall or the Proposed Development array area. This 'Report to Inform the Appropriate Assessment' (RIAA) has been developed for the Proposed Development and considers the Proposed Development boundary and updated Project Design Envelope (PDE) (see section 4) which form the basis of the consent Application(s). The MS-LOT advised in 2022 that the Proposed Development did not need to be re-scoped with respect to these boundary modifications.

9. Key components of the Proposed Development include:

- wind turbines;
- wind turbine foundations;
- inter-array cables;
- interconnector cables;
- OSPs/Offshore converter station platforms; and
- offshore export cables.

1.2. HABITATS REGULATIONS APPRAISAL

10. Following the United Kingdom's (UK) departure from the EU on 31 December 2020 (EU Exit), the UK is no longer an EU Member State. Notwithstanding, the Directive, as implemented by the Habitats Regulations, continues to provide the legislative backdrop for HRA. The changes implemented by EU Exit Regulations including the Conservation of Habitats and Species Amendment (EU Exit) (Scotland) Regulations 2019 ("EU Exit Regulations") have implemented only minor changes to the HRA regime. These changes are considered to have no material implications on the requirement or process for a HRA for the Project.

11. The Habitats Regulations require that an Appropriate Assessment must be carried out on all plans and projects that are likely to have a significant effect on a European site. European sites include Special Areas of Conservation (SACs), candidate SACs (cSACs), Sites of Community Importance (SCI), Special Protection Areas (SPAs) and, as a matter of policy (Scottish Government, 2020), possible SACs (pSACs), potential SPAs (pSPAs) and Ramsar Sites (listed under the Ramsar Convention on Wetlands of International Importance – where also designated as a European site).

12. In this report, and in accordance with EU Exit guidance issued by the Scottish Government, the term "European site" has been retained to refer to the above sites protected in European Member States,

Scotland and the rest of the UK (Scottish Government, 2020). However, where these sites are located in the UK, they now form part of the National Site Network. Post EU-Exit, the Habitats Regulations continue to refer to Annexes I and II of the Habitats Directive and Annex I of the Birds Directive and as such, reference is made to the annexes of the Habitats and Birds Directives in this report.

1.3. THE PURPOSE OF THIS RIAA

13. The RIAA has been prepared by RPS and Royal HaskoningDHV on behalf of the Applicant to support the HRA of the Proposed Development in the determination of the implications for European sites. The RIAA builds upon the HRA Stage One Screening Report (SSER, 2021b) completed in October 2021 and subsequent joint EIA Scoping and LSE Screening advice received in the Berwick Bank Wind Farm Scoping Opinion (MS-LOT, 2022) in February 2022 and considers the likely significant environmental effects of the Proposed Development as they relate to relevant European site integrity at Stage Two of the HRA process. This report will provide the competent authority with the information required to undertake an HRA Stage Two Appropriate Assessment (see section 2 for more detail on the HRA process).

14. The scope of this document covers all relevant European sites and relevant qualifying interest features where LSEs have been identified due to impacts arising from the Proposed Development. This includes both ‘offshore’ European sites and features (seaward of MHWS) and ‘onshore’ European sites (landward of MLWS). A parallel onshore HRA process has been undertaken for elements of the Project which take place above MHWS (as reported in Berwick Bank Wind Farm Onshore HRA Screening Report (SSER, 2021c), and these onshore elements will be considered here through in-combination assessment.

1.4. PROGRESS TO DATE

15. In accordance with the Habitats Regulations, a Screening exercise for the Proposed Development has been undertaken to support Stage One of the HRA process. The purpose of the Screening exercise was to determine whether the Proposed Development could result in an LSE on a European site, with reference to the Conservation Objectives of the site. The Screening exercise determined that LSEs from elements of the Proposed Development could not be discounted at Stage One.

16. The HRA Stage One Screening Report (SSER, 2021b) presents the Screening exercise, the purpose of which is summarised below:

- Identification of the relevant European sites which may include features (Annex I habitats, Annex I birds and Annex II species) which may be sensitive or vulnerable to potential effects arising from the construction, operation and maintenance and decommissioning of the Proposed Development;
- Consideration of the features of relevant European sites and identification of those which are not considered likely to be at risk of significant effects arising from the Proposed Development, either alone or in-combination with other plans or projects, so that they can be eliminated from further consideration within the HRA process;
- Consideration of features of relevant European sites and identification of those which are considered likely to be at risk of significant effects so that they can be taken forward to HRA Stage Two Appropriate Assessment; and
- Consideration of which of the potential impacts arising from the Proposed Development, either alone or in-combination with other plans or projects, are considered likely to result in LSEs to features of European sites and which impacts can be eliminated from consideration in further stages of the HRA[1].

17. HRA is an iterative process. Since the HRA Stage One Screening Report was shared with consultees in October 2021, aspects of the Proposed Development’s design have evolved (see section 4). Consultation representation and advice with respect to the HRA Stage One Screening Report (SSER, 2021b) were received along with the Scoping Opinion from MS-LOT on 4 February 2022. Consultation responses were also received as part of the Road Map consultation process for the Proposed Development (see section 3). The potential implications of these design changes on the HRA Screening exercise have been considered and a summary of the Screening exercise for the Proposed Development is provided in the relevant sections of the RIAA (i.e. Part Two for SACs and Part Three for SPAs). Where any changes to the HRA Screening outcomes presented in the HRA Stage One Screening Report (SSER, 2021b) have been made as a result of consultation, these are highlighted in the relevant Parts and sections of the RIAA.

1.5. STRUCTURE OF THE RIAA

18. For clarity and ease of navigation, this RIAA is structured and reported in several ‘Parts’, as follows:

- Executive Summary and Conclusions;
- Part One (this document) – Introduction and Background;
- Part Two – Consideration of SACs; and
- Part Three – Consideration of SPAs.

19. Each ‘Part’ of the RIAA is supported by a series of topic specific appendices and relevant documentation including European Site Summaries.

1.6. STRUCTURE OF THIS DOCUMENT

20. This document constitutes Part One of the RIAA and is structured as follows:

- Chapter 1: Introduction – this section (section 1) describes the Proposed Development and establishes the need for, and the purpose and structure of, the RIAA.
- Chapter 2: Habitats Regulations Appraisal – this section (section 2) sets out the process, principles, tests, (including those established by case law) and guidance applied to the RIAA.
- Chapter 3: Consultation – this section (section 3) provides a summary of the consultation undertaken (full details of the responses provided, and how these have been addressed, are considered in Parts Two and Three of the RIAA).
- Chapter 4: Information on the Proposed Development - drawing on the information presented in the Offshore EIA Report, this section (section 4) sets out information on the Proposed Development, considered pertinent to the HRA Stage 2 Appropriate Assessment. This includes relevant maximum design parameters and design updates since HRA Stage One Screening.

[1] Recognising the potential for non-significant effects to accumulate or act in-combination.

