DOGGER BANK D WIND FARM

Preliminary Environmental Information Report

Volume 1
Chapter 4 Project Description

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Prepared By: **Royal HaskoningDHV**	Prepared For: **Dogger Bank D Offshore Wind Farm**

Revision No.	Date	Status / Reason for Issue	Author	Checked by	Approved by
V1	09/04/2025	Final	TP / HP / PT	GS / JP / AT / GA	RH

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Glossary

Term	Definition
Birkhill Wood Substation	The onshore grid connection point for DBD identified through the Holistic Network Design process. Birkhill Wood Substation which is being developed by National Grid Electricity Transmission and does not form part of the Project.
Array Area	The area within which the wind turbines, inter-array cables and offshore platform(s) will be located.
Development Consent Order (DCO)	A consent required under Section 37 of the Planning Act 2008 to authorise the development of a Nationally Significant Infrastructure Project, which is granted by the relevant Secretary of State following an application to the Planning Inspectorate.
Energy Storage and Balancing Infrastructure (ESBI)	A range of technologies such as battery banks to be co-located with the Onshore Converter Station, which provide valuable services to the electrical grid such as storing energy to meet periods of peak demand and improving overall reliability.
Environmental Impact Assessment (EIA)	A process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information and includes the publication of an Environmental Statement.
Environmental Statement (ES)	A document reporting the findings of the EIA which describes the measures proposed to mitigate any likely significant effects.
Grid Connection	Thee offshore and onshore electricity transmission network connection to Birkhill Wood Substation.
Highest Astronomical Tide	The highest level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions,
Haul Roads	Temporary tracks set aside to facilitate transport access during onshore construction works.
Inter-Array Cables	Cables which link the wind turbines to the offshore platform(s).
Jointing Bays	Underground structures constructed at regular intervals along the onshore export cable corridor to facilitate the joining of discrete lengths of the installation of cables.
Landfall	The area on the coastline, south-east of Skipsea, at which the offshore export cables are brought ashore, connecting to the onshore export cables at the transition joint bay above Mean High Water Springs.
Link Boxes	Structures housing electrical equipment located alongside the jointing bays in the onshore export cable corridor and the transition joint bay at the landfall, which could be located above or below ground.

Term	Definition
Lowest Astronomical Tide	The lowest tide level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions.
Mean High Water Springs	MHWS is the average of the heights of two successive high waters during a 24-hour period.
Mean Low Water Springs	MLWS is the average of the heights of two successive low waters during a 24-hour period.
Offshore Construction Base Port(s)	The offshore construction base port(s) will be the home for the Project's service vessels, crew transfers and the control centre for managing marine logistics and traffic for offshore construction activities. At this stage, no decision has been made regarding which port(s) would be used for the Project's offshore construction. A decision upon the offshore construction base port(s) would not be made until post DCO determination.
Offshore Development Area	The area in which all offshore infrastructure associated with the Project will be located, including any temporary works area during construction, which extends seaward of Mean High Water Springs. There is an overlap with the Onshore Development Area in the intertidal zone.
Offshore Export Cable Corridor (ECC)	The area within which the offshore export cables will be located, extending from the DBD Array Area to Mean High Water Springs at the landfall.
Offshore Export Cables	Cables which bring electricity from the offshore platform(s) to the transition joint bay at landfall.
Offshore Platform(s)	Fixed structures located within the DBD Array Area that contain electrical equipment to aggregate and, where required, convert the power from the wind turbines, into a more suitable voltage for transmission through the export cables to the Onshore Converter Station. Such structures could include (but are not limited to): Offshore Converter Station(s) and an Offshore Switching Station.
Onshore Converter Station (OCS) Zone	The area within which the Onshore Converter Station and Energy Storage and Balancing Infrastructure will be located in vicinity of Birkhill Wood Substation.
Onshore Converter Station - OCS	A compound containing electrical equipment required to stabilise and convert electricity generated by the wind turbines and transmitted by the export cables into a more suitable voltage for grid connection into Birkhill Wood Substation.
Onshore Development Area	The area in which all onshore infrastructure associated with the Project will be located, including any temporary works area required during construction and permanent land required for mitigation and enhancement areas, which extends landward of Mean Low Water Springs. There is an overlap with the Offshore Development Area in the intertidal zone.

Term	Definition
Onshore Export Cable Corridor (ECC)	The area within which the onshore export cables will be located, extending from the landfall to the Onshore Converter Station zone and onwards to Birkhill Wood Substation.
Onshore Export Cables	Cables which bring electricity from the transition joint bay at landfall to the Onshore Converter Station zone (HVDC cables) and from the Onshore Converter Station zone onwards to Birkhill Wood Substation (HVAC cables).
Operation and Maintenance Base Port	The operation and maintenance (O&M) base port will be the home for the Project's service vessels, crew transfers and the control centre for managing marine logistics and traffic for offshore O&M activities. At this stage, no decision has been made regarding which port(s) would be used for the Project's offshore O&M activities. A decision upon an O&M base port would not be made until post DCO determination.
Project Design Envelope	A range of design parameters defined where appropriate to enable the identification and assessment of likely significant effects arising from a project's worst-case scenario. The Project Design Envelope incorporates flexibility and addresses uncertainty in the DCO application and will be further refined during the EIA process.
Safety Zones	A statutory, temporary marine zone demarcated for safety purposes around a possibly hazardous offshore installation or works / construction area.
Scour Protection	Protective materials used to avoid sediment erosion from the base of the wind turbine foundations and offshore platform foundations due to water flow.
Temporary Construction Compounds	Areas set aside to facilitate the construction works for the onshore infrastructure, which include the landfall construction compound, main and intermediate construction compounds for onshore export cable works and OCS and ESBI construction compounds.
The Applicant	SSE Renewables and Equinor acting through 'Doggerbank Offshore Wind Farm Project 4 Projco Limited'.
The Project	Dogger Bank D Offshore Wind Farm Project, also referred to as DBD in this PEIR.
Transition Joint Bay (TJB)	An underground structure at the landfall that houses the joints between the offshore and onshore export cables.
Trenching	Open cut method for cable or duct installation.
Trenchless Techniques	Trenchless cable or duct installation methods used to bring offshore export cables ashore at landfall, facilitate crossing major onshore obstacles such as roads, railways and watercourses and where trenching may not be suitable.
	Trenchless techniques included in the Project Design Envelope include Horizontal Directional Drilling (HDD), auger boring, micro-tunnelling, pipe jacking / ramming and Direct Pipe.
Wind Turbines	Power generating devices located within the DBD Array Area that convert kinetic energy from wind into electricity.

4 Project Description

4.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) presents a description of the key offshore and onshore infrastructure components of the Dogger Bank D Offshore Wind Farm (hereafter 'the Project' or 'DBD') and the main activities that will be undertaken during the construction, operation and maintenance, and decommissioning phases.

2. The key offshore components of the Project comprise the following :

- Wind turbines (**Section 4.8.1**);
- Foundation structures for wind turbines and offshore platforms (Sections 4.8.1.2 and 4.8.2.1);
- Scour and cable protection (**Sections 4.8.3.3** and **4.8.7.7**);
- Offshore platform(s), including Offshore Converter Station(s) and an Offshore Switching Station (hereafter collectively referred to as offshore platforms unless specified) (**Section 4.8.2**);
- Inter-array cables (**Section 4.8.5**); and
- Offshore export cables (Section 4.8.6).

3. As described in **Chapter 1 Introduction**, the Project is being developed to connect into Birkhill Wood Substation which will be located to the north of the existing Creyke Beck Substation in East Riding of Yorkshire.

4. The key onshore components of the Project comprise the following:

- Landfall and associated transition joint bay (TJB) and link box (**Section 4.9**);
- Onshore export cables and associated jointing bays and link boxes (**Section 4.9.5**); and
- Onshore Converter Station (OCS) and co-located Energy Storage and Balancing Infrastructure (ESBI) (**Section 4.9.6**).

5. **Plate 4-1** shows an overview of the Project's offshore and onshore infrastructure.

4.2 Project Design Envelope Approach

6. Throughout this PEIR, an approach referred to as the 'Project Design Envelope' is adopted. The concept of a Project Design Envelope is recognised in national planning policies and guidance including the Overarching National Policy Statement for Energy (EN-1) (DESNZ, 2023a), the NPS for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b) and the Planning Inspectorate (PINS) Advice Note Nine: Rochdale Envelope (PINS, 2018). Details of these policies are provided in **Chapter 3 Policy and Legislative Context**.

7. NPS EN-3 specifically recognises at Paragraph 2.8.74 that due to '*the complex nature of offshore wind farm development, many of the details of a proposed scheme may be unknown to the applicant at the time of application to the Secretary of State. Such aspects include:*

- *The precise location and configuration of turbines and associated development;*
- *The foundation type and size;*
- *The installation technique or hammer energy;*
- *The exact turbine blade tip height and rotor swept area;*
- *The cable type and precise cable or offshore transmission route; and*
- *The exact locations of offshore and/or onshore substations.*'

8. The Project Design Envelope is therefore based on the Project's maximum and minimum design parameters, where appropriate, and assumptions on the likely construction, operation and maintenance (O&M) and decommissioning methodologies to ensure the maximum adverse effect (i.e. worst-case scenario) is assessed in the EIA.

9. In line with the NPS, the Project Design Envelope is intended to enable potential for coordination with other local developments and futureproofing where appropriate. This will enable the Project to seek opportunities for reducing cumulative impacts on the environment and communities by ensuring efficiency in the development of transmission infrastructure where possible.

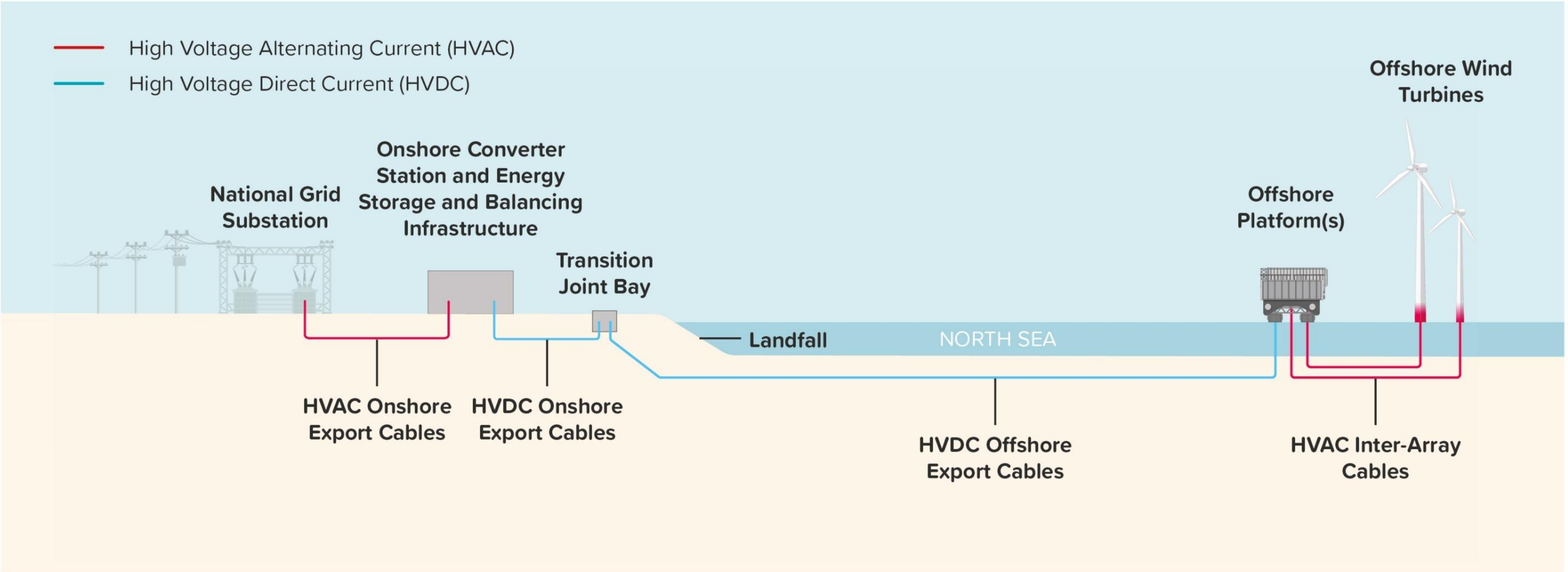


Plate 4-1 Overview of the Project's Infrastructure

10. The Project Design Envelope therefore covers the flexibility for the Project to be connected with an interconnector cable. To enable this potential for coordination, flexibility for up to two offshore platforms, which will form the basis of relevant environmental assessments, is included within the Project Design Envelope. One platform will be a converter station, and the second will be for a switching station. The switching station would allow for potential future coordination with an interconnector cable. No other additional infrastructure relating to an interconnector is included in the Project Design Envelope for PEIR to support coordination with an interconnector cable.

11. Relevant realistic worst-case scenarios, derived from the Project Design Envelope, are outlined within each technical chapter of this PEIR (**Chapter 8 Marine Physical Processes** to **Chapter 31 Climate Change**). These are presented on a receptor-by-receptor or impact-by-impact basis based on a range of feasible and likely build-out scenarios within the envelope. This approach prevents assessments from being undertaken on overly precautionary scenarios that would never be constructed and ensure the delivery of a proportionate EIA.

12. The development of the project design is an iterative and ongoing process. Therefore, the description of the key infrastructure components and their parameters are indicative based on available design information at this stage. Following PEIR publication, the Project Design Envelope will be further refined and confirmed in the Environmental Statement (ES) accompanying the Development Consent Order (DCO) application. The detailed design of the Project will be developed within the consented envelope and boundaries prior to construction.

4.3 Good Design for Energy Infrastructure

13. The Applicant will seek to adhere to the principles of 'good design' for energy infrastructure as outlined in NPS EN-1 (and subsequent advisory notes) (DESNZ, 2023a) in the design of the OCS and co-located ESBI. A **Design Vision** (document reference 7.4) (Commitment ID CO63) has been prepared, which constitutes the 'Design Approach Document' referred to in the Guidance titled Nationally Significant Infrastructure Projects: Advice on Good Design. This outlines the overall vision for the Project and sets out a series of 'Design Principles' that will be used to guide the detailed design of the Project.

14. The design principles set out the range of design choices available for elements of the OCS and co-located ESBI, the compound and its setting. These will be determined by the site context, design vision for the overall scheme, potential effects, mitigation requirements, enhancement measures and feedback from the community and key stakeholders. Design principles will also be governed by the technical parameters and standards required for energy infrastructure and design, and construction best practice. Setting design principles at an early stage of the Project will ensure that 'Good Design' is recognised and carried through to the detailed design and implementation stage.

15. The **Design Vision** (document reference 7.4) (Commitment ID CO63) will be further developed post-PEIR, and will be submitted in support of the DCO application. It will underpin ongoing design work for the OCS and co-located ESBI to ensure the Project meets the principles of Good Design for energy infrastructure.

16. The Design Vision will be subject to an independent design review process, undertaken at key points within the design process to ensure that proposals developed meet the test of Good Design. Feedback received during the process will be used to guide the design and inform the Design Principles developed for the DCO submission.

4.4 Site Description

17. The location of key offshore and onshore infrastructure is shown in **Figure 4-1** and **Figure 4-2** respectively**.** The Offshore Development Area consists of the Array Area and the offshore Export Cable Corridor (ECC) and extends seaward of Mean High Water Springs (MHWS) and is shown in **Figure 4-1**. The Onshore Development Area consists of the landward extent of the landfall above Mean Low Water Springs (MLWS), the onshore ECC, the OCS zones and is shown on **Figure 4-2**. The intertidal zone (i.e. the area between MHWS and MLWS) is therefore included in both the Offshore and Onshore Development Areas.

18. The Project's offshore Array Area is located in the Dogger Bank region of the southern North Sea, approximately 210km off the Yorkshire coast at its nearest point. The Project's offshore export cables make landfall at a location south-east of Skipsea in the East Riding of Yorkshire. From there, the onshore export cables run through a predominantly agricultural landscape with dispersed rural settlements to the OCS zone and onwards to the grid connection point at the proposed National Grid Birkhill Wood Substation located south of Beverley, East Riding of Yorkshire. Further details are provided in **Section 4.4.2**.

19. The site selection process leading up to the refinement of the Offshore and Onshore Development Areas for the PEIR is discussed in **Chapter 5 Site Selection and Consideration of Alternatives**.

4.4.1 Offshore

20. The Array Area is where all generating infrastructure will be located, as well as the offshore platform(s) required to transmit the electricity to shore. The Array Area is defined by The Crown Estate's Agreement for Lease. An additional 2km buffer is included within the Offshore Development Area around the Array Area which may serve as a temporary construction area, if required. However, it should be noted that this 2km buffer is not applied to the eastern boundary of the Array Area as this would result in an overlap with the Netherlands Exclusive Economic Zone (EEZ). The Array Area is 262km^2 in size and 210km from shore at its closest point and is located in the Dogger Bank Special Area of Conservation (SAC).

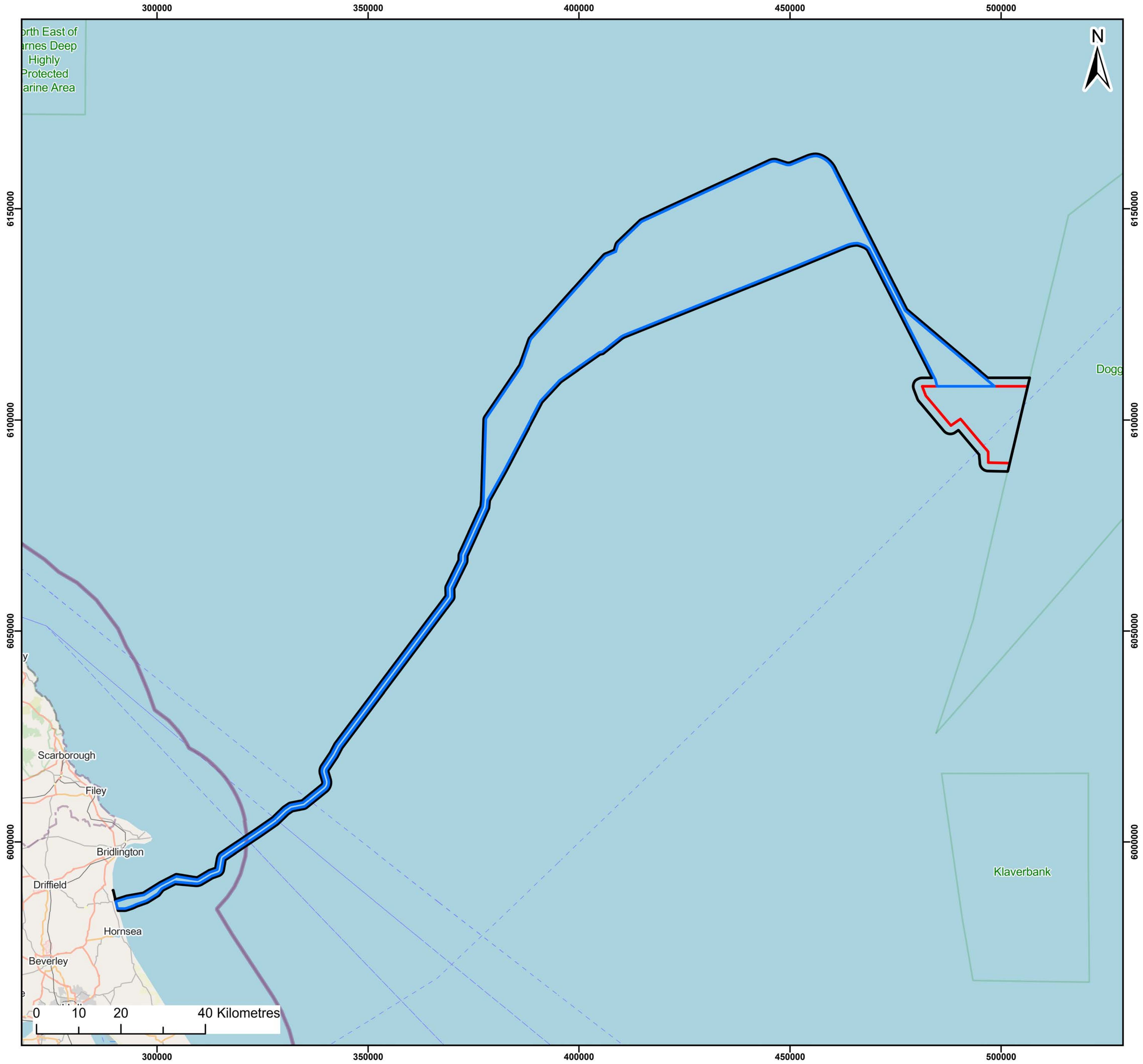
21. Water depths within the Array Area vary from 21.2m to 34.6m relative to Lowest Astronomical Tide (LAT). The seabed is generally shallowest in the southeastern corner of the Array Area and slopes as it moves northwest where it plateaus at approximately 26m. There are a number of seabed troughs in the north and southwest of the Array Area where the depth locally increases to more than 30m.

22. The offshore ECC will connect the Array Area to the landfall to allow the transmission of the electricity. The offshore ECC exits the Array Area from the northern boundary and then travels north-west until it reaches the northern boundary of the Dogger Bank SAC where the offshore ECC widens. The widening of the offshore ECC in the area to the north of the Dogger Bank SAC is to enable flexibility inn future offshore ECC routing due to current uncertainty over a potential future Marine Protected Area (MPA) extension[1] in this area (refer to **Section 5.9.1** of **Chapter 5 Site Selection and Consideration of Alternatives** for more information on the potential extension). The offshore ECC then narrows to an approximately 1km wide route to the landfall, noting that it was not possible to maintain an exact 1km width for the entire route on account of a number of constraints, particularly in the nearshore region.

23. At the time of writing, geophysical surveys of the offshore ECC are still ongoing, therefore, information on bathymetry and sediment type are yet to be confirmed. Given what is already known about the wider region through the existing Dogger Bank projects under construction by the Applicant, as well as those in the planning pipeline, it is anticipated the depths will be relatively shallow in the Dogger Bank region and the sediment type will be predominantly sand with some areas of gravel, cobbles and boulders predominantly in the nearshore region. Water depths along the offshore ECC are likely to vary more, however, it is not anticipated the bathymetry will reach significant depths.

24. There is a small overlap of the offshore ECC with the Holderness Inshore Marine Conservation Zone (MCZ) as it approaches the landfall. The offshore ECC avoids routeing through the Holderness Offshore MCZ, although there is a marginal overlap with the buffer applied to the ECC for temporary work areas (illustrated on **Page 2** of **Figure 5 - 9**).

[1] Use of MPA extensions was confirmed as a measure of strategic benthic compensation by DESNZ in January 2025 (DESNZ, 2025)



Legend:

- DBD Array Area
- Offshore Development Area
- Offshore Export Cable Corridor

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Project:

Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title:

Offshore Development Area

Figure:	4-1	Drawing No:	PC3991-RHD-OF-ZZ-DR-Z-0150		
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Co-ordinate system: WGS 1984 UTM Zone 31N

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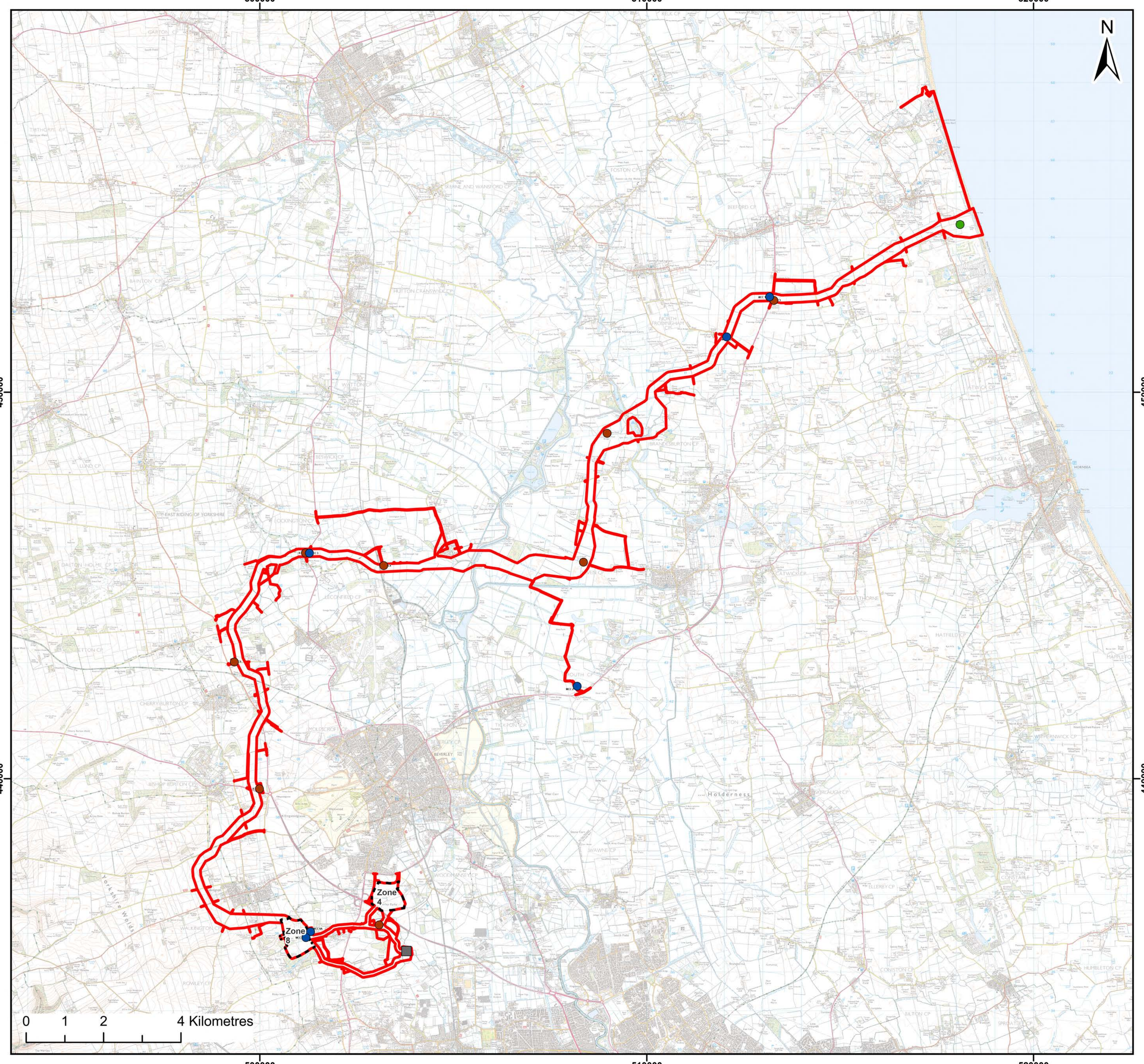

Legend:

- Onshore Development Area
- Onshore Converter Station Zone Options
- Indicative Birkhill Wood Substation Location

Indicative Construction Compound Locations

- Intermediate Construction Compound for Onshore Export Cable Works
- Main Construction Compound for Onshore Export Cable Works
- Landfall Construction Compound

Note: Two additional construction compounds for the Onshore Converter Station and Energy Storage Balancing Infrastructure will be required. These will be sited within the Onshore Converter Station zone.

Source: © Haskoning DHV UK Ltd, 2024.

Project: Dogger Bank D Offshore Wind Farm	DOGGER BANK WIND FARM
Title: Onshore Development Area - Page 1 of 8	
Figure: 4-2	Drawing No: PC6250-RHD-XX-ON-DR-GS-0149

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Co-ordinate system: British National Grid

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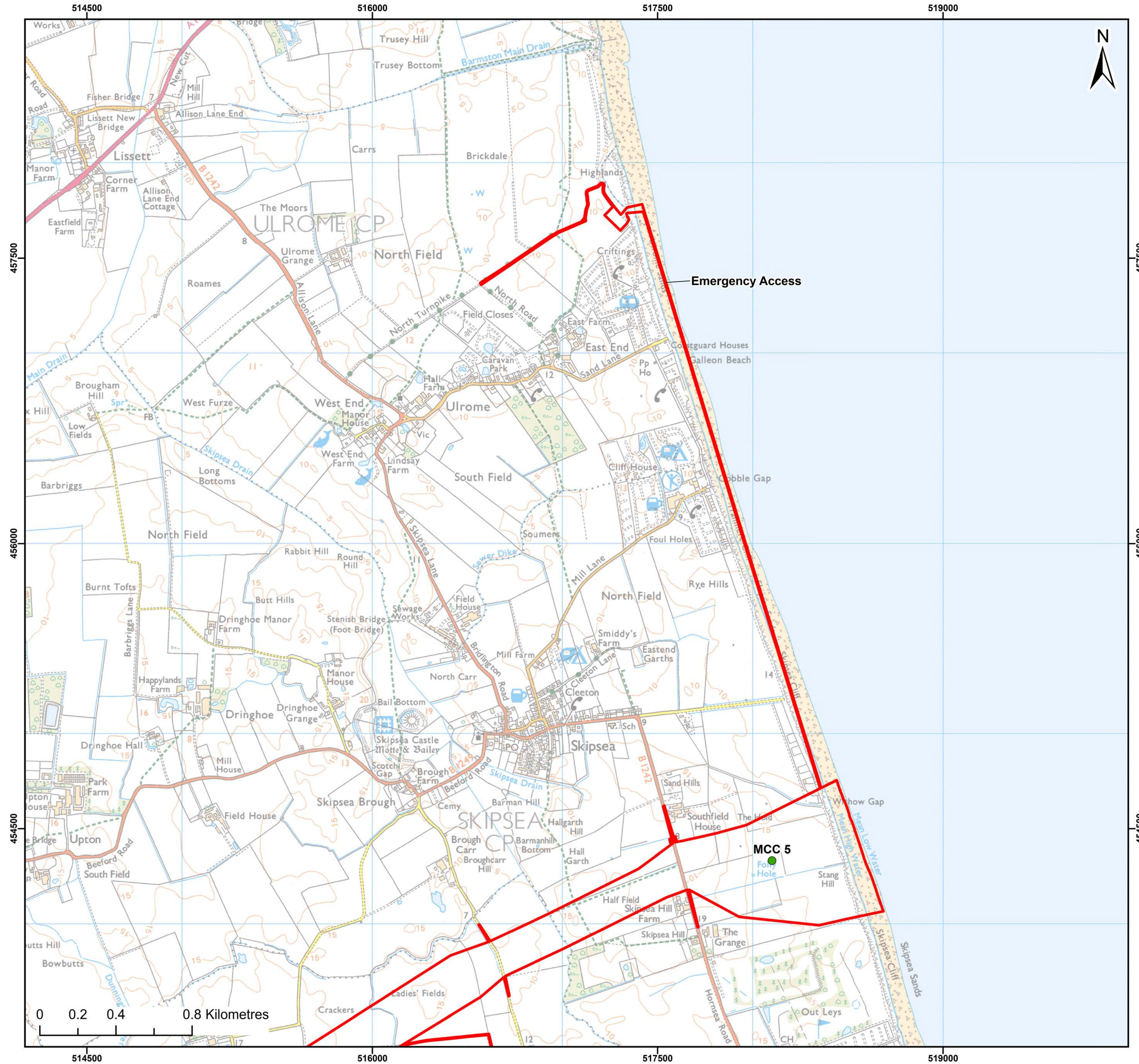

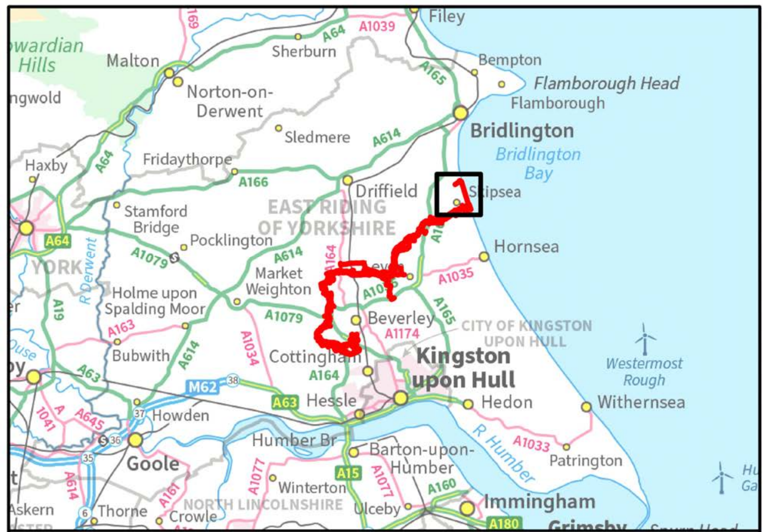

Legend:

Onshore Development Area

Indicative Construction Compound Locations

Landfall Construction Compound

Note: Two additional construction compounds for the Onshore Converter Station and Energy Storage Balancing Infrastructure will be required. These will be sited within the Onshore Converter Station zone.