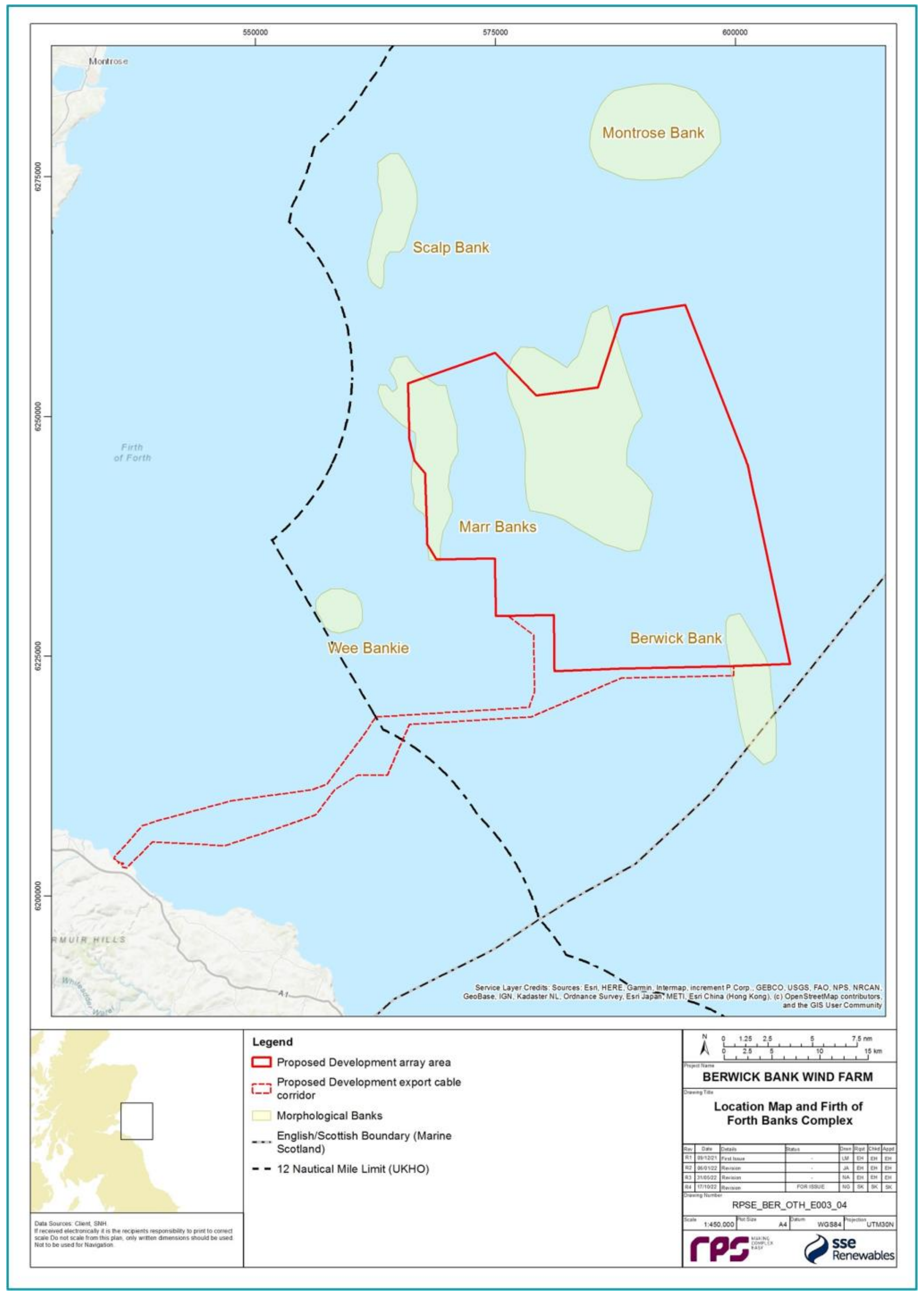

Figure 1.1: Location of the Proposed Development

2. HABITATS REGULATIONS APPRAISAL

2.1. LEGISLATIVE CONTEXT

21. The EU Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora, protects habitats and species of European nature conservation importance. Together with Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'), the Habitats Directive establishes a network of internationally important sites, designated for their ecological status. This network of designated sites is comprised of the following:

- Special Areas of Conservation (SACs) which are designated under the Habitats Directive and promote the protection of flora, fauna and habitats; and
- Special Protection Areas (SPAs) which are designated under the Birds Directive in order to protect rare, vulnerable and migratory birds.

22. SACs are designated for the conservation of Annex I habitats (including priority types which are in danger of disappearance) and Annex II species (other than birds). SPAs are designated for the conservation of Annex I birds and other regularly occurring migratory birds and their habitats. The annexed habitats and species for which each site is designated correspond to the qualifying interest features of the sites. From these features, the Conservation Objectives of the site are derived.

23. The UK is no longer an EU Member State. Notwithstanding, the Habitats Directive as implemented by the Habitats Regulations continue to provide the legislative backdrop for HRA in the UK. The HRA process implemented under the Habitats Regulations continues to apply (subject to minor changes effected by the EU Exit Regulations) and the UK is currently bound by HRA judgments handed down by The Court of Justice of the European Union (CJEU) prior 31 to December 2020[2].

24. The objective of the Habitats Regulations is to conserve, at a favourable conservation status (FCS), those habitats and species listed in Annexes I and II of the Habitats Directive and Annex I of the Wild Birds Directive.

25. In addition to sites formally defined as European sites in the Habitats Regulations, Scottish Planning Policy (Scottish Government, 2020) acknowledges that Ramsar sites are afforded the same protection where they are also designated as a European site. As a matter of Scottish planning policy, the Scottish Government also states that authorities should afford the same level of protection to proposed SACs and SPAs (i.e. sites which have been approved by Scottish Ministers for formal consultation but which have not yet been designated) as they do to sites which have been designated (Scottish Government, 2020).

26. Under the Habitats Regulations, before granting approval (i.e. planning permissions, licenses and consents) for a development likely to have a significant effect on an SAC or SPA/Ramsar site, an Appropriate Assessment must be made by the competent authority, of the proposed plan or project's potential for adverse effects on integrity of the site in view of that site's Conservation Objectives.

2.2. EUROPEAN SITES (POST EU EXIT)

27. The National Site Network comprises of European sites in the UK that already existed (i.e. were established under the Habitats or Birds Directives) on 31 December 2020 (or proposed to the European Commission

[2] The UK Supreme Court may depart from binding pre-EU Exit case law if they consider it 'right to do so' and the Inner House of the Court of Session may depart from such case law in certain circumstances

(EC) before that date) and any new sites designated under the Habitats Regulations under an amended designation process.

2.3. THE HRA PROCESS

28. HRA is generally recognised as a progressive, four-stage process built around the wording of Articles 6(3) and 6(4) of the Habitats Directive, with the outcome at each stage defining the requirement for and scope of the next. These stages are summarised in Figure 2.1.

29. Article 6(3) of the Habitats Directive requires that: *"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and if appropriate, after having obtained the opinion of the general public".*

30. Thus, Article 6(3) provides a two-stage process:

- The first stage involves a screening for LSE; and
- The second stage arises where, having screened the proposed development, the relevant competent authority determines that an appropriate assessment is required, in which case it must then carry out that appropriate assessment.

31. This RIAA is concerned with the second stage of the process (i.e. the appropriate assessment), which seeks to assess and decide whether a plan or project, alone or in combination with other projects or plans, will have an adverse effect on the integrity of a European site. This RIAA also summarises the conclusions of the HRA Stage 1 Screening Report (SSER, 2021b) and updates made to the screening conclusions, since this was published in October 2021, to account for feedback received from stakeholders during consultation.

32. The EU-Exit Regulations establish management objectives for the national site network. These are called the network objectives[3]. The objectives in relation to the National Site Network are to:

- i) maintain or restore certain habitats and species listed in the Habitats Directive to favourable conservation status (FCS); and
- ii) contribute to ensuring the survival and reproduction of certain species of wild bird in their area of distribution and to maintaining their populations at levels which correspond to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements.

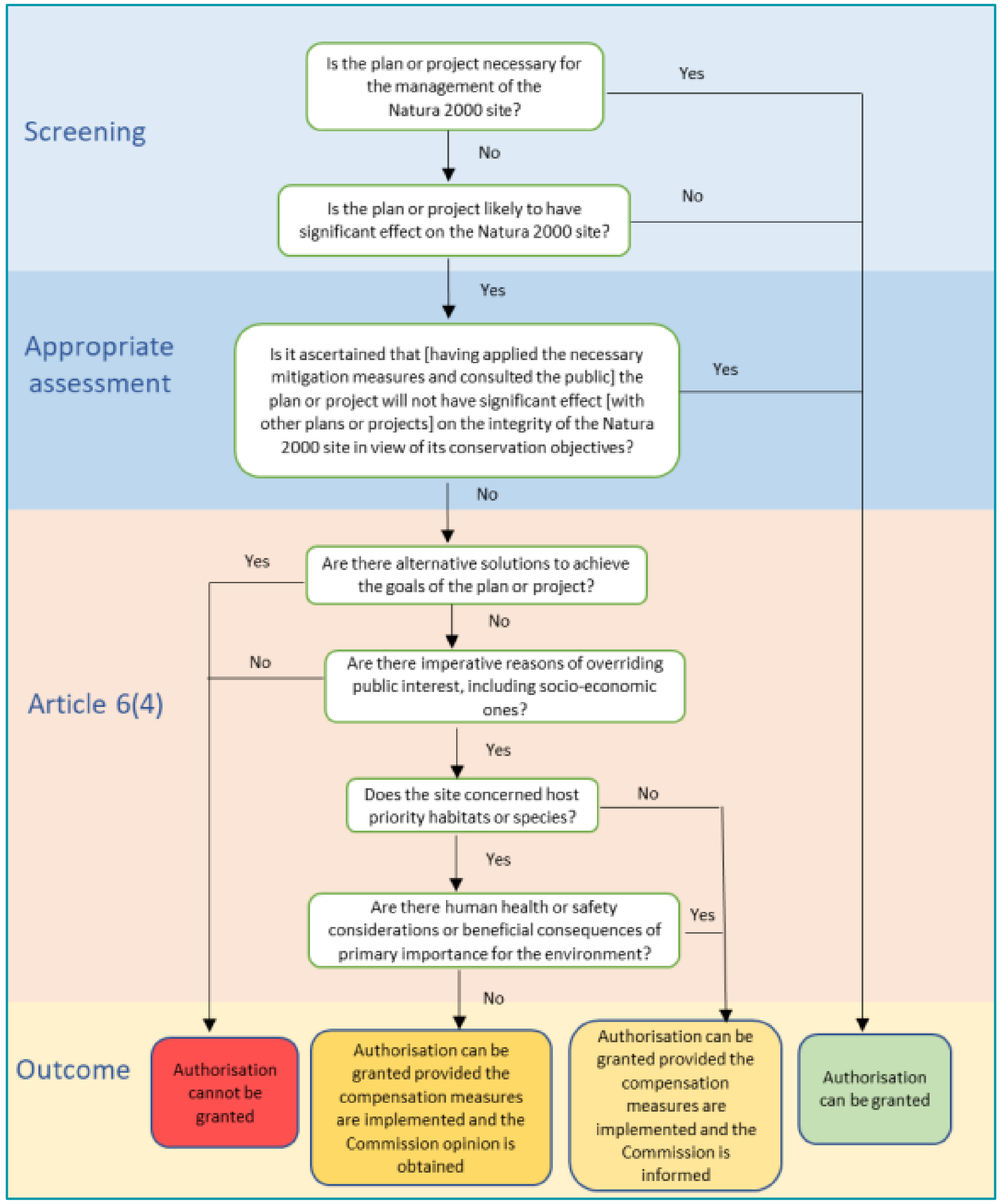

Figure 2.1: Stages in the Habitats Regulations Appraisal Process (Taken from European Commission, 2021)

[3] See: eu-exit-habitats-regulations-scotland.pdf (www.gov.scot)

2.4. GUIDANCE

33. Following the UK's departure from the EU, reference to EC guidance on the interpretation of HRA concepts continues to apply. Scottish Government (December 2020) EU Exit: The Habitats Regulations in Scotland (Marine Scotland, 2020) states that in the longer term, guidance may be updated and/or new guidance may be produced, for example to replace guidance by the European Commission. However, in the shorter term existing guidance continues to apply and should still be used.

34. Accordingly, this RIAA is undertaken in accordance with the following guidance documents:

- Scottish Natural Heritage (January 2015) (Published 2019)[4] Habitats Regulations Appraisal of Plans - Guidance for plan-making bodies in Scotland - Jan 2015;
- Scottish Natural Heritage (2019) SNH Guidance Note: The handling of mitigation in Habitats Regulations Appraisal – the People Over Wind CJEU judgement;
- Scottish Natural Heritage (2016) Habitats Regulations Appraisal (HRA) on the Firth of Forth A Guide for developers and regulators;
- Scottish Government (2013) HRA Advice Sheet 1 - Aligning Development Planning procedures with Habitats Regulations Appraisal requirements (Version 1 - July 2012);
- Scottish Government (2018). Marine Scotland Consenting and Licensing Guidance for Offshore Wind, Wave and Tidal Energy Applications. October 2018;
- Scottish Natural Heritage (2014). Natura Casework Guidance: How to consider plans and projects affecting Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). February 2014;
- European Commission (EC) (2021) Assessment of plans and projects in relation to Natura 2000 sites - Methodological guidance on Article 6(3) and (4) of the Habitats Directive 92/43/EEC. European Commission Notice Brussels C(2021) 6913 final;
- EC (2020) Guidance document on wind energy developments and EU nature legislation. European Commission Notice Brussels C(2020) 7730 final;
- EC (2018) Managing Natura 2000 sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC';
- EC (2007) Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EE. Clarification on the Concepts of: Alternative Solutions, Imperative Reasons of Overriding Public Interest, Compensatory Measures, Overall Coherence, Opinion of the Commission;
- EC (2006) Nature and Biodiversity Cases Ruling of the European Court of Justice; and
- The Habitats Regulations Assessment Handbook (Tyldesley and Chapman, 2021).

35. Reference has further been made to the following publications in Scotland and England that seek to explain the changes made to the Habitats Regulations to make them operable from 1 January 2021:

- Scottish Government (December 2020) EU Exit: The Habitats Regulations in Scotland (Marine Scotland, 2020); and
- Department for Environment, Food and Rural Affairs (January 2021) Policy Paper - Changes to the Habitats Regulations 2017 (DEFRA, 2021).

36. The statutory nature conservation bodies (SNCBs) have produced conservation advice for European sites under their statutory remit. This conservation advice provides information on sites and features and guidance on how to achieve FCS. Conservation advice is discussed further in Part Two and Part 3 of the RIAA.

2.5. RELEVANT CASE LAW

37. The caselaw that defines key assessment parameters such as the definition of "integrity" and "significance", the consideration of *ex situ* effects and the consideration of mitigation measures are discussed in section 2.5.1, section 2.5.2 and section 2.5.3.

2.5.1. CONSIDERATION OF MITIGATION MEASURES

38. The CJEU ruled that mitigation measures could not be taken into account at the screening stage of appropriate assessment in C-323/17 'People Over Wind and Sweetman v Coillte Teoranta' (April 2018) (Sweetman 2). This judgement was complied with during screening stage for the Proposed Development and no mitigation measures were considered in the HRA Stage One Screening Report (SSER, 2021b).

2.5.2. ADVERSE EFFECTS ON THE INTEGRITY OF EUROPEAN SITE

39. The European Commission's guidance on managing Natura 2000 sites (EC, 2018) advises that the purpose of the appropriate assessment is to assess the implications of the plan or project in respect of the site's Conservation Objectives, either individually or in combination with other plans or projects. The conclusions should enable the competent authorities to ascertain whether the plan or project will adversely affect the integrity of the site concerned. The focus of the appropriate assessment is therefore specifically on the species and/or the habitats for which the European site is designated.

40. EC (2018) also emphasises the importance of using the best scientific knowledge when carrying out the appropriate assessment in order to enable the competent authorities to conclude with certainty that there will be no adverse effects on the integrity of the site. This guidance notes that it is at the time of the decision authorising implementation of the project that there must be no reasonable scientific doubt remaining as to the absence of adverse effects on the integrity of the site in question.

41. The judgment of the CJEU confirmed in its ruling in Case C-258/11 that 'Article 6(3) of the Habitats Directive must be interpreted as meaning that a plan or project not directly connected with or necessary to the management of a site will adversely affect the integrity of that site if it is liable to prevent the lasting preservation of the constitutive characteristics of the site that are connected to the presence of a priority natural habitat whose conservation was the objective justifying the designation of the site in the list of SCIs, in accordance with the directive. The precautionary principle should be applied for the purposes of that appraisal'. EC (2018) advises that the logic of such an interpretation would also be relevant to non-priority habitat types and to habitats of species.

42. The 'integrity of the site' can be usefully defined as the coherent sum of the site's ecological structure, function and ecological processes, across its whole area, which enables it to sustain the habitats, complex of habitats and/or populations of species for which the site is designated (EC, 2018). In Sweetman, Ireland, Attorney General, Minister for the Environment, Heritage and Local Government v An Bord Pleanála) (C-258/11) (Sweetman 1) it was determined that the ecological structure and function of a European site would be adversely affected with reference to the site's overall ecological functions and "the lasting preservation of the constitutive characteristics of the site." In a dynamic ecological context, it can also be considered as having the sense of resilience and ability to evolve in ways that are favourable to conservation (EC, 2018).

[4] See https://www.nature.scot/doc/habitats-regulations-appraisal-plans-guidance-plan-making-bodies-scotland-jan-2015

43. EC (2018) notes that if the competent authority considers the mitigation measures are sufficient to avoid the adverse effects on site integrity identified in the appropriate assessment, they will become an integral part of the specification of the final plan or project or may be listed as a condition for project approval.

44. EC (2020) advises that it is for the competent authorities, in the light of the conclusions made in the appropriate assessment on the implications of a plan or project for the European site concerned, to approve the plan or project. This decision can only be taken after they have made certain that the plan or project will not adversely affect the integrity of the site. That is the case where no reasonable scientific doubt remains as to the absence of such effects.

45. EC (2020) also reaffirms that the authorisation criterion laid down in the second sentence of Article 6(3) of the Habitats Directive integrates the precautionary principle and makes it possible to effectively to prevent the protected sites from suffering adverse effects on their integrity as the result of the plans or projects. A less stringent authorisation criterion could not as effectively ensure the fulfilment of the objective of site protection intended under that provision. The onus is therefore on demonstrating the absence of adverse effects rather than their presence, reflecting the precautionary principle. It follows that the appropriate assessment must be sufficiently detailed and reasoned to demonstrate the absence of adverse effects, in light of the best scientific knowledge in the field.

46. In accordance with the Waddenzee Judgment[5], the measure of significance is made against the Conservation Objectives for which the sites were designated.

2.5.3. CONSIDERATION OF *EX SITU* EFFECTS

47. EC (2018) advises that Article 6(3) and Article 6(4) safeguards be applied to European sites subject to LSEs from any development pressures, including those which are external to those European site(s).

48. The CJEU developed this point when it issued a ruling in case C-461/17 ("Brian Holohan and Others v An Bord Pleanála") that determined inter alia that Article 6(3) of Directive 92/43/EEC must be interpreted as meaning that an appropriate assessment must on the one hand, catalogue the entirety of habitat types and species for which a site is protected, and, on the other, identify and examine both the implications of the proposed project for the species present on that site, and for which that site has not been listed, and the implications for habitat types and species to be found outside the boundaries of that site, provided that those implications are liable to affect the Conservation Objectives of the site.

49. In that regard, consideration has been given at Screening (and where necessary, based on the outcomes of that Screening) in this RIAA to implications for habitats and species located both inside and outside of the European sites with reference to those sites' Conservation Objectives where effects upon those habitats and/or species are liable to affect the Conservation Objectives of the sites concerned.

3. CONSULTATION

3.1.1. THE ROAD MAP PROCESS

50. A 'Road Map' process has been undertaken to facilitate early engagement with stakeholders throughout the pre-Application phase of the Proposed Development. Road Maps have been produced for a number of topics and the HRA process which have been used as tools to reach and record points of agreement, for example assessment methodologies presented in the Offshore EIA Report and impacts screened-in to this RIAA. The Road Map process has facilitated focus in the RIAA to be on LSE, as defined by the Habitats Regulations.

51. The Road Maps considered relevant for the purposes of HRA Stage Two Appropriate Assessment are those produced for the following topic groups:

- Benthic, Fish and Shellfish and Physical Processes;
- Marine Mammals; and
- Offshore Ornithology.