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Project:

Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title:

Onshore Development Area - Page 2 of 8

Figure:	4-2	Drawing No:	PC6250-RHD-XX-ON-DR-GS-0149		
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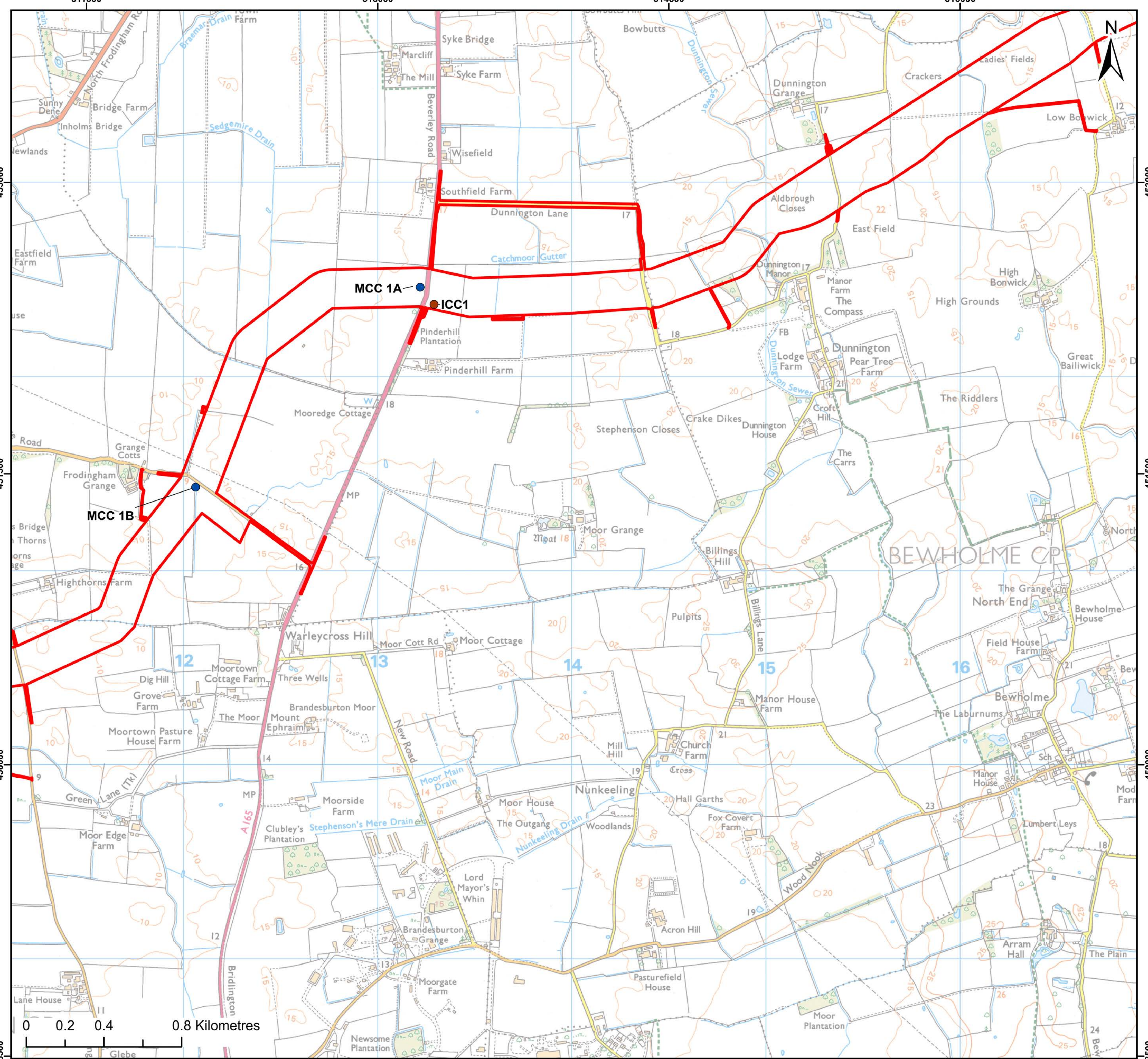

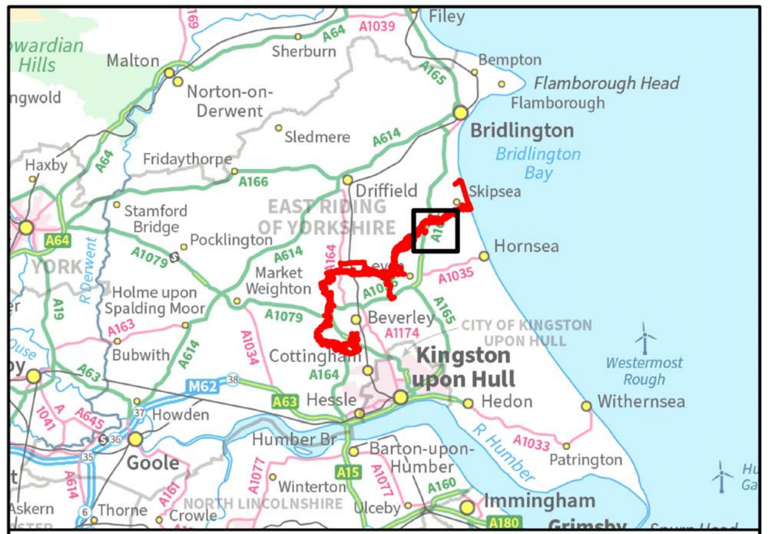

Legend:

Onshore Development Area

Indicative Construction Compound Locations

- Intermediate Construction Compound for Onshore Export Cable Works
- Main Construction Compound for Onshore Export Cable Works

Note: Two additional construction compounds for the Onshore Converter Station and Energy Storage Balancing Infrastructure will be required. These will be sited within the Onshore Converter Station zone.

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Project: Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title: Onshore Development Area - Page 3 of 8

Figure:	4-2	Drawing No:	PC6250-RHD-XX-ON-DR-GS-0149		
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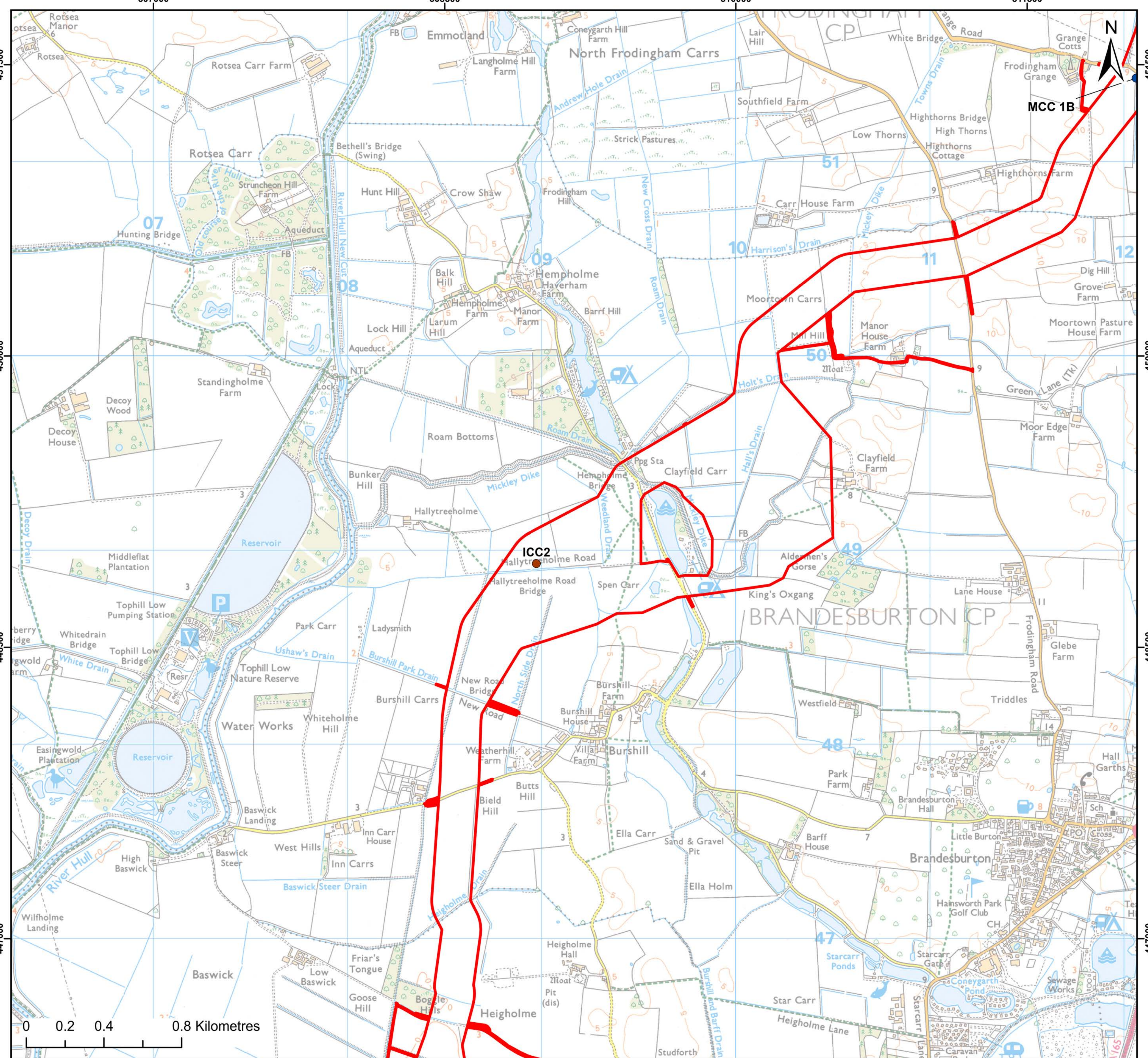

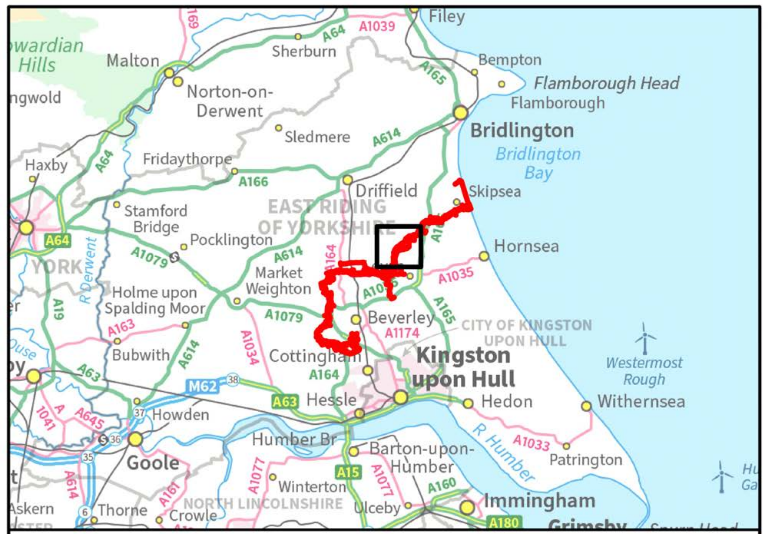

Legend:

Onshore Development Area

Indicative Construction Compound Locations

Intermediate Construction Compound for Onshore Export Cable Works

Main Construction Compound for Onshore Export Cable Works

Note: Two additional construction compounds for the Onshore Converter Station and Energy Storage Balancing Infrastructure will be required. These will be sited within the Onshore Converter Station zone.

Project: Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title: Onshore Development Area - Page 4 of 8

Figure: 4-2	Drawing No: PC6250-RHD-XX-ON-DR-GS-0149				
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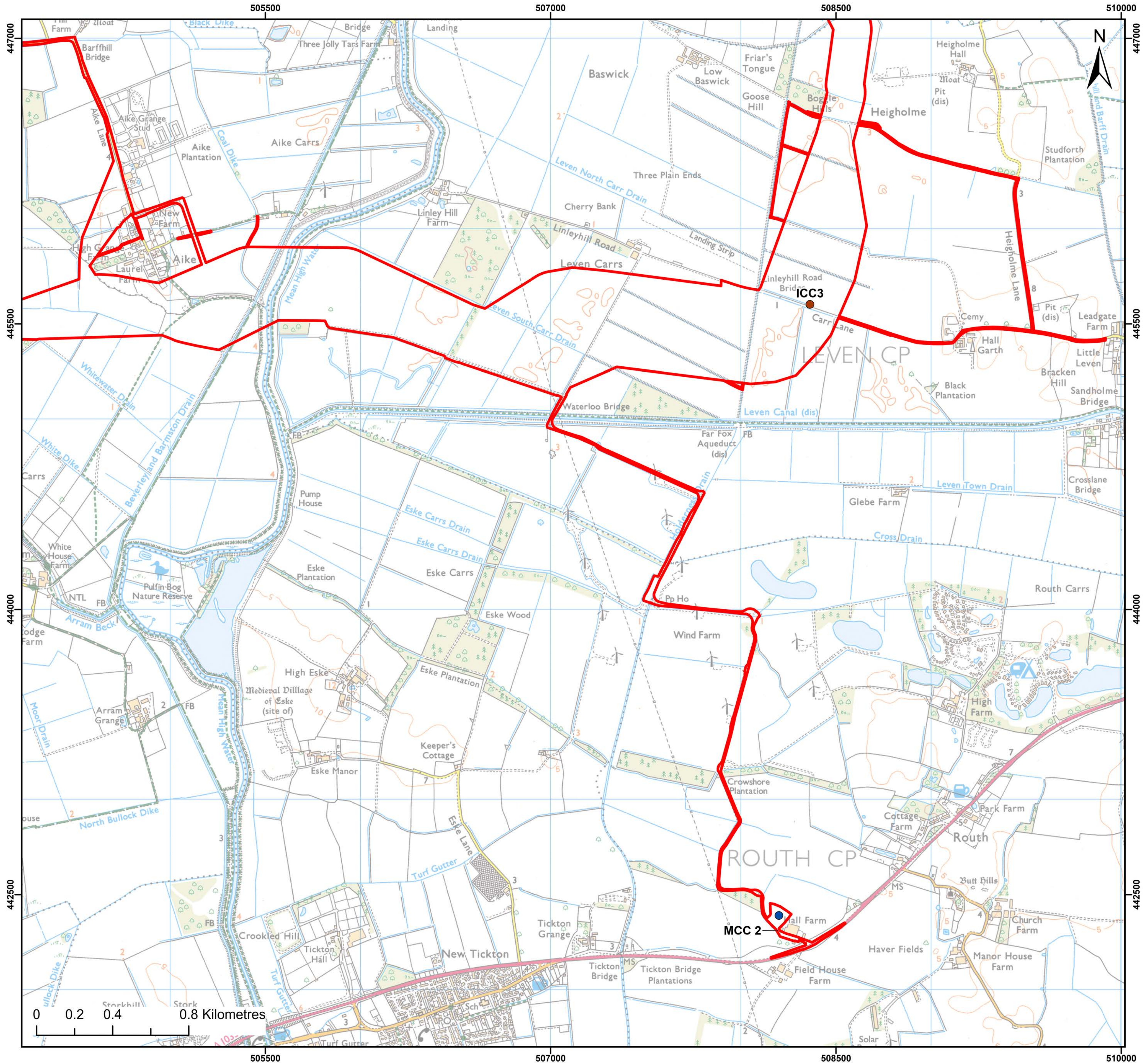

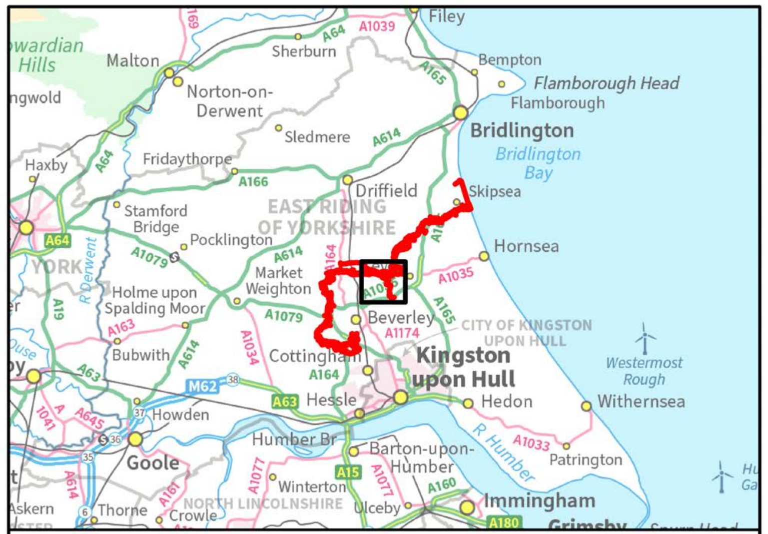

Legend:

Onshore Development Area

Indicative Construction Compound Locations

- Intermediate Construction Compound for Onshore Export Cable Works
- Main Construction Compound for Onshore Export Cable Works

Note: Two additional construction compounds for the Onshore Converter Station and Energy Storage Balancing Infrastructure will be required. These will be sited within the Onshore Converter Station zone.

Source: © Haskoning DHV UK Ltd, 2025.

Project:

Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title:

Onshore Development Area - Page 5 of 8

Figure:	4-2	Drawing No:	PC6250-RHD-XX-ON-DR-GS-0149		
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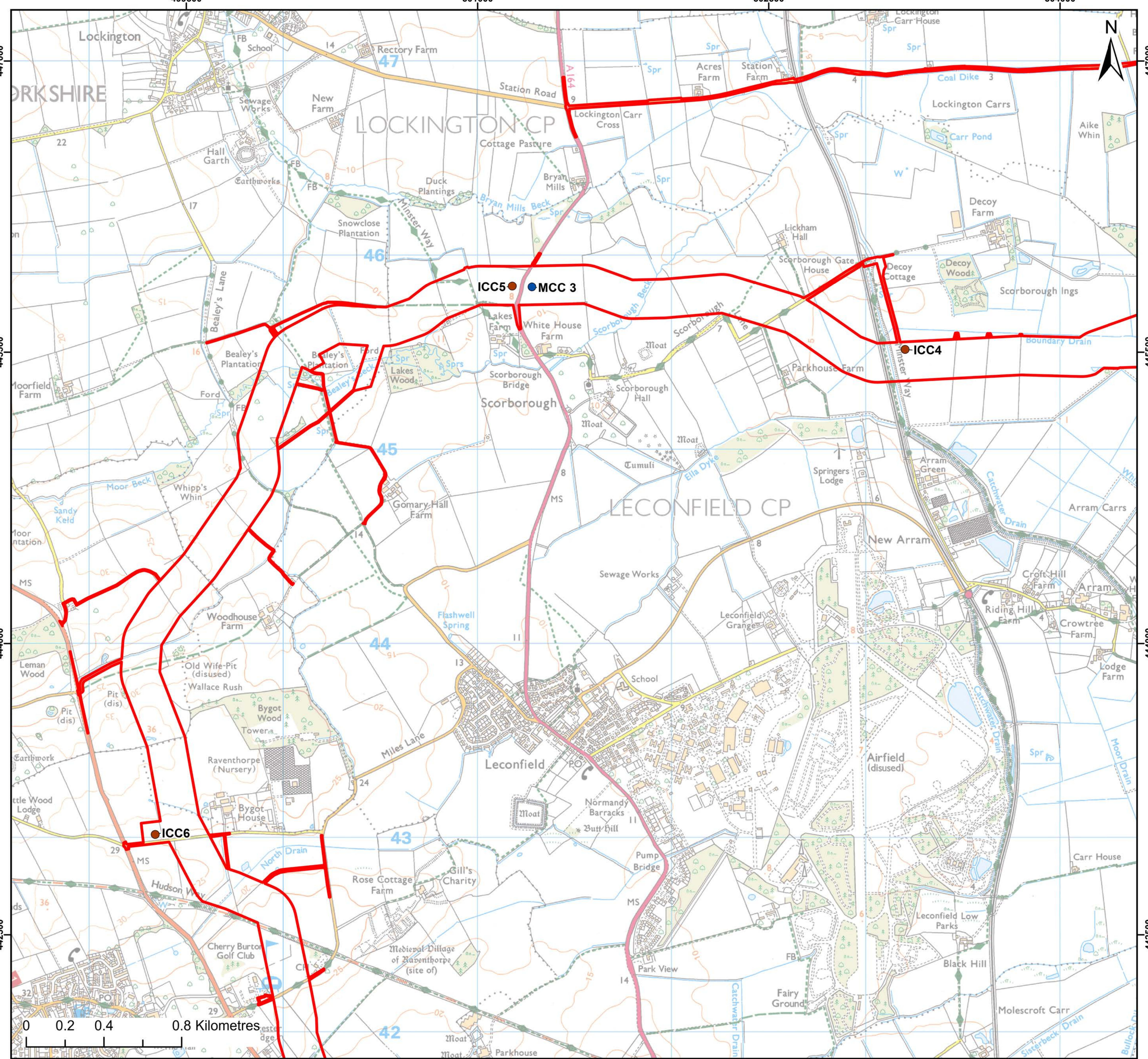

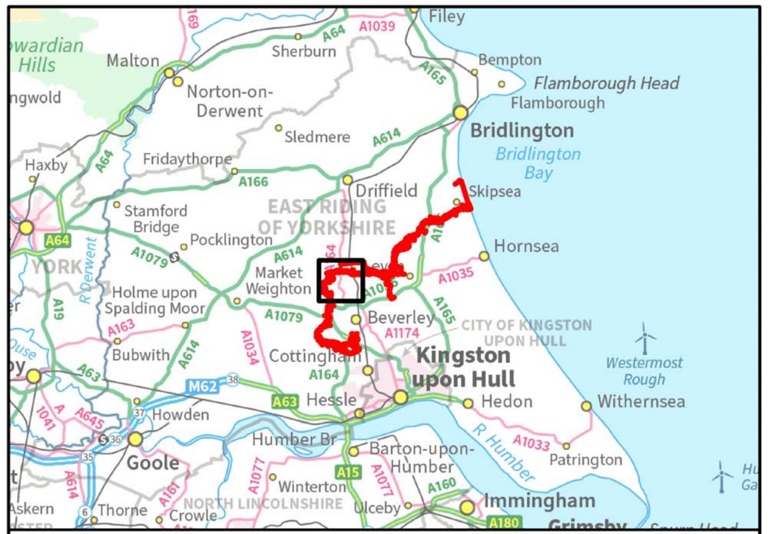

Legend:

Onshore Development Area

Indicative Construction Compound Locations

Intermediate Construction Compound for Onshore Export Cable Works

Main Construction Compound for Onshore Export Cable Works

Note: Two additional construction compounds for the Onshore Converter Station and Energy Storage Balancing Infrastructure will be required. These will be sited within the Onshore Converter Station zone.

Project: Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title: Onshore Development Area - Page 6 of 8

Figure:	4-2	Drawing No:	PC6250-RHD-XX-ON-DR-GS-0149		
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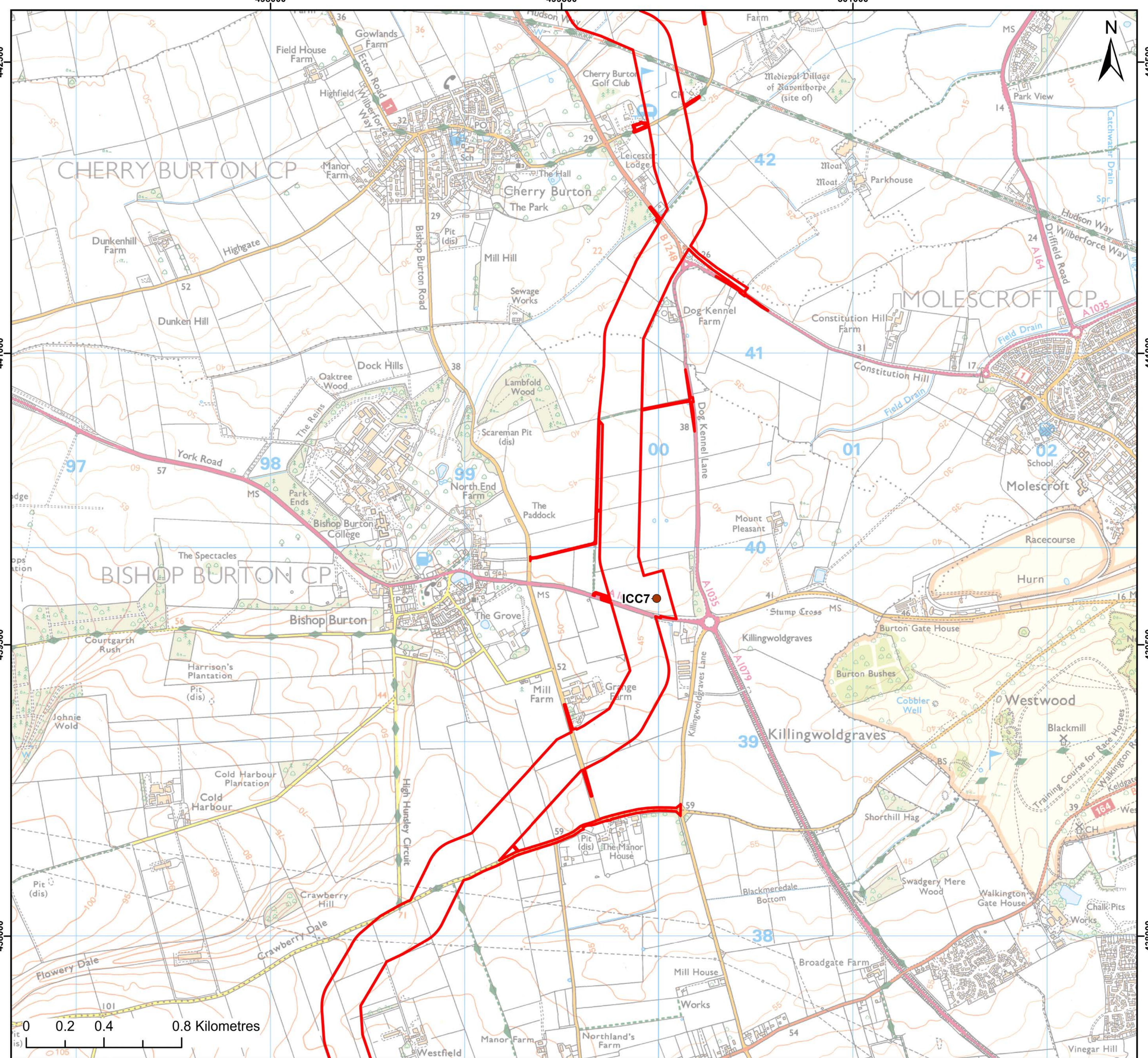

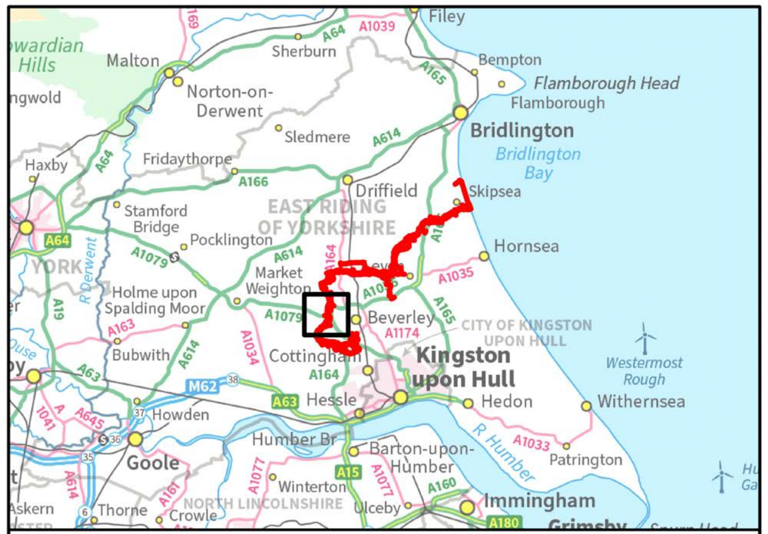

Legend:

Onshore Development Area

Indicative Construction Compound Locations

Intermediate Construction Compound for Onshore Export Cable Works

Note: Two additional construction compounds for the Onshore Converter Station and Energy Storage Balancing Infrastructure will be required. These will be sited within the Onshore Converter Station zone.

Project:

Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title:

Onshore Development Area - Page 7 of 8

Figure: 4-2	Drawing No: PC6250-RHD-XX-ON-DR-GS-0149				
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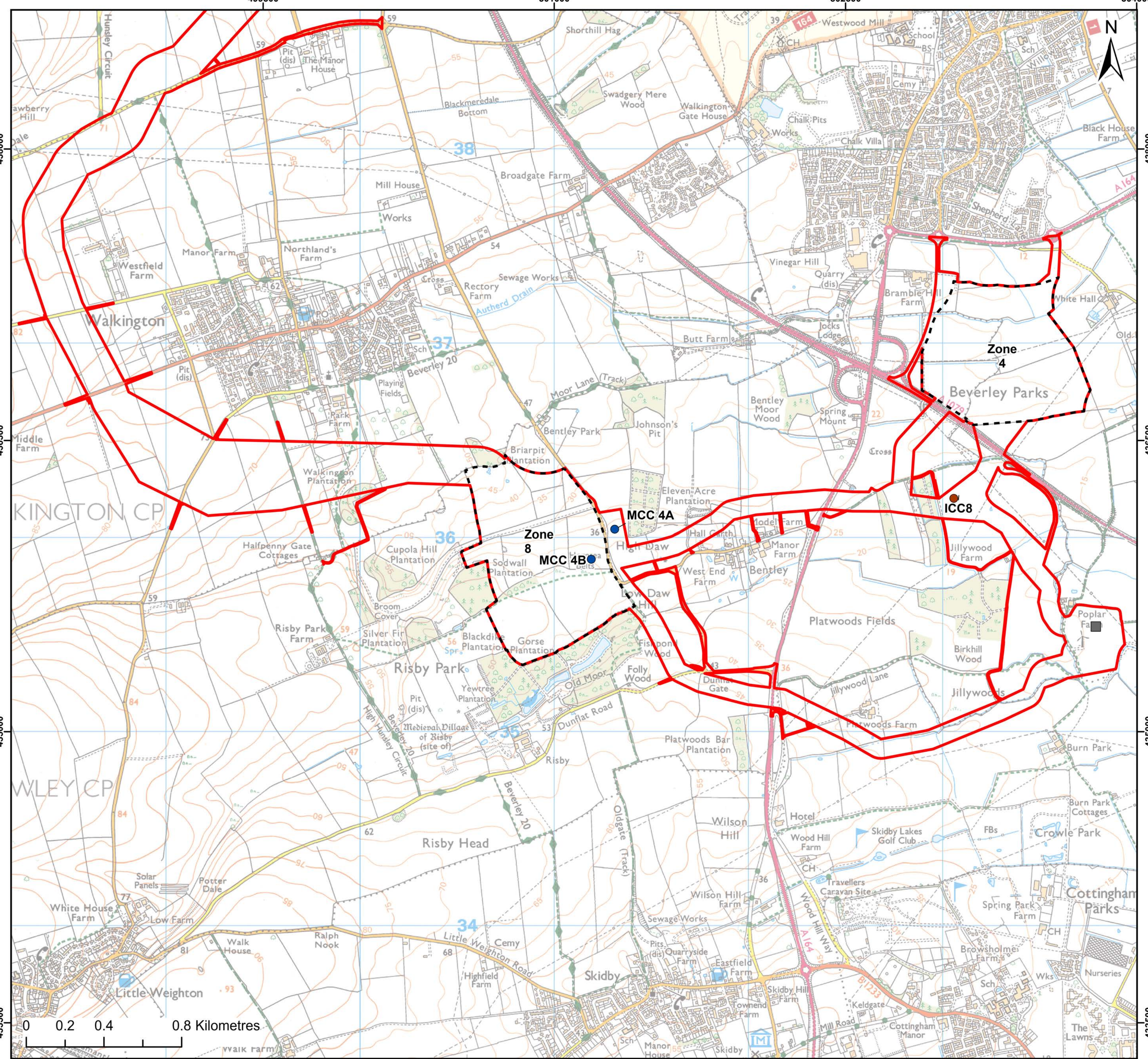

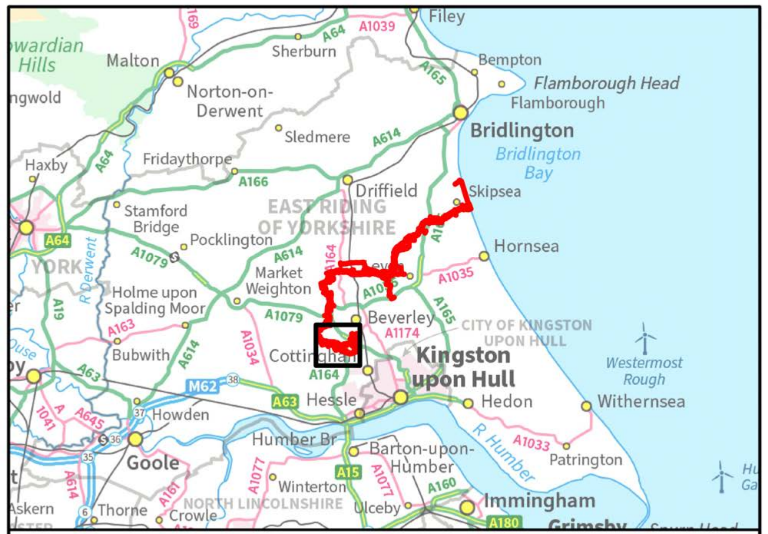

Legend:

- Onshore Development Area
- Onshore Converter Station Zone Options
- Indicative location of Birkhill Wood Substation

Indicative Construction Compound Locations

- Intermediate Construction Compound for Onshore Export Cable Works
- Main Construction Compound for Onshore Export Cable Works

Note: Two additional construction compounds for the Onshore Converter Station and Energy Storage Balancing Infrastructure will be required. These will be sited within the Onshore Converter Station zone.