52. The Road Maps outlined the key stages of both the EIA and HRA processes and define the steps within each stage for discussion of important issues with stakeholders. At the conclusion of the Road Map process, three meetings had been held to discuss benthic ecology, fish and shellfish and coastal processes, four were held specifically to discuss the marine mammal assessments and six meetings were held for ornithology. The key discussion points arising during the various Road Map meetings are set out as part of the consultation summaries presented in Part Two (for SACs) and Part Three (for SPAs) of the RIAA.

3.1.2. CONSULTATION TO DATE

53. Consultation has been undertaken with statutory stakeholders during key stages of the Proposed Development.

54. As explained in section 1.4, consultation was undertaken with MS-LOT, Marine Scotland Science (MSS) and Scottish Natural Heritage (SNH), acting under its operating name NatureScot (hereinafter referred to as NatureScot) on the 2020 Berwick Bank proposal. Advice on the LSE Screening (as it pertained to the 2020 Berwick Bank proposal) was received on 11 May 2021. Comments applicable to the LSE Screening for the Proposed Development were taken into consideration, as far as is appropriate, in the HRA Stage One Screening Report (SSER, 2021b) and are listed in full in in Part Two (for SACs) and Part Three (for SPAs) of the RIAA as 'relevant consultation to date'.

55. Further, this RIAA has been developed alongside the Proposed Development's Offshore EIA Report as part of the EIA process. Where design, supporting information or stakeholder feedback is common to both assessments this has been used, as referenced. The Offshore EIA Report for Berwick Bank Offshore Wind Farm was submitted to MS-LOT and shared with consultees in November 2022, together with this report.

56. Statutory consultation was undertaken on the HRA Stage One Screening Report for the revised Proposed Development and advice on the LSE Screening was received on 4 February 2022.

57. A summary of the details of all consultation undertaken to date which is relevant to the HRA process is presented in Part Two of the RIAA for SACs, and Part Three of the RIAA for SPAs.

[5] Landelijke Vereniging tot Behoud van de Waddenzee and Nederlandse Vereniging tot Bescherming van Vogels v Staatssecretaris van Landbouw, Natuurbeheer en Visserij (C-521/12)

3.1.3. TRANSBOUNDARY CONSULTATION

58. Based on the outcomes of the HRA Stage One Screening Report (SSER, 2021b), it is considered that there is no potential for significant transboundary effects either alone, or in-combination, therefore, no transboundary consultation has been carried out with respect to this RIAA or its contents.

4. INFORMATION ON THE PROPOSED DEVELOPMENT

4.1. OVERVIEW OF THE PROPOSED DEVELOPMENT

59. This chapter of the RIAA provides an outline description of the Proposed Development and describes the activities likely to be associated with the construction, operation and maintenance, and decommissioning of the Proposed Development. It summarises the design and components of the Proposed Development infrastructure, based on conceptual design information and refinement of the Proposed Development parameters following receipt of the Offshore EIA Scoping Opinion for the initial Berwick Bank Wind Farm Proposal, and understanding of the environment from site-specific survey and desk-top analysis.

4.1.2. PROJECT DESIGN ENVELOPE

60. The Project Design Envelope (PDE) approach (also known as the Rochdale Envelope approach) has been adopted for the assessment of the Proposed Development. The PDE concept allows for some flexibility in project design options, particularly for foundations and wind turbine type, where the full details of a Project are not known at Application submission.

61. The PDE establishes a series of realistic design assumptions from which worst case parameters are drawn for the Proposed Development.

4.2. OFFSHORE INFRASTRUCTURE

4.2.1. OVERVIEW

62. The key offshore components of the Proposed Development (seaward of MHWS), as shown in Figure 4.1, 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 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.

63. 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.

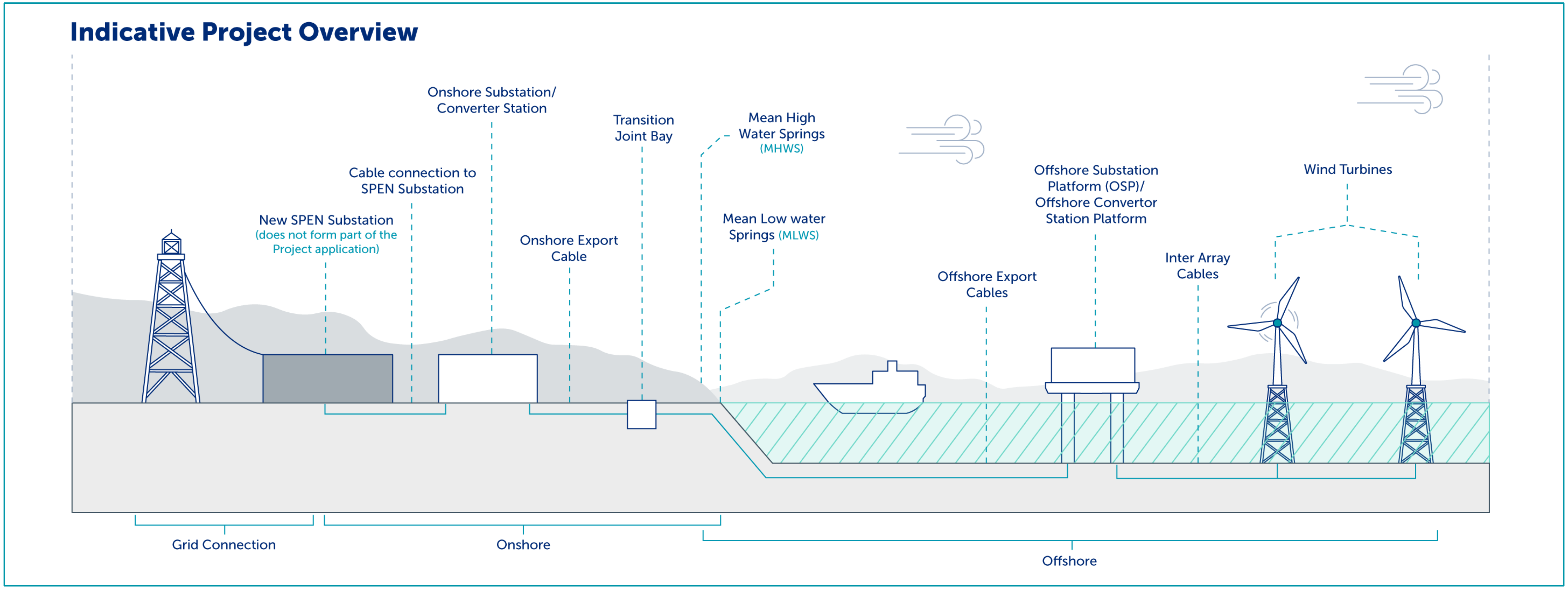

Figure 4.1: Project Overview[6]

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

4.2.2. WIND TURBINES

64. 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 turbine.

65. A range of wind turbine models have been considered. The parameters in Table 4.1 provide for both the maximum number of wind turbines, as well as the largest wind turbine within the PDE. As set out in paragraph 69, 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 4.1 describes the maximum parameters that apply.

66. The wind turbines will comprise a horizontal axis rotor with three blades connected to the nacelle of the wind turbine. Table 4.1 presents the design envelope for wind turbines while Figure 4.2 illustrates a schematic of a typical offshore wind turbine.

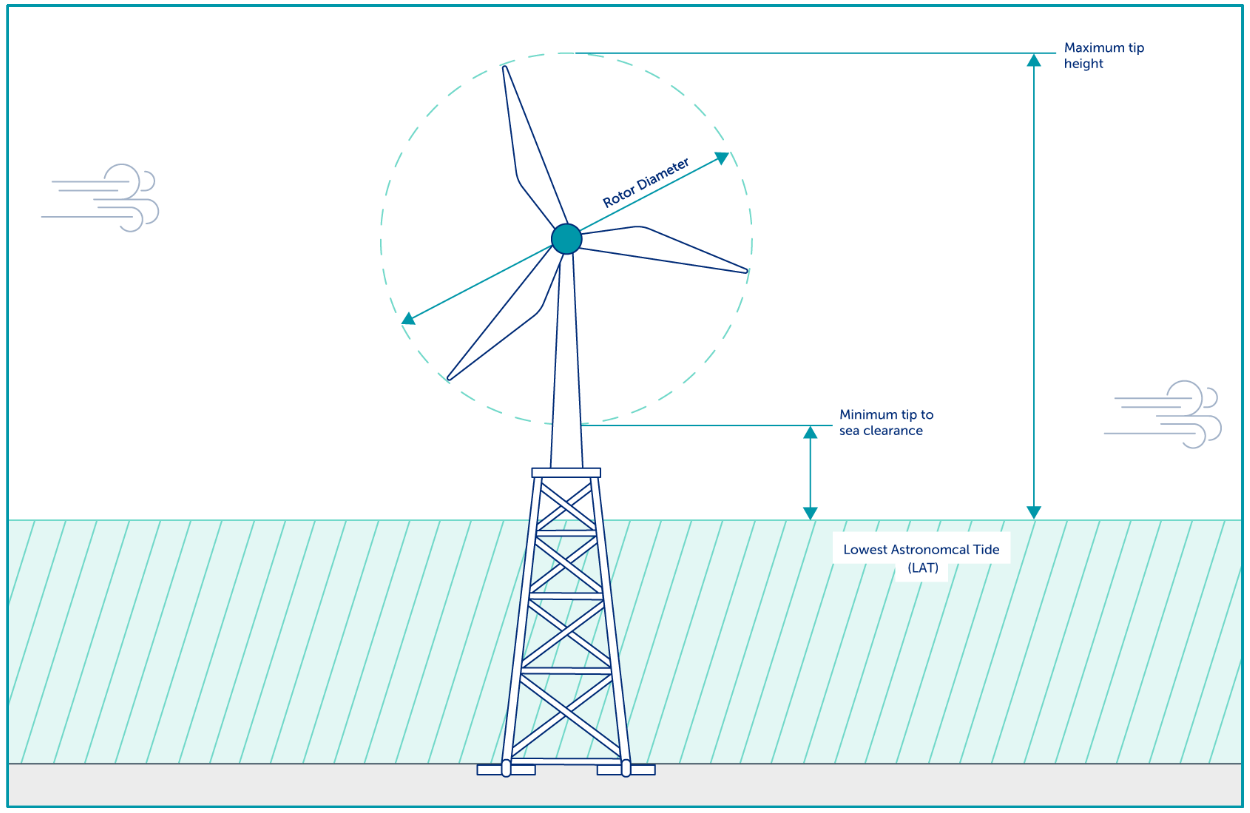

Figure 4.2: Indicative Schematic of an Offshore Wind Turbine on a Jacket Foundation