Source: © Haskoning DHV UK Ltd, 2025.

Project:

Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title:

Onshore Development Area - Page 8 of 8

Figure:	4-2	Drawing No:	PC6250-RHD-XX-ON-DR-GS-0149		
Revision:	Date:	Drawn:	Checked:	Size:	Scale:
04	07/05/2025	JH	AG	A3	1:20,000
03	18/03/2025	JH	AG	A3	1:20,000

Co-ordinate system: British National Grid

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4.4.2 Onshore

4.4.2.1 Landfall

25. The offshore export cables will be brought ashore at the landfall, located south-east of Skipsea and connected to the onshore export cables at the TJB. The onshore ECC is approximately 55km long (50km from Landfall to the OCS Zone, and 5km onward connection from the OCS zone to the Birkhill Wood Substation) and runs through a predominantly agricultural landscape with dispersed rural settlements along the route.

4.4.2.2 Onshore Export Cable Corridor

26. This section describes the route of the onshore ECC from the landfall to the grid connection point via the OCS zone, which is illustrated on **Figure 4-2** (page 8).

27. From the landfall, the onshore ECC heads west, crossing Hornsea Road (B1242) and continuing north of Dunnington before turning south-west after crossing Beverley Road (A165).

28. It continues in a south-westerly direction towards Hempholme and turns south, passing north-west of Burshill. The corridor continues in a southerly direction before turning west at Beverley Airfield located east of Leven.

29. The onshore ECC continues in a westerly direction keeping north of Leven Canal, crossing the River Hull, the Hull-Scarborough railway line and Driffield Road (A164) before turning and heading south between Scorborough and Etton.

30. It then continues in a southerly direction, crossing Malton Road (B1248) and running to the east of Cherry Burton and Bishop Burton. After crossing Beverley Road (A1079), the corridor arches around west of Walkington and crosses Hunsley Road (B1230) before reaching OCS Zone 8.

31. After this point, the onshore ECC continues in an easterly direction and diverges into two corridor sections (i.e. the northern and southern corridor sections). These sections have been retained through the site selection process and are included in the onshore ECC to maintain flexibility for routeing the onshore export cables into and out of the two OCS zones under consideration.

32. For OCS Zone 8, both the northern and southern corridor sections are being considered for onward routeing to the grid connection point. From Zone 8, the northern corridor section crosses Beverley Road (A164) adjacent to Bentley and terminates at the Birkhill Wood Substation. The southern corridor section crosses Skidby Bypass (A164) further south of Bentley before terminating at the Birkhill Wood Substation.

33. For OCS Zone 4, only the northern corridor section is being considered. The northern corridor section follows the route as described in the paragraph above but includes two separate crossing locations of the Beverley Bypass (A1079) for routeing onshore export cables in and out of Zone 4.

34. Where relevant, the northern and southern corridor sections are assessed separately in the technical chapters of the PEIR where the assessment of likely significant effects materially differs between the options. This is to ensure a robust assessment is undertaken regardless of which option is taken forward.

35. The identification of the preferred corridor section (i.e. northern or southern corridor section) will be undertaken based on a balanced consideration of environmental, engineering and land factors and stakeholder feedback received through statutory consultation and other technical consultation and is dependent on the identification of the preferred OCS zone as discussed in **Section 4.4.2.2**.

4.4.2.3 Onshore Converter Station Zone

36. The OCS zone will be located in the vicinity of the grid connection point at the Birkhill Wood Substation, south of Beverley. It is proposed that the OCS and co-located ESBI will be co-located within the same zone.

37. To maintain necessary flexibility at this stage, two OCS zone options are included in the Project Design Envelope. Only one OCS zone will be taken forward to development, as such, there is no cumulative development scenario in which infrastructure would be located in both zones. The two OCS zones[2] considered at PEIR are described below and shown on **Figure 4-2**:

- OCS Zone 4: Infrastructure to be built on agricultural land south of Beverley at the junction between Beverley Road (A164) and Beverley Bypass (A1079); and
- OCS Zone 8: Infrastructure to be built on agricultural land west of Bentley and Beverley Road (A164).

[2] The numbering of the OCS zones is based on the initial nine OCS zone options considered through the site selection process. Zone 4 and Zone 8 have been short listed (see **Chapter 5 Site Selection and Consideration of Alternatives**) and included in the Onshore Development Area.

38. Where relevant, the two OCS zone options (Zones 4 and 8) are assessed separately in the technical chapters of the PEIR where the assessment of likely significant effects materially differs between the options. This is to ensure a robust assessment is undertaken regardless of which option is taken forward.

39. The selection of the preferred OCS zone option (i.e. Zone 4 or Zone 8) will be undertaken based on a balanced consideration of environmental, engineering and land factors, and stakeholder feedback received through statutory consultation and other technical consultation.

4.5 Design Commitments

40. The Project has made a number of design commitments to avoid, prevent and minimise potential adverse environmental effects. These design commitments have helped to shape the project design. Key design commitments are presented in **Table 4-1**.

41. Full details of all commitments made by the Project are provided within **Volume 2, Appendix 6.3 Commitments Register**. Proposed commitments may evolve during the pre-application phase as the EIA progresses and in response to refinements to the Project Design Envelope and stakeholder feedback. The final commitments, including design commitments, will be confirmed in the Commitments Register which will be submitted with the DCO application.

4.6 Consultation

42. Consultation regarding the Project has been undertaken through a number of forums, as discussed in **Chapter 7 Consultation**. Relevant feedback from the following consultation activities undertaken to date have shaped the development of the project design:

- Scoping Opinion received from the Planning Inspectorate on 2nd August 2024 in response to the EIA Scoping Report;
- Ongoing Evidence Plan Process (EPP) and other technical consultation with key consultees;
- Non-statutory consultation undertaken from 10th September to 22nd October 2024 with local communities; and
- Ongoing direct discussions with landowners and asset owners, parish and town councils and interest groups.

43. Details of the consultation responses regarding the project design and how they have been considered during the preparation of this chapter are outlined in **Volume 2, Appendix 4.1 Consultation Responses for Project Description**.

44. Following statutory consultation on the PEIR, stakeholder feedback will be considered and refinements to the project design made where possible and appropriate. These refinements will inform the final Project Design Envelope presented in the ES, which the final results of the EIA will be based on.

45. Full details of consultation undertaken throughout the EIA process will be presented in the Consultation Report, which will be submitted with the DCO application.

Table 4-1 Commitments Relevant to the Project Design

Commitment ID	Proposed Design Commitment	How the Design Commitment will be Secured
CO2	A Layout Plan (including sub-sea cables and the wind turbines) will be provided and agreed with the Marine Management Organisation (MMO) following consultation with Trinity House and the Maritime and Coastguard Agency (MCA). The Layout Plan will take account of the distribution of geophysical anomalies of archaeological interest and the requirement to avoid Archaeological Exclusion Zones (AEZ).	DML Condition - Layout Plan
CO7	The Project will ensure compliance with Marine Guidance Note (MGN) 654 and its annexes, where applicable, including implementation of an Emergency Response Cooperation Plan (ERCoP) for all phases of the Project and completion of a Search and Rescue (SAR) checklist.	DML Condition - Emergency Response and Cooperation Plan
CO9	Aids to navigation (marking and lighting) will be deployed in accordance with the latest relevant available standard industry guidance and as advised by Trinity House, Maritime and Coastguard Agency (MCA) and Civil Aviation Authority (CAA) and Ministry of Defence (MoD) as appropriate. This will include a buoyed construction area around the Array Area. Consultation with Trinity House, MCA, and CAA will occur to determine appropriate lighting and marking.	DML Condition - Aids to Navigation Plan
CO13	There will be a minimum blade tip clearance of at least 26m above highest astronomical tide, and 28m above lowest astronomical tide.	DCO Works
CO16	There will be appropriate marking of all offshore infrastructure associated with the Project on suitably scaled UK Hydrographic Office (UKHO) Admiralty Charts.	DML Condition
CO17	Safety zones of up to 500m will be applied for during construction, major maintenance and decommissioning phases and up to 50m for installed structures pre-commissioning. Where defined by risk assessment, guard vessels will also be used to ensure adherence with safety zones or advisory passing distances to mitigate impacts which pose a risk to surface navigation during construction, maintenance and decommissioning phases. Where deemed appropriate by risk assessment, guard vessels will be used to reduce risks to surface navigation during construction, maintenance and decommissioning.	Secured through a Safety Zone Application submitted post-consent.
CO23	At the landfall, trenchless installation techniques will be implemented and exit pits will be located beyond Mean Low Water Springs (MLWS). Installation will be at a suitable depth below the base of the cliff to avoid potential impacts to the Withow Gap Site of Special Scientific Interest (SSSI).	DCO Works DCO Requirement - Code of Construction Practice
CO24	A Cable Specification and Installation Plan will be provided and submitted for approval prior to offshore construction. The Cable Specification and Installation Plan will detail the methods used for construction of offshore export and inter-array cables. Where possible, cable burial will be the preferred method for cable protection. Where cable protection is required, this will be minimised so far as is feasible. All cable protection will adhere to the requirements of Marine Guidance Note (MGN) 654 with respect to changes greater than 5% to the under-keel clearance in consultation with the Maritime and Coastguard Agency (MCA) and Trinity House. Any damage, destruction or decay of cables must be notified to the MCA, Trinity House, Kingfisher and UK Hydrographic Office (UKHO) no later than 24 hours after being discovered.	DML Condition - Cable Specification and Installation Plan
CO26	Micro-siting of the offshore cables will be used to minimise the requirement for seabed preparation as far as is practicable.	DML Condition - Cable Specification and Installation Plan
CO27	Cable burial will be the preferred method of cable protection where practicable. The target depth of cable burial will be informed by the Cable Burial Risk Assessment (CBRA) and identified in the Cable Specification and Installation Plan).	DML Condition - Cable Specification and Installation Plan
CO32	Installation of cable ducts at crossings of Environment Agency Main Rivers will be undertaken using trenchless installation techniques. Installation of cable ducts at crossings of Beverley and North Holderness Internal Drainage Board (IDB) maintained drains will be undertaken using trenchless installation techniques unless agreed otherwise.	DCO Requirement - Code of Construction Practice
CO33	At trenchless crossings of Environment Agency Main Rivers, crossing entry and exit points will be located at least 20m from the bank of the Main River or the nearest landward toe of any associated flood defence structure.	DCO Requirement - Code of Construction Practice

Commitment ID	Proposed Design Commitment	How the Design Commitment will be Secured
	At trenchless crossings of Internal Drainage Board maintained drains and where trenchless techniques are proposed for other ordinary watercourses, crossing entry and exit points will be located at least 9m from the bank of the drain or watercourse.	
CO35	A Watercourse Crossing Method Statement (WCMS) will be provided as part of the Code of Construction Practice (CoCP). The WCMS will be developed in accordance with the Outline CoCP and will include details of the crossing technique and construction methodology to be undertaken at each crossing and associated environmental mitigation measures. Where open cut trenching is proposed for ordinary watercourses, temporary measures to maintain the flow of water and mitigate adverse effects on the watercourse and flood risk will be implemented during construction. Where the Environment Agency's Main Rivers are to be crossed by temporary haul roads, bailey or similar clear span bridges will be used. For other watercourses, temporary culverts with an overlying haul road will be used where existing access is not available and where temporary bridges are not practicable. Temporary culverts will be adequately sized to avoid impounding flows (including appropriate climate change allowances), and the invert set below the bed level to allow bedload transport.	DCO Requirement - Code of Construction Practice
CO36	Onshore export cables will be installed at a minimum depth of 2m (to the top of the duct / cable or otherwise) below the channel bed of watercourses, including the landward toe of any associated flood defences. The final depth at each watercourse crossing will be dependent on local geology and geomorphology risks and will take into consideration anticipated climate change-related changes in fluvial flows and erosion that may occur over time. Crossing-specific vertical clearance depth will be agreed with the relevant authorities through the Watercourse Crossing Method Statement (WCMS).	DCO Requirement - Code of Construction Practice
CO37	With the exception of watercourse crossings, onshore export cable installation works will be located at a minimum of 6m from the outside edge of any pipe which is forming a culverted Internal Drainage Board (IDB) maintained drain where practicable. Where works are required within 6m, this will be agreed with the Beverley and North Holderness IDB prior to the commencement of the relevant works to ensure access to the IDB's assets is maintained during construction.	DCO Requirement - Code of Construction Practice
CO38	A Drilling Fluid Breakout Management Plan will be provided as part of the Code of Construction Practice (CoCP). The Drilling Fluid Breakout Management Plan will be developed in accordance with the Outline CoCP and will detail mitigation measures to reduce the risk of fluid breakouts during trenchless installation works and a response plan should a fluid breakout occur.	DCO Requirement - Code of Construction Practice
CO41	To protect groundwater bodies, the depth of excavation works will be kept as shallow as possible in line with construction and operational requirements. The target burial depth of onshore export cables will be approximately 1.2m to the top of the installed cable ducts, except where trenchless installation techniques are used or where deeper burial depth would be required due to other restrictions such as interactions with surface and buried infrastructure and landowner requirements.	DCO Requirement - Code of Construction Practice
CO58	Crossings of and construction in proximity to third-party assets will be undertaken in line with the latest relevant guidance. The crossing / construction methodology will be agreed with the relevant asset owner / operator prior to the commencement of the relevant construction works. Crossing and proximity agreements with existing pipeline and cables owner / operators will be sought.	DCO Requirement - Code of Construction Practice
CO60	All onshore export cables will be buried underground for the entire length of the cable corridor. No overhead pylons will be installed as part of the consented works.	DCO Works
CO61	Jointing bays along the onshore export cable corridor and the transition joint bay (TJB) at landfall will be buried underground, with the land above reinstated, except where access will be required to underground link boxes via manhole cover at ground level and where link boxes in proximity to jointing bays are installed above-ground.	DCO Requirement - Detailed Design (Onshore)
CO63	Detailed design of infrastructure in the Onshore Converter Station (OCS) zone will be developed in accordance with the Design Vision. The Design Vision submitted as part of the application for development consent will set out design principles to ensure good design with respect to aesthetic, functionality and sustainability considerations.	DCO Requirement - Detailed Design (Onshore)
CO66	Operational lighting (with the exception of low-level, motion-sensor security lighting) at the Onshore Converter Station (OCS) zone will only operate when required for operation and maintenance (O&M) activities during low light conditions. Any operational lighting will be designed in accordance with the latest relevant guidance and legislation and to minimise light spill. Details of the location, height, design and luminance of operational lighting to be used will be provided as part of the detailed design.	DCO Requirement - Detailed Design (Onshore)

Commitment ID	Proposed Design Commitment	How the Design Commitment will be Secured
CO72	Temporary access points off the public highway will be installed to facilitate vehicular access from the road to temporary works areas for construction. The access points will be constructed prior to the main construction activities for each stage of construction works and in accordance with the principles established in the Outline Construction Traffic Management Plan (CTMP).	DCO Requirement - Construction Traffic Management Plan DCO Requirement - Code of Construction Practice
CO75	Routeing of construction Heavy Goods Vehicles (HGV) and employee traffic will be directed to and managed at temporary construction compounds where possible to reduce vehicle movements on the public highway network. Onwards travel to the works site will be via the installed temporary haul roads to reduce the number of access points required and construction vehicle movements along the public highway network.	DCO Requirement - Construction Traffic Management Plan
CO76	Temporary construction compounds will utilise the most suitable roads as access points and be located close to main A roads and away from population centres where practicable to minimise impacts on local communities.	DCO Requirement - Construction Traffic Management Plan
CO77	To avoid disruption to transport users of road and rail infrastructure from the installation of cable ducts during construction, trenchless installation techniques will be used for all A and B roads, the Hull-Scarborough railway line and the following local roads: Dunnington Lane, Grange Road, Frodingham Road, Hempholme Lane, Scorborough Lane, Leconfield Road, Finchcroft Lane, Little Weighton Road, Walkington Heads and Risby Lane.	DCO Works DCO Requirement - Construction Traffic Management Plan
CO83	To avoid direct impacts to Local Wildlife Sites (LWS) from the installation of cable ducts during construction, micro-siting or trenchless installation techniques will be used where reasonably practicable. Where direct impacts cannot be avoided, bespoke mitigation will be agreed with the relevant authorities where required.	DCO Requirement - Ecological Management Plan DCO Requirement - Code of Construction Practice
CO100	All areas of land temporarily disturbed during construction in the Onshore Development Area, including any temporary construction compounds and haul roads, will be reinstated to pre-existing conditions as far as reasonably practicable. Reinstatement will commence as soon as practicable following completion of the relevant works in the area. In areas of agricultural cropland where temporary loss or disturbance is required, soils will be reinstated within no more than 24 months, wherever practicable and unless otherwise requested by the relevant landowners.	DCO Requirement - Landscape Management Plan DCO Requirement - Ecological Management Plan DCO Requirement - Code of Construction Practice
CO101	Reinstatement of cable trenches, haul roads and other land temporarily disturbed within the onshore export cable corridor will commence as soon as reasonably practicable following the completion of duct installation works in each section. Where access is required to be retained for cable pull-in, jointing and commissioning works, land will be reinstated following the completion of all onshore export cable construction activities.	DCO Requirement - Landscape Management Plan DCO Requirement - Ecological Management Plan DCO Requirement - Code of Construction Practice
CO104	Crossing ID WX-29 as listed within the Onshore Crossing Schedule located in the vicinity of the Hempholme Pumping Station will be installed using trenchless techniques. The crossing will be a minimum 30m from the sheet piles, located to the south of the Hempholme Pumping Station. The cables will be installed at a minimum depth of 5m below the bed level of Mickley Dike and the flood defence structures.	DCO Works DCO Requirement - Code of Construction Practice
CO110	Where agreed with the relevant landowners and subject to detailed design and construction requirements, link boxes along the onshore export cable corridor and at the landfall will be located at or as close to field boundaries as reasonably practicable.	DCO Requirement - Detailed Design (Onshore)

4.7 Construction Programme

46. An indicative construction programme for the Project is presented in **Plate 4-2.** The programme includes indicative timescales for offshore, landfall and onshore construction activities, including the commissioning works. The programme illustrates the anticipated duration of the key construction activities, with an estimated total construction duration of five years. Should the DCO be granted in 2028, the earliest construction start year is anticipated to be 2029, with first power scheduled for 2032 and the Project becoming fully operational in 2033.

47. The construction programme is dependent on several factors that may be subject to change such as the grid connection timeline agreed with National Grid, consenting timeframe, funding mechanisms, the lead-in times associated with detailed design and procurement activities, and site and weather conditions during construction. Therefore, details within the construction programme are indicative at this stage and provided as a reasonable basis to inform the EIA. Further details on the specific timescales included within the technical assessments are set out within the chapters of the PEIR.

48. Construction working hours for offshore activities (including any activities in the intertidal zone) are assumed to be 24 hours a day and seven days a week. However, a seasonal restriction is proposed so far as feasible in relation to vessel movements within the Greater Wash SPA to avoid potentially significant impacts to red-throated divers.

49. Core construction working hours for onshore activities are 07:00 to 19:00 hours Monday to Saturday. Vehicle movements on the public highway network and employees' arrival and departure to / from site may occur outside of the core working hours. Onshore construction activities will not take place on Sunday, bank holidays or outside core working hours, except in the following circumstances:

- Where extended and continuous periods (up to 24 hours a day, seven days a week) of working are required such as trenchless installation works, concrete pouring and cable pull-in and jointing operations;
- Deliveries of abnormal indivisible loads that may otherwise cause congestions on the public highway network;
- Testing and commissioning of installed onshore electrical infrastructure;
- Daily start-ups and shut-downs, limited to site inspections, housekeeping and safety checks;
- Emergency works; and
- Works as otherwise agreed in writing with the relevant local authority.

50. Further details of onshore construction timings are provided in the **Outline Code of Construction Practice** (document reference 8.9) provided with the PEIR.

Plate 4-2 Indicative Project Construction Programme

4.8 Offshore Components

4.8.1 Wind Turbine Parameters and Installation

51. The Project Design Envelope includes a range of turbine options to reflct the ongoing evolution of wind turbine technology. The wind turbine model will be selected post consent based upon the options available prior to construction and to ensure the most economic option is selected. This section therefore sets maximum (and minimum, where appropriate) worst-case parameters that are carried forward into the relevant chapters. The wind turbine parameters, which form part of the Project Design Envelope, are summarised in **Table 4-2**.

52. The conventional three-bladed horizontal-axis wind turbines, which will be selected by the Project, include the following key components (see **Plate 4-3**):

- Rotor (comprising three wind turbine blades and a hub to connect the three blades to the rest of the turbine);
- Nacelle housing the electrical generator, gearbox and the control electronics; and
- Tower, consisting of a tubular steel structure affixed to the wind turbine foundation.

Table 4-2 Project Design Envelope - Wind Turbines Parameters

Parameter	Value
Maximum number of turbines	113
Minimum rotor diameter (m)	236
Maximum rotor diameter (m)	337
Minimum lower blade tip height above Lowest Astronomical Tide (LAT) (m)	27.96
Maximum blade tip height above Highest Astronomical Tide (HAT) (m)	370
Maximum hub height above HAT (m)	201.5

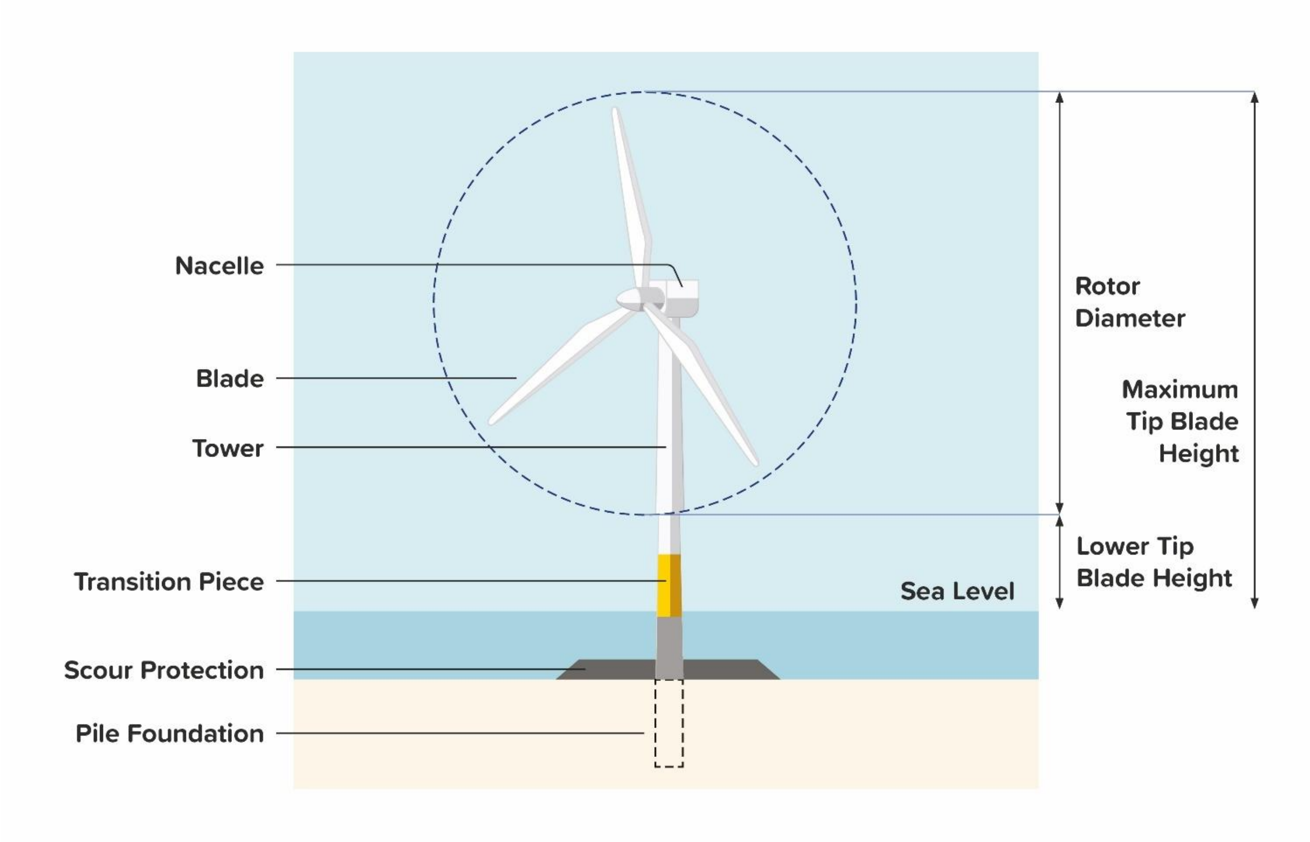

Plate 4-3 Indicative Wind Turbine Schematic

4.8.1.1 Wind Turbine Layout

53. The final wind turbine layout will not be determined until the post-consent phase, taking into account several parameters such as ground conditions, wind resource and the size of the wind turbine that is selected for construction. Factors such as Search and Rescue (SAR) considerations (CO7 in **Table 4-1**), as well as supply chain and market conditions will also influence the eventual layout of the Array Area, therefore a final layout will not be submitted with this PEIR chapter, nor with the DCO application.

54. An outline layout is provided in the relevant chapters based upon a minimum wind turbine separation distance of 3.5 times the rotor diameter (1,416m for the largest turbine option and 826m for the smallest turbine option). The outline layout includes the maximum number of smaller turbines in these chapters, as it is considered that this represents the greater environmental effect of more structures in the Array Area.

4.8.1.2 Wind Turbine Foundations

55. The wind turbine foundation type(s) selected will ultimately depend on the final detailed site investigations, engineering design studies and the procurement process. At this stage, the following options are being considered based upon what is currently known about the site conditions:

- Monopiles;
- Piled jackets; and
- Suction bucket jackets.

56. The final foundation type that is selected will be fabricated offsite and stored at a suitable port facility where they will be loaded onto a suitable installation vessel or barge and transported to the Array Area.

4.8.1.2.1 Monopiles

57. Monopile foundations typically consist of a single tubular piece, formed out of a number of rolled steel plates welded together, that is driven into the seabed by impact piling or vibro-piling. The assessments of effects for disturbance from piling at the Project will be undertaken assuming the use of noise reduction technology at the ES stage, assuming that monopiles remain within the project design and a significant effect is predicted. Updated guidelines will be taken into account regarding the use of noise reduction at the time of DCO submission. In areas of firmer ground conditions drilling of the seabed may be required prior to piling. This is only considered for the installation of monopile foundations in the assessment as it provides the worst-case assessment in terms of drill arisings. The drill arisings (spoil) would be disposed of adjacent to the foundation location, from a vessel pipe that would be above or slightly below the sea surface. At the point of disposal, the spoil will be expected to settle onto the seabed in the immediate vicinity of each foundation (see **Chapter 8 Marine Physical Processes** for further details).

58. A separate transition piece (TP) is typically fitted on top of the monopile via a bolted or grouted connection which will include ladders, a boat landing feature, a small crane and a flange for connection to the wind turbine tower. However, recently there have been a number of projects using TP-less monopiles that have this additional infrastructure embedded into the monopile itself.

59. The monopile foundation parameters, which form part of the Project Design Envelope, are presented in **Table 4-3** and indicated on **Plate 4-4**.

Table 4-3 Project Design Envelope - Monopile Wind Turbine Foundations Parameters

Parameter	Value
Diameter of monopile at seabed (m)	18
Maximum column diameter (m)	18.5
Maximum hammer energy required for piling (kJ)	8,000
Pile penetration depth below seabed (m)	60
Drilling (if required)	
Percentage of locations to be drilled	50
Drill diameter (m)	18
Volume of drill arisings per pile (m^3)	15,270
Total volume of drill arisings (m^3)	870,390

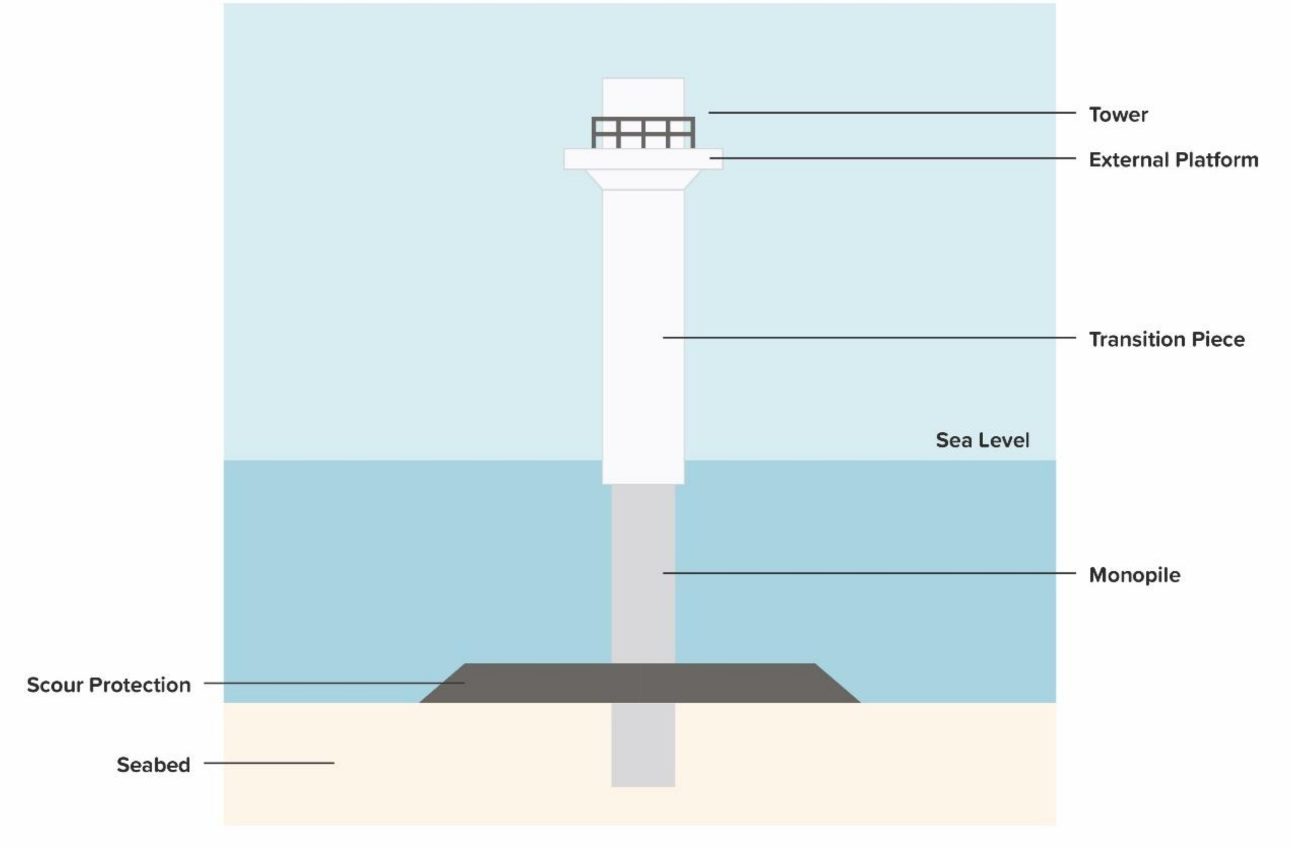

Plate 4-4 Indicative Monopile Foundation Schematic

4.8.1.2.2 Piled Jackets

60. Piled jacket foundations are formed of a tubular steel pieces welded into a lattice that are then fastened to the seabed with steel pin-piles that are piled through the legs of the jacket. The pin-piles are connected to the jacket legs via a grouted or deformed connection. Unlike monopiles, there is no separate TP that is affixed onto the top of a piled jacket foundation as the TP and ancillary infrastructure is embedded into the design of the jacket.

61. The installation process typically comprises the following stages:

- A piling template is placed on the seabed;
- Piles are installed;
- The piling templates are recovered for re-use; and
- Jackets are then lowered onto the piles.
- Jacket secured to piles, typically via grouted connection.

Or:

- Jackets are lowered onto the seabed;
- Piles are installed through jacket legs or pile sleeves; and
- Jacket secured to piles, typically via grouted connection.

62. Pin-pile installation methodology is similar to that used for monopiles and, depending on approach, will take approximately 24 hours for the piling operations and then approximately another 24 hours for the jacket installation and the grouting. Although it is possible that drilling may be required for piled jackets, the volume of drill arisings will be less than that for monopile foundations above and is therefore not considered here.

63. The parameters for the piled jacket foundations, which form part of the Project Design Envelope, are presented in **Table 4-4** and indicated on **Plate 4-5**.