67. The maximum rotor blade diameter will be no greater than 310 m, with a maximum blade tip height of 355 m above LAT (Lowest Astronomical Tide) and a minimum 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 the Offshore EIA Report. 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).

68. Figure 4.3 presents an indicative wind farm layout based on the maximum design scenario of 307 wind turbines, while Figure 4.4 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).

Table 4.1: Design Envelope: Wind Turbines

Parameter	Maximum Design Envelope [7]
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
Minimum rotor diameter (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

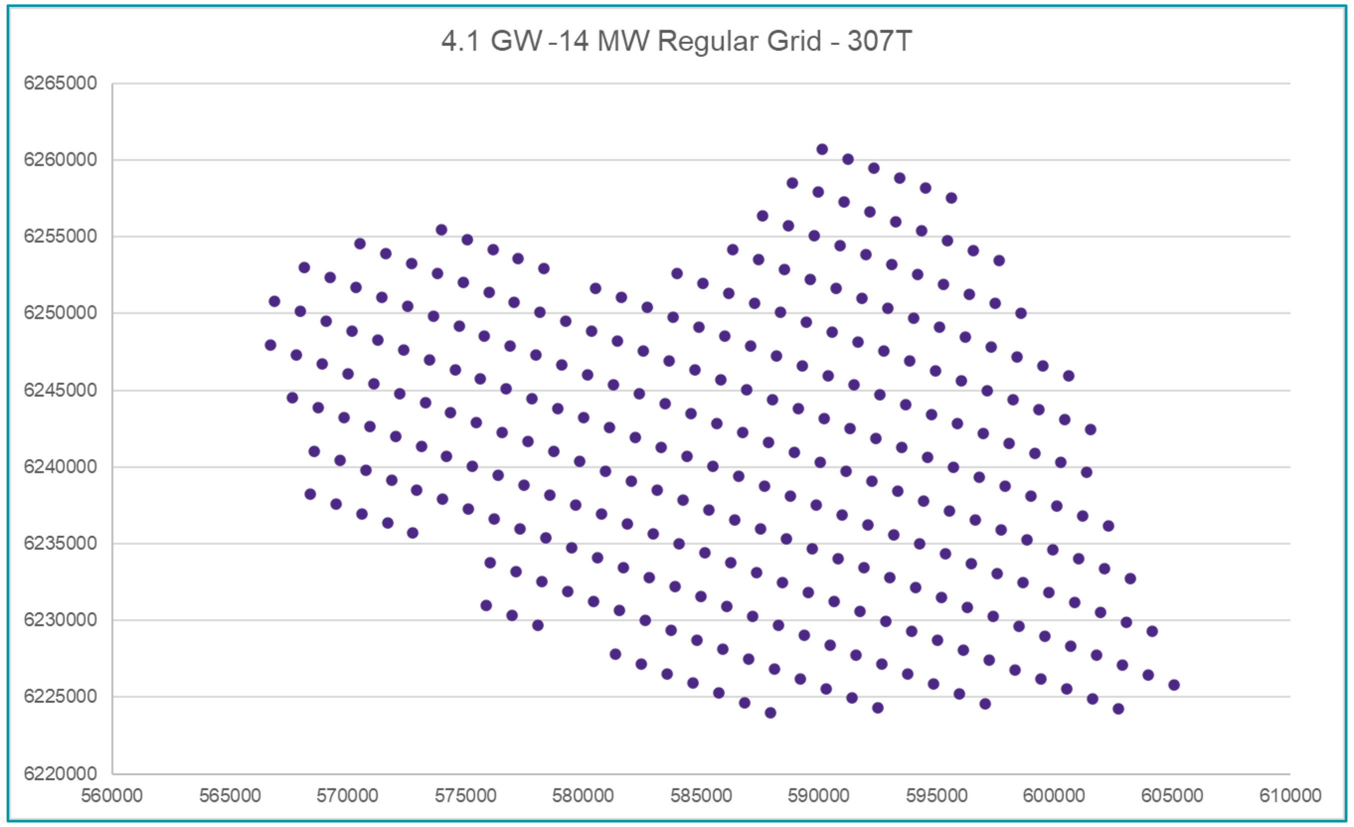

Figure 4.3: Berwick Bank Wind Farm Preliminary Indicative Layout for 307 Wind Turbines Each Square Being 5 km x 5 km)

[7] 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".

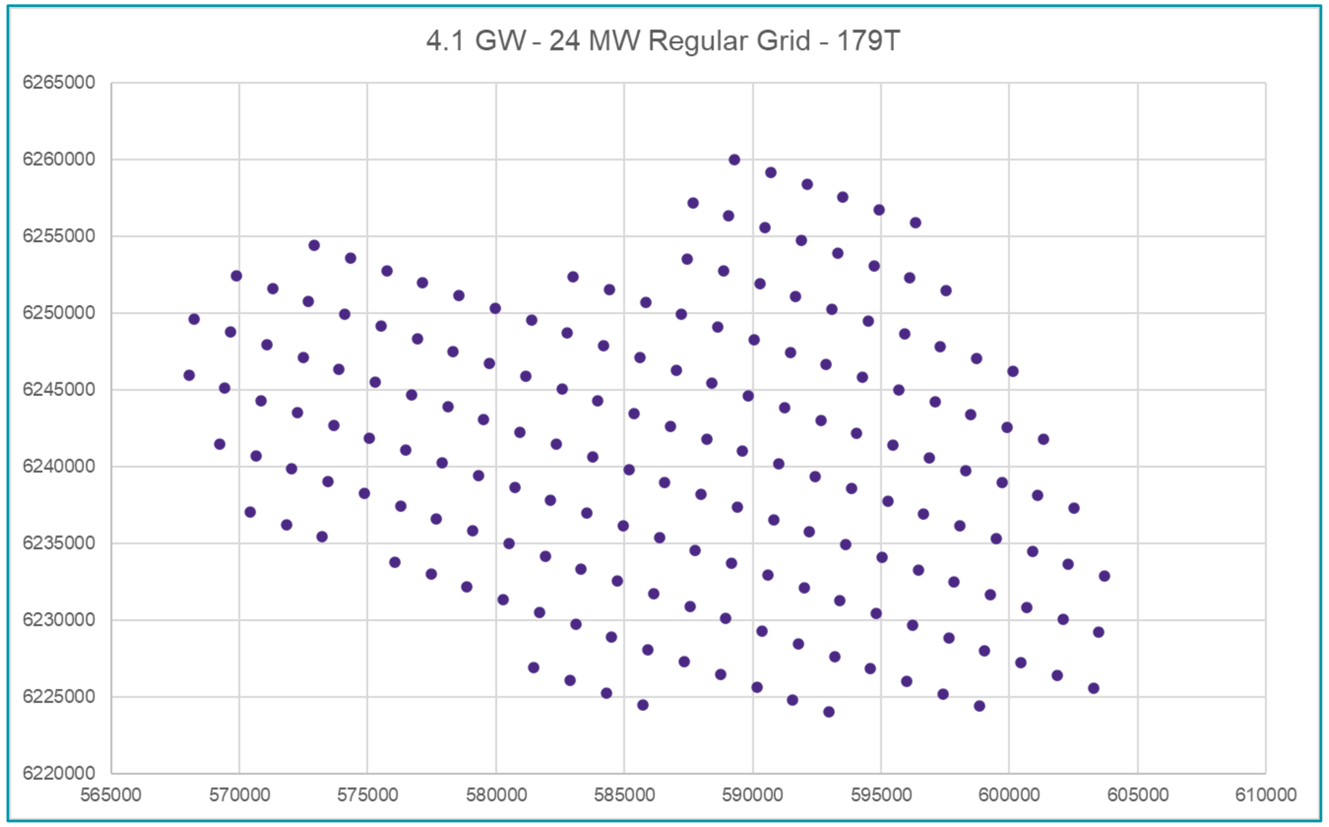

Figure 4.4: Berwick Bank Wind Farm Preliminary Indicative Layout for 179 Wind Turbines Each Square Being 5 km x 5 km)

69. 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

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

70. 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.

71. 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 4.2.3.

Piled jacket foundation

72. 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 4.5). 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 4.2.

Table 4.2: Design Envelope: 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 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[8]
Maximum scour protection footprint (per jacket) (m^2)	2,280
Maximum area foundation footprint (per jacket) (m^2) including scour protection	2,470
Maximum hammer energy (kJ) (maximum energy theoretically possible)	4,000

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

Parameter	Maximum Design Envelope
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
Maximum diameter of pin piles (m)	5.5

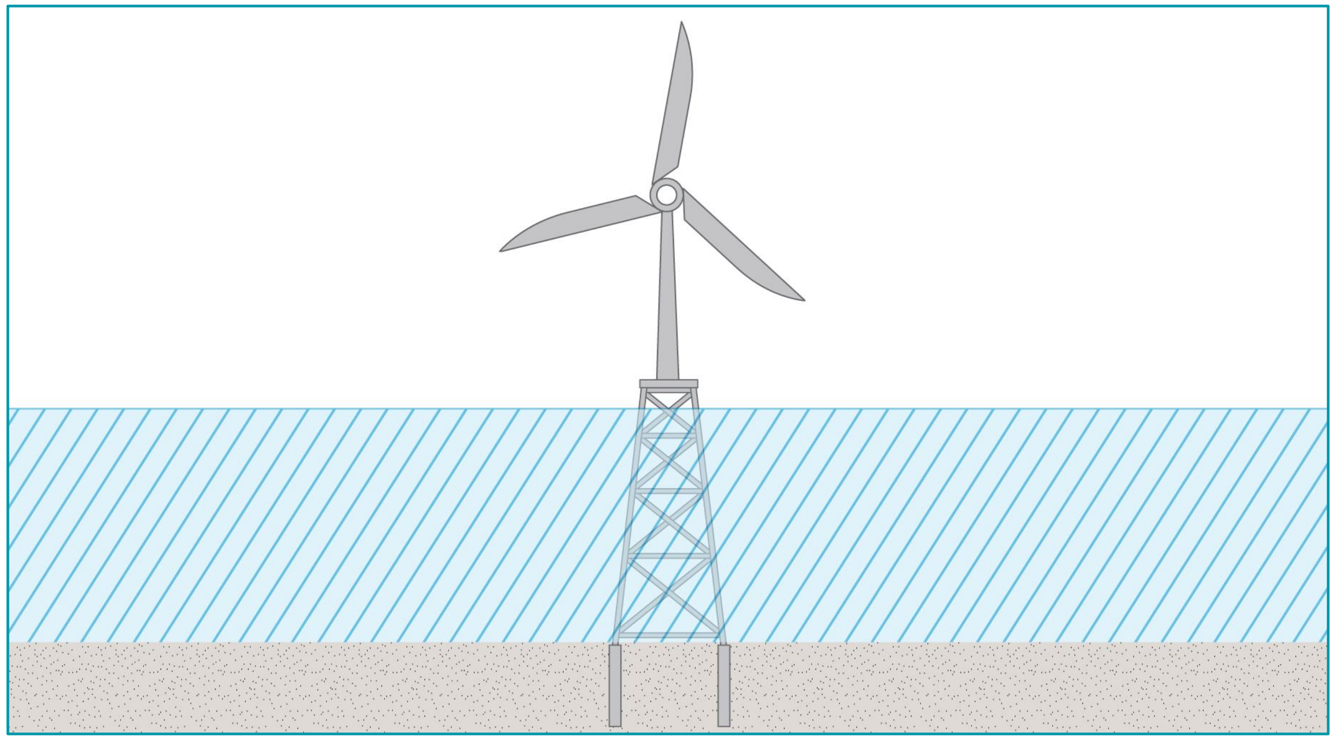

Figure 4.5: Indicative Schematic of a Jacket Foundation with Pin Piles

Suction caisson jacket foundations

73. 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 4.6). 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.

74. 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 4.3.

Table 4.3: Design Envelope: Jacket Foundation with Suction Caisson

Parameter	Maximum Design Envelope
Maximum number of jackets 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[9]
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

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

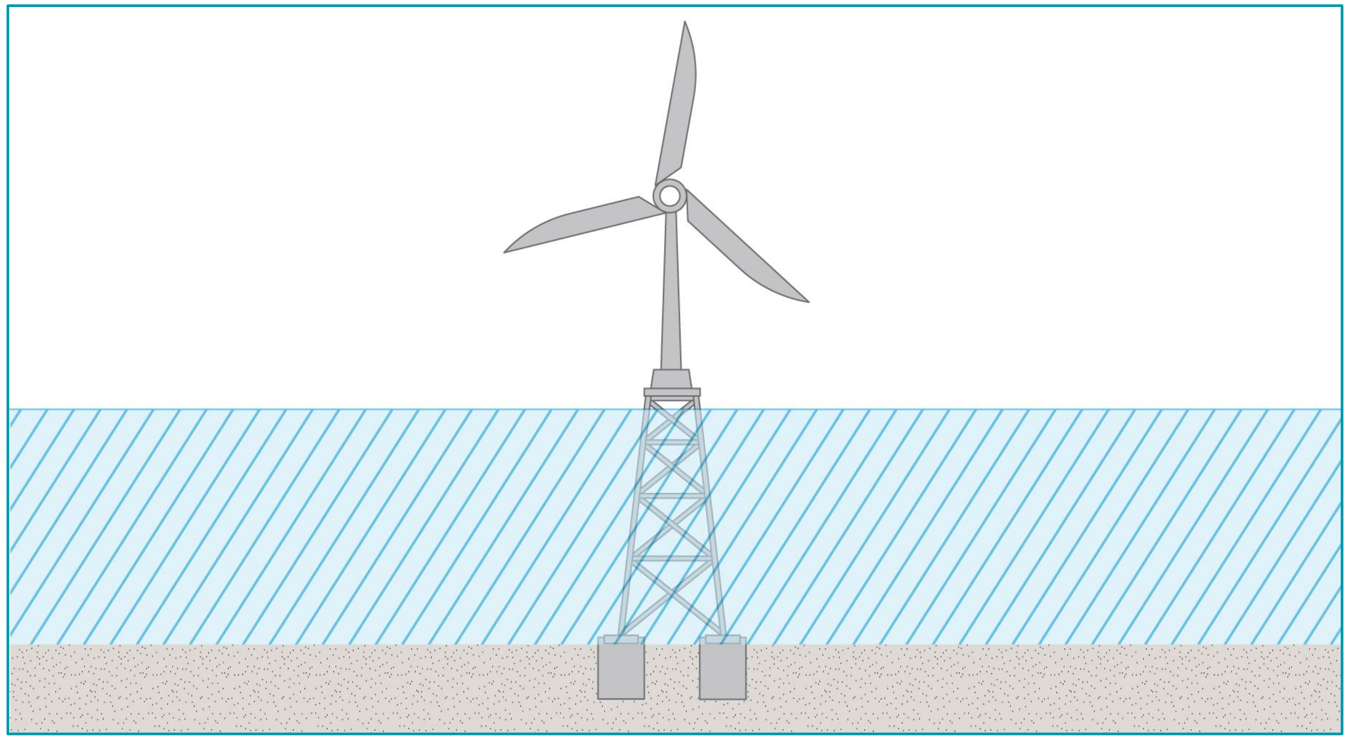

Figure 4.6: Indicative Schematic of a Jacket Foundation with Suction Caissons

4.2.3. OFFSHORE SUBSTATION PLATFORMS AND OFFSHORE CONVERTOR STATION PLATFORMS

75. 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.

76. The offshore export cables and landfall infrastructure for the Cambois connection is being consented separately to the Proposed Development but has been considered cumulatively as part of this Application.

77. 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 would be required for the Cambois connection (see Table 4.4); or
  - up to five larger HVAC OSPs to facilitate connections to Branxton and two HVDC Offshore convertor station platforms that would be required for the Cambois connection (see Table 4.5).
- HVDC Option: Up to five HVDC Offshore convertor station platforms, two for the Branxton connection and two for the additional Cambois connection (see Table 4.6) This also includes an offshore interconnector platform.

78. 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 4.4 and Table 4.5 (Combined Options) and Table 4.6 (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 4.4: Design Envelope: OSP/Offshore Convertor Station Platforms (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 4.5 Design Envelope: OSP/Offshore Convertor Station Platforms (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 4.6: 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

79. Table 4.7 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 4.7: 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

80. 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 4.2.2. The PDE for offshore platforms piled jacket foundations is shown in Table 4.8(Combined Option A), Table 4.9 (Combined Option B) and Table 4.10 (HVDC Option). The PDE for offshore platforms suction caissons foundations is shown in Table 4.11 (Combined Option A), Table 4.12 (Combined Option B) and Table 4.13 (HVDC Option).

Table 4.8: 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 4.9 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 4.10: 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
Maximum leg diameter (m)	5
Maximum number of piles per platform	32
Maximum pin pile diameter (m)	4

Parameter	Maximum Design Envelope
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 4.11: 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 4.12: 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 4.13: 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

4.2.4. SCOUR PROTECTION FOR FOUNDATIONS

81. 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.

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

83. 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 parameters for foundations with piled jackets or suction caissons are presented in Table 4.14.

Table 4.14: 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 wind turbine) (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

4.2.5. SUBSEA CABLES

84. 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 anchors during cable laying (see Table 4.15 to Table 4.18).