Table 4-4 Project Design Envelope - Piled Jacket Wind Turbine Foundations

Parameter	Value
Number of legs per foundation	4
Number of pin-piles per leg	2
Number of pin-piles per foundation	8
Maximum pin-pile diameter (m)	5
Maximum hammer energy required for piling (kJ)	5,000
Maximum pile penetration depth below seabed (m)	80

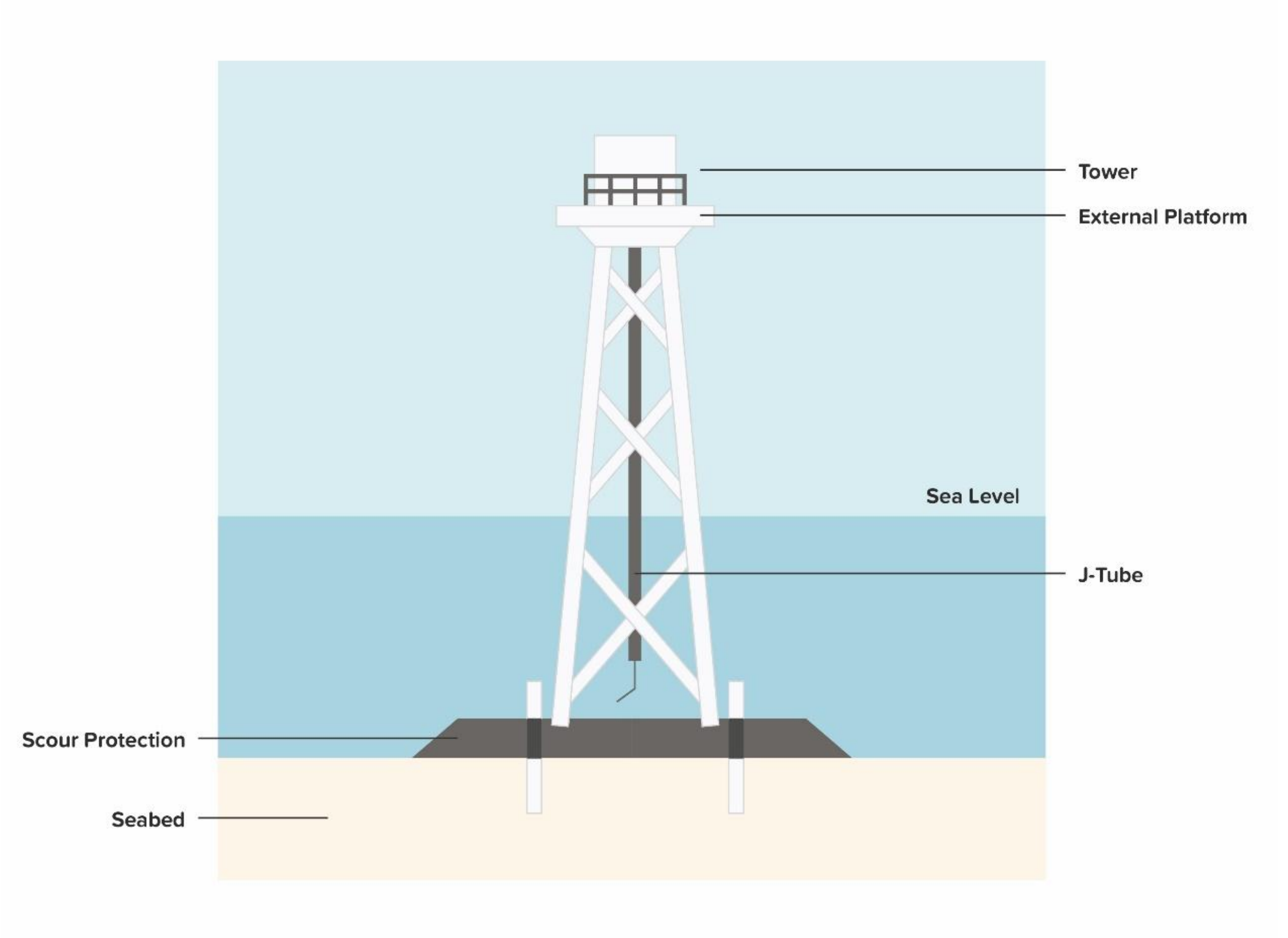

Plate 4-5 Indicative Piled Jacket Foundation Schematic

4.8.1.2.3 Suspension Bucket Foundations

64. Multi-leg suction bucket foundations are similar in design to the multi-leg piled jacket foundations, discussed in **Section 4.8.1.2.2**, as both feature a steel lattice structure. However, unlike the piled jacket foundations, the suction bucket foundations are not secured to the seabed through piling. Instead, they use multiple suction buckets that are embedded into the seabed by creating a negative pressure through pumping water out from inside the bucket. The difference in pressure pushes the bucket into the seabed, creating a seal. Pumping is ceased once the buckets' reach the desired depth.

65. Targeted seabed levelling will be required for suction bucket foundations to ensure that all of the buckets are placed onto the seabed at the same level.

66. The installation process typically comprises the following stages:

- The jacket is lowered onto the seabed;
- Water is pumped from the bucket(s); and

- At the desired depth, the pump is turned off.

67. A single suction bucket jacket installation is expected to take approximately 24 hours, on average, from vessel arrival to vessel departure, assuming no weather delays. The suction jacket foundation piling foundation parameters, which form part of the Project Design Envelope, are presented in **Table 4-5** and indicated on **Plate 4-6.**

Table 4-5 Project Design Envelope - Suction Bucket Wind Turbine Foundations

Parameter	Value
Maximum number of legs (buckets) per foundation	4
Suction bucket diameter (m)	18.75
Suction bucket penetration depth below seabed (m)	17.5

68. Monosuction bucket foundations which utilise a single bucket per foundation are not being taken forward for the Project.

4.8.1.3 Wind Turbine Installation

69. A detailed wind turbine installation procedure will be provided prior to construction. However, it is likely that the installation sequence will generally adhere to the conventional method listed below (details of the installation works specifically related to the foundations are given in **Section 4.8.1.2**):

- The wind turbine components (blades, pre-assembled nacelle and tower) will be loaded onto a suitable wind turbine installation vessel at the marshalling port (likely to be within the UK or Europe);
- The installation vessel will transit to the Array Area where the components will be individually lifted via a crane onto the pre-installed foundation and transition piece. The tower will be installed first, after which the nacelle is placed on top. The hub is then rotated to allow the blades to be installed individually onto the hub. Technicians will fasten components in place once they are assembled. The installation vessel will typically use jack-up legs or dynamic positioning to ensure it is stable during the installation sequence;

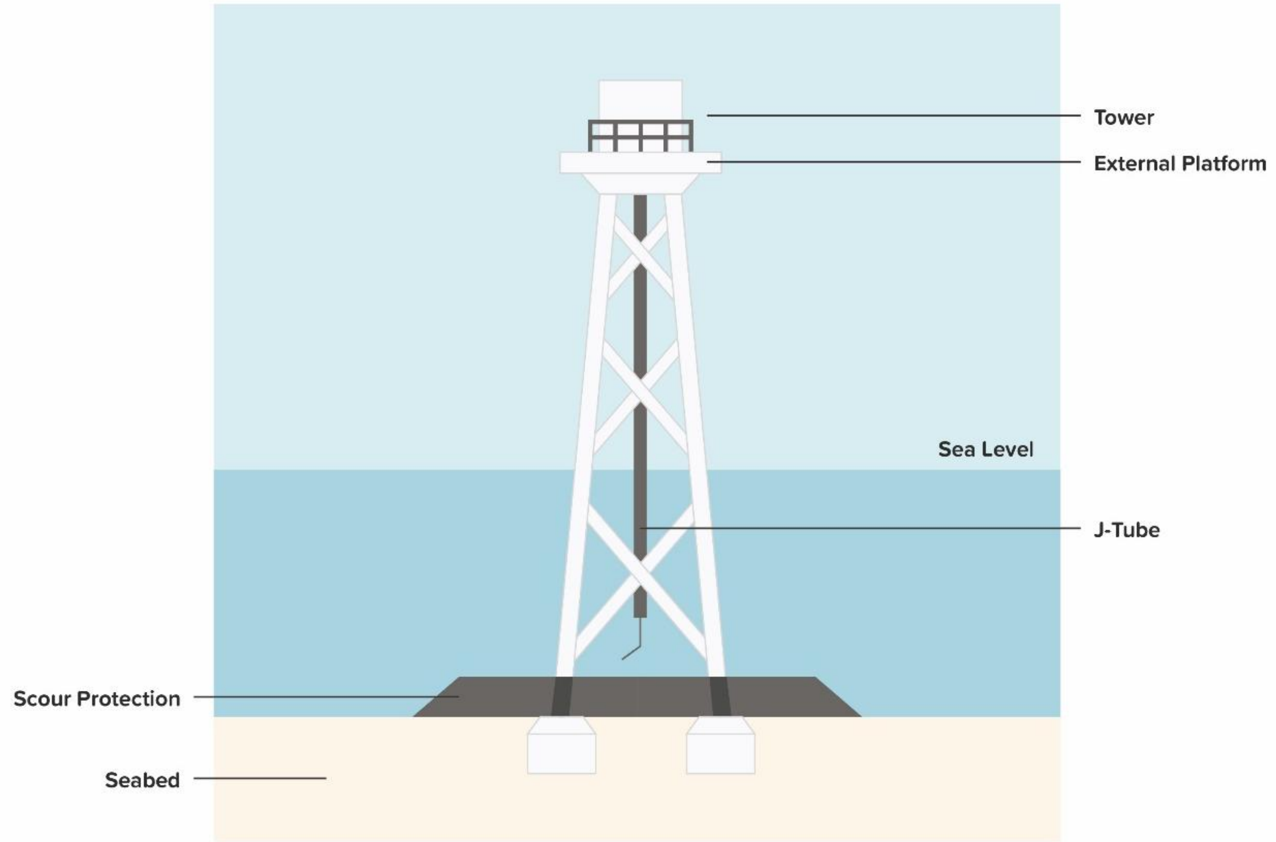

Plate 4-6 Indicative Suction Bucket Foundation Schematic

- Alternatively, the wind turbine components may be loaded onto barges or dedicated transport vessels at the marshalling port and installed by an installation vessel that remains on site throughout the installation campaign; and
- Once the wind turbine is assembled or a string of turbines, cable connections and offshore commissioning can commence.

70. Each installation vessel or barge may be assisted by a range of support vessels. These are typically smaller vessels such as tugs, guard vessels, anchor handling vessels, or similar. It is assumed that these vessels will make the same general movements to and from around the wind farm area as the installation vessels they are supporting. See **Section 4.8.9** for further details of vessel types, numbers, and movements.

4.8.2 Offshore Platform(s) Parameters and Installation

71. The offshore platform(s) are structures that will collect the electricity from the turbines and house electrical equipment that supports critical functions to maximise the efficiency of transmission. This will include changing the voltage (transformer) and type of current (converter). The Project will include up to two offshore platforms, with one serving as the primary platform for onwards transmission to the UK grid connection point. This primary platform will contain the following key infrastructure:

- Transformers;
- Switchgear;
- Valves;
- DC disconnector;
- Other electrical power systems;
- Instruments, meters and control systems;
- Auxiliary power system;
- Navigation, aviation, and safety marking and lighting;
- Storage; and
- Cranes.

72. The second offshore platform will be used as a switching station for the purposes of facilitating coordination with an interconnector cable, if taken forward (as discussed in **Section 4.1**). It will operate at a single voltage to collect the electricity from multiple sources. This switching station will facilitate the interconnection of the transmission system of the DBD windfarm to a potential secondary connection point, in addition to the existing connection into the UK grid. However, the connection between the Switching Station to the secondary connection point is not included in this DCO application.

73. The offshore platform(s) will be located within the Array Area with the specific location to be confirmed post-consent following further detailed site investigations. The platform(s) will not be permanently manned but during the operation and maintenance phase they will receive periodic visits from staff via boat or helicopter.

74. At this stage the exact parameters of the offshore platform(s) are not known, however, if two platforms are taken forward it is considered that the parameters of each platform will be smaller than if one larger platform is taken forward.

75. Indicative offshore platform parameters which form part of the Project Design Envelope for Offshore Platform(s) are provided in **Table 4-6**. It is noted that a single large or two small platforms are mutually exclusive.

Table 4-6 Project Design Envelope - Offshore Platform(s) Topside

Parameter	Value	
	Two platforms (per platform)	**One platform**
Indicative topside length (m)	75	125
Indicative topside width (m)	60	90
Indicative topside height (m above LAT)	50	65
Indicative topside footprint (m^2)	4,500	11,250

4.8.2.1 Offshore Platform(s) Foundations

76. The offshore platform topside will be installed upon a foundation(s) that is attached to the seabed. As with the wind turbine foundations, a number of options are being considered at this stage, listed below:

- Monopiles;
- Piled jacket foundation;
- Suction bucket foundation;
- Gravity base foundation; and
- Arup Concept Elevating (ACE) platform.

77. Monopile, piled jacket and suction bucket foundations are all also considered for the wind turbine foundations, full details on the design of these foundations are provided in **Section 4.8.1.2**.

78. The offshore platforms differ in size and function to the wind turbines, as such the maximum design parameters for their foundations are not the same as those for the wind turbine foundations. The project design envelopes for monopile, piled jacket and suction bucket foundations to support the offshore platform(s) are listed in **Table 4-7**, **Table 4-8**, and **Table 4-9**, respectively.

Table 4-7 Project Design Envelope - Offshore Platform(s) Monopile Foundations

Parameter	Value	
	Two Platforms	One Platform
Number of monopiles	12 (2 platforms of 6 monopiles each)	10
Diameter of monopile at seabed (m)	18	
Maximum column diameter (m)	18	
Maximum hammer energy required for piling (kJ)	8,000	
Pile penetration depth below seabed (m)	100	
Drilling (if required)		
% of locations to be drilled	50	
Drill diameter (m)	15	
Volume of drill arisings per pile (m^3)	17,670	
Total volume of drill arisings (m^3)	106,020 (6 monopiles)	

Table 4-8 Project Design Envelope - Offshore Platform(s) Piled Jacket Foundations

Parameter	Value	
	Smaller Design	Larger Design
Number of legs per foundation	8	20
Number of pin-piles per leg	4	
Number of pin-piles per foundation	24	60
Maximum pin-pile diameter (m)	5	
Maximum hammer energy required for piling (kJ)	5,000	
Maximum pile penetration depth below seabed (m)	100	

Table 4-9 Project Design Envelope - Offshore Platform(s) Suction Bucket Foundations

Parameter	Value	
	Smaller Design	Larger Design
Maximum number of legs (buckets) per foundation	8	20
Suction bucket diameter (m)	20	
Suction bucket penetration depth below seabed (m)	20	
Suction bucket height above seabed (m)	10	

4.8.2.1.1 Gravity Base Foundations

79. Gravity base foundations are concrete or steel structures that are floated or transported by barge to site and then ballasted when in the correct location and deposited onto the seabed. This foundation type is stable by way of its sheer weight. They vary in shape but typically consist of a wide base footprint to provide stability, with a number of columns rising through the water column and splash zone to provide support to the topsides at the defined interface level. The Project Design Envelope for gravity base foundations for the offshore platform(s) is provided in **Table 4-10** and indicated on **Plate 4-7**.