Inter-array cables

85. Inter-array cables carry the electrical current produced by the wind turbines to an offshore substation or 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, and multiple cable 'strings' will connect back to each offshore substation/convertor platform.

86. 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 4.15.

Table 4.15: 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
Target Minimum 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

87. 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.

These cables will be either HVDC or a combination of HVDC and HVAC. Table 4.16 provides the maximum design scenario for interconnector cables.

88. The interconnector cables will have a target minimum 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 95). 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 4.16: 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)[10]	18,800
Maximum number of anchors and anchor repositions per km of cable	One every 500 m

Offshore export cables

89. 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).

90. 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. There is the potential for seabed preparation to be required prior to cable installation, with methods such as jet trencher, mechanic trencher or grapnel currently being considered for cable installation.

91. 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.

92. 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 4.8). The punch out of the cable for onwards installation to the wind farm will be completed by using one of the four methods listed in Table 4.17, noting pre-sweeping/ dredging may be required in some areas.

93. Table 4.17 provides examples of each of the tools which may be used at the Proposed Development and Figure 4.8 illustrates trenchless technique installation method.

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

Table 4.17: 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 chainsaws 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.

94. The maximum design scenario for the offshore export cables is described in Table 4.18.

Table 4.18: 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
Target Minimum cable burial depth (m)	0.5
Maximum 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
Total maximum width of seabed disturbed by cable installation tool (m)	15

Parameter	Maximum Design Envelope
Maximum area of seabed disturbed for offshore export cable route (km^2) (cable installation)	12.43
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

95. 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. The maximum design scenario for inter-array, interconnector and offshore export cables, are presented in Table 4.19.

Table 4.19: 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

96. 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.

97. 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 101).

Rock placement

98. 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 4.7).

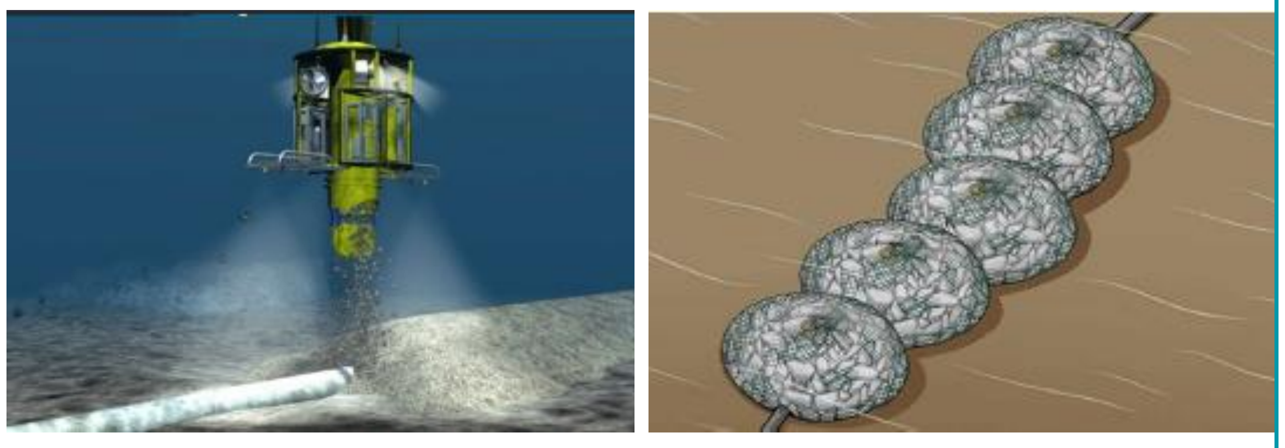

Figure 4.7: Rock Cable Protection Methods (Left: Rock Placement; Right: Rock Bags)

99. 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 4.19), 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.

100. 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 101). The number of rock bags required is dependent on the length of cable which requires protection.

Cable crossing

101. 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 4.19. Further description of the crossing methodology is described in section 3.1.1.

102. 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 protection are accounted for in Table 4.19. The design will look to minimise cable crossings with up to 78 inter-array crossings in total.

Table 4.20: 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

4.3. SITE PREPARATION ACTIVITIES

103. 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 nine months 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.

104. An overview of these activities is provided below.

4.3.1. PRE-CONSTRUCTION SURVEYS

105. 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.

106. 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.

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

108. 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.

4.3.2. CLEARANCE OF UNEXPLODED ORDNANCE

109. 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.

110. 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).

111. 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).

112. The maximum design scenario for UXO clearance is provided in Table 4.21.

Table 4.21: 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

4.3.3. SAND WAVE CLEARANCE

113. In some areas within the Proposed Development array area and along the Proposed Development export cable corridor, existing sand waves and similar bedforms may be required to be removed before cables are installed. 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.

114. 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 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.

115. 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.

116. The maximum design scenario for sand wave clearance in the Proposed Development array area and Proposed Development export cable corridor is summarised in Table 4.22. Final values for sand wave clearance will be refined following completion of a geophysical survey campaign prior to construction.

117. In addition to sand wave clearance, boulder clearance and pre-lay grapnel run may be required to prepare the site for cable installation. This is described as part of cable installation in section 3.1.1.

Table 4.22: Design Envelope: Sand Wave Clearance Parameters

Parameter	Maximum Design Envelope
Inter-Array/OSP 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

4.3.4. BOULDER CLEARANCE

118. 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.

119. 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 4.23 provides the maximum design scenario for boulder clearance in the Proposed Development array area and Proposed Development export cable corridor.

120. The cable route may be pre-ploughed for the removal of discreet boulders. Should more dense boulder fields be encountered, there may be a need for additional techniques. This decision will be informed by the geophysical and pre construction surveys.

Table 4.23: 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

4.3.5. VESSELS FOR SITE PREPARATION ACTIVITIES

121. Table 4.24 includes all vessels to be used during site preparation activities.

Table 4.24: 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 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**

3.1. CONSTRUCTION PHASE

3.1.1. METHODOLOGY

122. 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.

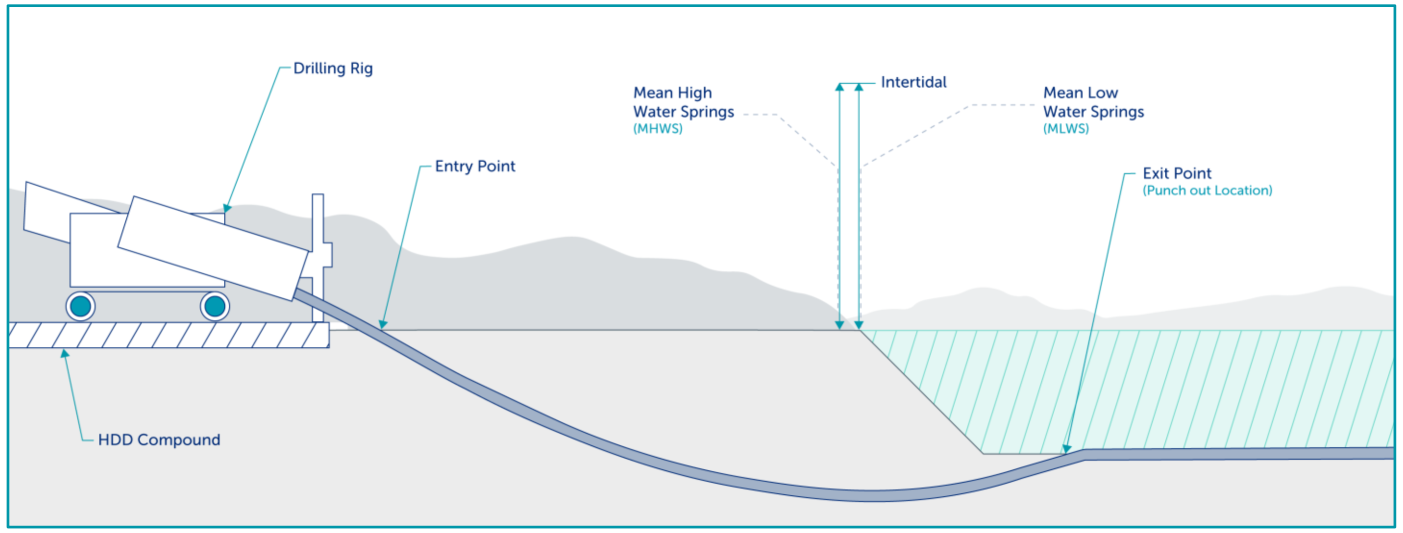

Figure 4.8: Typical Long Section of Trenchless Technique Method

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

Step 1 – Offshore export cables – landfall installation

124. Figure 4.9 shows the Proposed Development export cable corridor as it reaches landfall at Skateraw.

125. It is proposed that the cables are installed through the intertidal zone using trenchless technology, such as HDD (Figure 4.8). 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.

126. 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.

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

128. 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 an 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.

129. 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.

130. There are typically two pull 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.

131. 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.

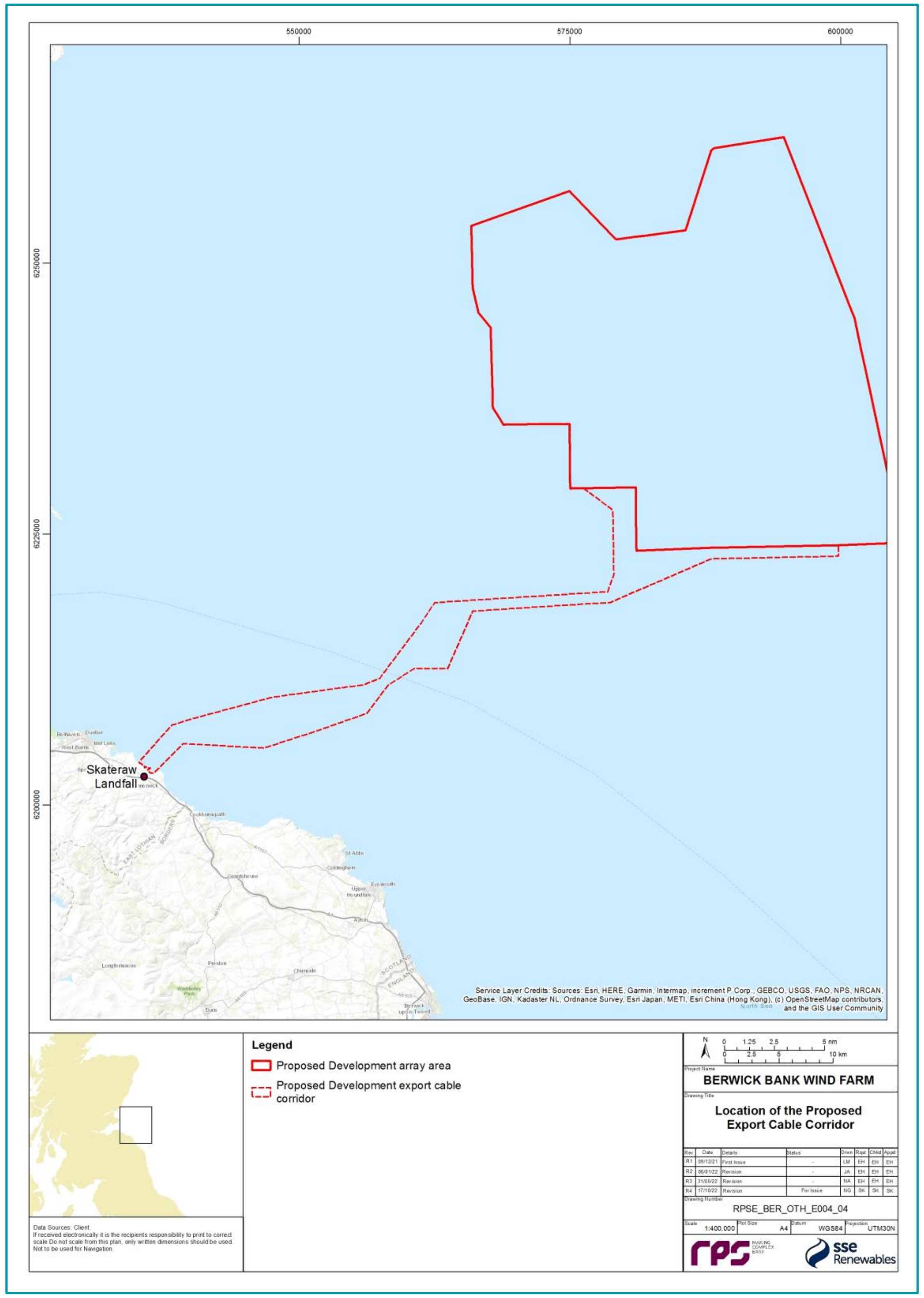

Figure 4.9: Location of the Proposed Development Export Cable Corridor

Table 4.25: **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 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

132. 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 3.1.2 for further detail on vessels to be used at the Proposed Development).

133. Jacket foundations could use either piles or suction caissons. Information on the methodology to be followed during suction caissons installation is provided in paragraphs 73 and 74. 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.

134. Piling characteristics are presented in Table 4.26. 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.

135. 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, with no concurrent piling of OSPs/Offshore convertor station platforms. Table 4.26 provides the maximum deign scenario for the jacket piling.

Table 4.26: **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[11]	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
Minimum distance between concurrent piling events (m)	900	n/a

[11] 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	
Maximum distance between concurrent piling events (km)	49.43	n/a

136. Drilling characteristics are presented in Table 4.27. 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.

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

Table 4.27: 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

138. 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 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.

139. 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

140. 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 4.17 may be required.

141. The same installation and cable protection methodologies apply as described for the offshore export cables in paragraphs 142 to 146. Cable crossing required for the inter-array and interconnector cables are discussed in paragraph 102.

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

Offshore export cables installation

142. 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.

143. 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 4.25.

Cable protection installation

144. Cable protection will be used where minimum target burial depths are not achieved during installation and at cable crossings (see section 4.2.5). Cable protection systems are also used as cables approach and enter the wind turbines and OSPs/Offshore convertor station platforms (see section 4.2.5).

145. 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.

146. Further information is provided in paragraphs 95 to 100.

Cable crossing installation

147. As explained in paragraph 101, 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 paragraph 145. 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

148. 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.

149. 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.

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

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

3.1.2. INSTALLATION VESSELS AND HELICOPTERS

152. 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.

153. Installation vessel and helicopter parameters are presented in Table 4.28 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. It should be noted that the numbers presented are an estimated maximum design 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 4.28: Design Envelope: Infrastructure Installation (Proposed Development Array Area and Export Cable Corridor (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	1,488
Survey vessels	8	464
Crew transfer vessels	14	3,342
Scour/cable protection installation vessels	10	3,390
Resupply vessels	20	245
Helicopters	13	3,214
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**

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 Application, jack-up vessel parameters are presented in Table 4.29.

Table 4.29: 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
Maximum seabed footprint (m^2)	1,000

3.1.3. CONSTRUCTION PORTS

154. 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.

155. 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.

156. 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 RIAA, 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 RIAA 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.

157. Construction personnel will transit to the location of the Proposed Development on the installation vessels or other vessels listed in Table 4.28. 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.

3.1.4. CONSTRUCTION PROGRAMME

158. 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.

159. 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 cable installation, or commencement of wind turbine installation while foundation installation is being completed.

160. 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.

3.1.5. RECOMMENDED SAFE PASSING DISTANCES AND AIDS TO NAVIGATION

Safety zones, recommended safe passing distances and Notice to Mariners

161. 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

162. 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.

163. 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

164. 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

165. 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).

166. 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.

4.4. OPERATION AND MAINTENANCE PHASE

4.4.1. METHODOLOGY

167. 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.

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

169. Table 4.30 provides a list of all operation and maintenance activities planned for the Proposed Development.

170. 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 4.30: 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.
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.

Parameter	Maximum Design Envelope		
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.
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 cables 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.

Parameter	Maximum Design Envelope		
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.

4.4.2. OPERATION AND MAINTENANCE VESSELS

171. The maximum design scenario for operation and maintenance vessel requirements for the Proposed Development are presented in Table 4.31.

Table 4.31: 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)

4.5. HEALTH AND SAFETY

172. 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.

173. 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.

174. 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.

175. 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.

4.6. WASTE MANAGEMENT

176. 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.

177. 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.

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

4.7. DECOMMISSIONING PHASE

179. 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. Marine Scotland Licensing Operations Team (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.

180. 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 4.8.

181. 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.

4.7.1. OFFSHORE DECOMMISIONING

Wind turbines

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

Foundations

183. Piled foundations are likely to be cut approximately at seabed using pile cutting devices, depending on seabed mobility, and removed. Suction caisson foundations will be fully removed.

184. 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

185. 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*".

186. 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 184, 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 RIAA, the most adverse scenario has been assessed for each topic.

Offshore cables

187. It is proposed that offshore 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 RIAA, the most adverse scenario has been assessed for each topic.

4.8. REPOWERING

188. 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.

189. 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 4.4.

190. 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 RIAA, 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.

4.9. MAXIMUM DESIGN SCENARIOS

191. The Maximum Design Scenarios considered for the assessment of potential impacts on receptor groups considered in the RIAA are outlined in the relevant sections of Part Two of the RIAA for SACs, and Part Three of the RIAA for SPAs.

4.10. CHANGES TO THE DESIGN SINCE HRA SCREENING

192. A list of the main changes to the PDE since October 2021 (and the completion of the HRA Stage One Screening Report (SSER, 2021b) are summarised below. The implications of these changes for the HRA Screening outcomes are reported in the relevant sections of Part Two of the RIAA for SACs, and Part Three of the RIAA for SPAs

- Boundary refinement resulting in a reduction in the size of the Proposed Development from 1,314 km^2 to 1,014 km^2;
- Selection of the Skateraw landfall option in December 2021 (Thorntonloch option discounted) resulting in the modification of the Proposed Development export cable corridor (see Figure 4.9)
- Trenchless techniques selected as the only PDE option for the landfall (i.e. open cut trenching methods discounted);
- Change to the construction programme which could now start in 2025 (and run for 96 months), rather than start in 2027 and run for 58 months;
- Increase in the offshore export cable voltage from 320 kV to 525 kV;
- The option of suction caissons for the OSP/ Offshore Converter Station Platforms foundations has been added to the PDE, alongside the option of pile jackets for the OSP/ Offshore Converter Station Platforms foundations; and
- Reduction in the number of offshore export cables from 12 to eight.

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