Table 4-10 Project Design Envelope - Offshore Platform(s) Gravity Base Foundations

Parameter	Value	
	Smaller Design	Larger Design
Number of legs per foundation in the water column	6	
Diameter of legs (m)	15	18
Dimension of base on seabed (m)	60 x 60	90 x 90
Height of base off seabed (m)	15	

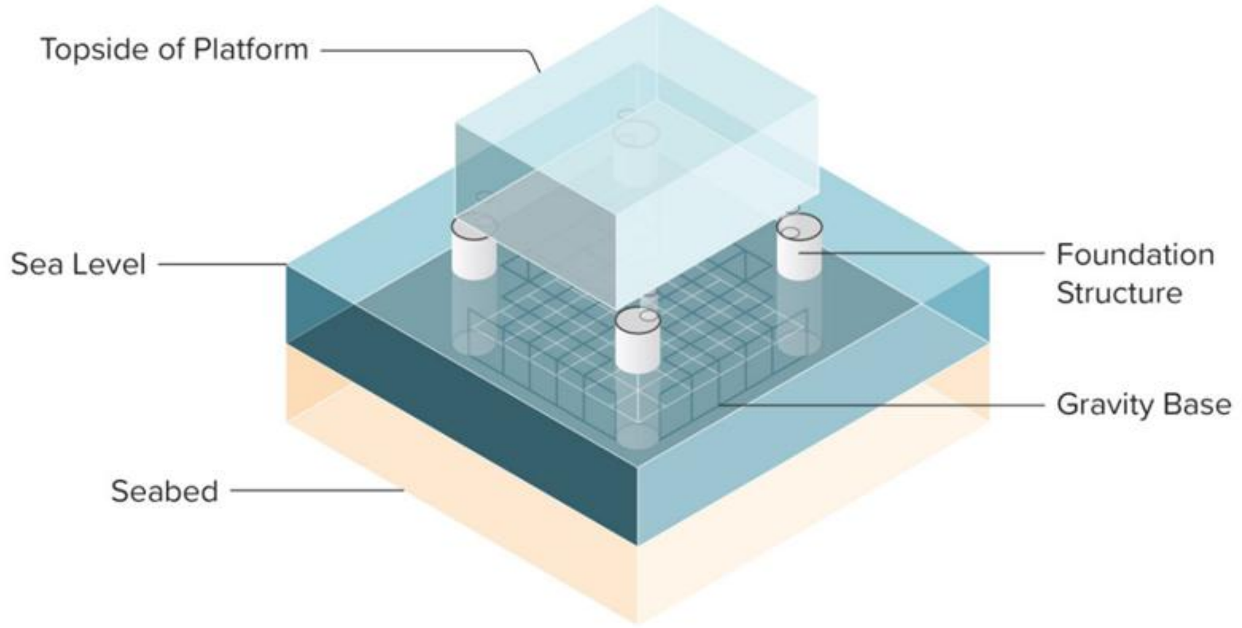

Plate 4-7 Indicative Gravity Base Foundation Schematic

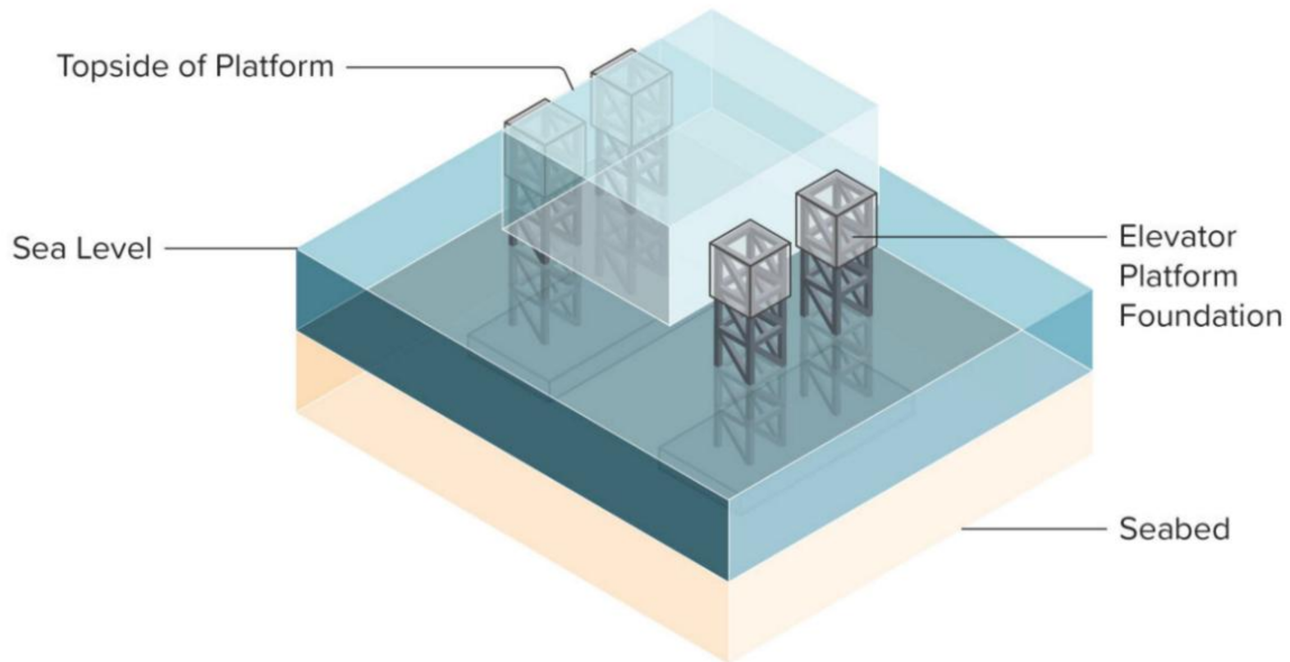

Plate 4-8 Indicative Arup Concept Elevating Platform Foundation Schematic

4.8.2.1.2 Arup Concept Elevating Platform

80. The Arup Concept Elevating (ACE) platform is a self-installing fixed design for offshore platforms, consisting of a jack-up leg system that is integrated with the topsides with lattice legs that can be lowered onto the seabed where skirts penetrate the upper sediments and are secured via suction. The lattice legs are based on a jack-up design, with the jacking facilities separate from the legs as a centre-hole strand-jacking system commonly used on land for heavy lift operations. The suction skirt design provides the stability for the platform without the requirement for any piling work. The Project Design Envelope for ACE foundations for the offshore platform(s) is provided in **Table 4-11** and indicated on **Plate 4-8**.

Table 4-11 Project Design Envelope - Offshore Platform(s) ACE Foundations

Parameter	Value	
	Smaller Design	Larger Design
Maximum number of legs per foundation	4	6
Footprint of lattice leg (m)	16 x 16	
Footing footprint on seabed (m x m)	32 x 32	
Seabed penetration of footprint (m)	6	
Total height of concrete footing (m)	7	

4.8.2.2 Offshore Platform Installation

81. Depending on the exact configuration of the foundation design and scale of the topsides, the topsides will either be installed via an offshore lift (a), or a "float-through" approach (b).

a. The offshore lift is the standard method of installing topsides onto foundations where the mass and dimensions are within the capabilities of available heavy lift vessels (HLVs). The topside is transported to the offshore site by barge where the HLV lifts the structure from the barge and over the foundations. The topside is then lowered onto the foundation with an arrangement of bumpers and guides providing alignment with interface positions before final set-down. The topside is then secured to the foundation via bolted or welded connections.

b. The float-through approach will be used where the topsides mass or dimensions exceed the capacity of available HLVs. The foundation will be designed for sufficient available draft and column spacing to allow a transport vessel to pass through the foundation with the topside on board. The vessel is then ballasted to lower the topside on to the interface points, where an arrangement of guides will ensure alignment, following this, the topsides would be secured to the foundation via bolted or welded connections.

82. The ACE platforms are designed and fabricated as an integrated topsides and foundation solution. These components will therefore be fabricated as-one onshore, which simplifies the offshore installation process as the structure can be floated out to the required position where the jacket legs are lowered to interface with the seabed and subsequently lift the topsides to the required elevation where it is secured.

4.8.3 Pre-Installation Foundation Works for Wind Turbines and Offshore Platforms

83. Prior to commencement of installation activities, surveys will be undertaken to confirm that the seabed is clear of any obstructions (including archaeological, benthic, and unexploded ordnance (UXO)) in order to inform micro-siting of infrastructure, clearance operations, and seabed preparation to avoid potentially sensitive (or dangerous) receptors. The pre-construction surveys will also be designed for environmental monitoring purposes.

84. Depending on the type of foundations selected for the wind turbines and the offshore platform(s), some degree of seabed preparation (e.g. UXO, boulder and sandwave clearance) may be required to provide a level surface upon which the foundation will be installed, or to deposit scour protection to protect the structural integrity of the foundation during operations. The following sections describe the Project Design Envelope in relation to these ancillary works to the foundations.

4.8.3.1 Unexploded Ordnance

85. UXO clearance may be required for foundation and cable installation (see **Section 4.8.7**).

86. The North Sea is heavily littered with UXO from World War I and World War II, and it is common to encounter these during surveys and construction. UXO pose a risk to health and safety where they coincide with locations of planned infrastructure and vessel activity, and therefore a strict approach to identify and, if required, dispose of UXO must be adhered to. If UXO are confirmed, the hierarchy to manage the risk is: first, avoid them entirely; second, remove them (commonly referred to as 'lift and shift'); and as a last resort, detonate them in situ.

87. At this stage of the Project, it is not possible to determine if any UXO would be present in the Offshore Development Area, nor how many UXO would require detonation. The results of the pre-construction geophysical survey will be analysed by an appropriate UXO contractor or consultant to determine a list of potential UXO targets for investigation. A UXO identification survey (often combined with an archaeological Remotely Operated Vehicle (ROV) survey) will then be undertaken prior to construction to ascertain whether any of the potential UXOs can be confirmed as such. This UXO identification and clearance procedure will be subject to individual Marine Licence application(s) upon receipt of the target list from the UXO specialist in the post-consent phase.

4.8.3.2 Dredging

88. Some of the foundation types will require levelling and dredging of the soft mobile sediments. It is likely that dredging will not be required for monopile and piled jacket foundations as they do not necessarily rely on a completely level seabed. However, suction bucket and gravity base (which includes ACE) foundations will require a level seabed to ensure the stability of the foundation.

89. If suction bucket or gravity base foundations are selected, vessels such as a Trailing Suction Hopper Dredger will be used to remove the required amount of sediment to level the seabed. The spoil will likely be side-cast adjacent to the foundation locations. In some cases, it may be necessary to place a layer of gravel on the seabed prior to the installation of gravity base foundations.

4.8.3.3 Scour Protection

90. Scour is a hydrodynamic process which results in seabed erosion and subsequent ‘scour hole’ formation around wind turbines and offshore platform(s) foundations and may compromise the structural integrity of the structures over time. Scour protection is the primary mitigative measure to prevent this from occurring and involves the deposit of a material around the foundation to protect the seabed around the structure.

91. Several types of scour protection exist, including (but not exclusively); mattress protection, sand bags, rock bags, and flow modifiers. However, the most common method of scour protection involves the deposit of large quantities of rock placement around the foundation base.

92. The full method of scour protection installation will be decided post-consent. However, a typical approach is to deposit a layer of small rocks (the filter layer) where the foundation will be, and to install the foundation on or through the filter layer. Afterwards, a layer of larger, higher graded rock is deposited on top (the armour layer) to protect the seabed at the foundation base. The filter layer can also be laid after the foundation has been installed and it is possible to avoid two layers by using a heavier rock material with a wider gradation.

93. The quantity of scour protection required for the Project will vary depending on the foundation types that are selected for the wind turbines and the offshore platform(s). The project design envelopes per wind turbine and offshore platform foundation are provided in **Table 4-12** and **Table 4-13**, respectively. Note the worst-case foundation types are suction bucket for wind turbines and monopiles for offshore platform(s).

Table 4-12 Project Design Envelope - Scour Protection around Wind Turbine Foundations

Parameter	Value		
	Monopiles	Piled Jacket	Suction Bucket
Total scour protection area including structure footprint (m^2)	556,751	784,220	1,617,482
Total scour protection volume (m^3)	962,195	1,012,480	4,043,705

Table 4-13 Project Design Envelope - Scour Protection around Offshore Platform(s) Foundations

Parameter	Value				
	Monopiles	Piled Jacket	Suction Bucket	Gravity Base	ACE
Total scour protection area including structure footprint (m^2)	50,000	20,000	44,000	30,000	18,000
Total scour protection volume (m^3)	75,000	30,000	60,000	40,000	10,000

4.8.4 Aids to Navigation, Lighting and Colour Scheme

94. The Project will be designed and constructed in compliance with the requirements of the Civil Aviation Authority (CAA), Maritime and Coastguard Agency (MCA) and Trinity House (the General Lighthouse Authority) in respect to all aids to navigation. This includes the lighting and marking of all offshore structures above the sea surface. The location of all infrastructure will be submitted to the UK Hydrographic Office (UKHO) so that the Admiralty Charts can be updated accordingly (refer to the design commitments listed in **Table 4-1**).

95. Further details on aids to navigation and lighting can be found in **Chapter 15 Shipping and Navigation** and **Chapter 16 Aviation, Radar and Military**.

96. Throughout the construction phase, buoys will be used to mark the boundary of the Offshore Development Area (Commitment ID CO9). The extent of these will be confirmed with Trinity House prior to deployment.

97. The colour scheme of the wind turbines is typically off white to light grey, and the surface-piercing section of the foundation structures tend to be bright yellow, and will be confirmed until post-consent, ensuring compliance with MGN 654 (Commitment ID CO9).

4.8.5 Inter-Array Cables

98. Inter-array cables carry the High Voltage Alternating Current (HVAC) electricity generated from the individual turbines and link it to the offshore platform(s), where it is converted to High Voltage Direct Current (HVDC). The wind farm is typically designed so that a group of turbines can be linked together on the same cable 'string' to maximise the efficiency of the cabling network. It is assumed that, should inter-platform cabling be required to transmit electricity between two platforms, this is included within the definition and parameters of the inter-array cables.

99. The inter-array cables will consist of a number of cores, usually made from copper or aluminium, and a fibre optic cable, surrounded by layers of insulation material and armour to protect the cable from damage.

100. The Project Design Envelope for the inter-array cables is provided in **Table 4-14**.

Table 4-14 Project Design Envelope - Inter-Array Cables

Parameter	Value
System voltage (kV)	Up to 132
Total inter-array cable length (km)	400

4.8.6 Offshore Export Cables

101. Offshore export cables transmit the HVDC electricity generated by the wind farm from the offshore platform(s) to the landfall. They are typically larger in size than inter-array cables as they transport a larger amount of electricity. The design of the cables will be broadly similar to that of the inter-array cables (**Section 4.8.6**), although there will be up to two export cables to transmit the electricity and one fibre optic cable, which may also be bundled together with the export cable. The fibre optic cable enables the communication and transfer of data for monitoring of the cable condition.

102. Further information on buried and non-buried cables is provided in **Section 4.8.7.6** and **Section 4.8.7.7**. The Project Design Envelope for the offshore export cables is provided in **Table 4-15**.

Table 4-15 Project Design Envelope – Offshore Export Cables

Parameter	Value
Description of transmission configuration	Up to 2 HVDC cables, and 1 fibre optic cable
Number of trenches	2
HVDC cable voltage (kV)	Up to 500 kV
HVDC cable length (km)	800km (two cables in two trenches of 400km length)

4.8.7 Cable Installation Procedures

4.8.7.1 UXO Identification and Clearance

103. A description in relation to the identification and clearance of UXO is presented in **Section 4.8.3**.

4.8.7.2 Boulder Clearance

104. Geophysical surveys will be undertaken prior to construction. The results of these surveys will be analysed to assess the presence of boulders on the export cable and inter-array cable routes. It is not always possible to microsite around large boulder fields, they can cause cable exposure and cause damage to the cable installation equipment. Therefore, a boulder clearance campaign may be required, depending on the density of the boulders that are confirmed.

105. Boulders can be cleared through a variety of means, the most common of which is a grab tool mounted on a Remotely Operated Vehicle (ROV). However, in the event of a high-density boulder field, a clearance plough may also be used.

4.8.7.3 Sandwave Clearance

106. Sandwaves are mobile bedforms that are formed through marine processes, they may prevent the cable burial tools from operating efficiently or pose a risk of cable exposure. To prevent this from occurring, clearance of the sandwaves may be undertaken, allowing the cables to be buried below the level where natural sandwave movement occurs. This may also be a requirement for some foundation types, such as suction bucket or gravity base.

107. At this early stage, the Project is not currently able to define the extent, or lack thereof, of sandwaves in the Array Area or Offshore ECC. Assumptions have therefore been made about the amount of sandwave clearance that will be required relating to cable installation, with 100% of the offshore export cable assumed to required clearance within the Dogger Bank SAC, and 20% of the offshore export cable requiring clearance outside of the Dogger Bank SAC, although it is anticipated this will be refined for the ES upon receipt of more geophysical data. An indicative inter-array cable layout is not available for this PEIR submission, therefore sandwave clearance on the inter-array cabling has been considered qualitatively. Quantitative modelling and re-assessment will be included at the ES stage. The Project Design Envelope for sandwave clearance activities is provided in **Table 4-16**.

Table 4-16 Project Design Envelope - Sandwave Clearance

Parameter	Value
Offshore Export Cables	
Width of dredging corridor (m)	35
Sandwave clearance requirement (km)	230.4
Total cleared area (km^2)	8.064

4.8.7.4 Pre-Lay Grapnel Run

108. Following a pre-lay survey and potential boulder clearance works, a Pre-Lay Grapnel Run will be undertaken prior to cable laying operations to ensure the route is clear of obstructions such as discarded trawling gear or abandoned cables. A vessel will be mobilised with grapnels, chains, and recovery winch to undertake the works.

4.8.7.5 Out of Service Cable Removal

109. Where the export or inter-array cables cross out-of-service (OoS) cables, the OoS cable will be removed from the seabed prior to cable installation. It is likely the section of OoS cable intersecting with the ECC will be de-trenched, secured and cut and recovered to the vessel.

4.8.7.6 Cable Burial

110. Inter-array and offshore export cables will be buried beneath the seabed wherever possible. The full installation method and target burial depth will be defined post-consent based on a detailed cable burial risk assessment (Commitment ID CO24). Currently, pre-trenching (whereby the cable is laid after trenching has occurred), post-lay burial (whereby the cable is buried after it is laid on the seabed from a suitable cable lay vessel) and simultaneous lay and burial techniques are all options. The following burial methodologies are being considered for both cable types:

- Jet-trenching (jetting);
- Ploughing (jet assisted); and
- Mechanical trenching (mechanical cutting-jet assisted).

111. It may be the case that just one or a combination of the methodologies above are used for the Project. The Project Design Envelope for cable burial techniques is provided in **Table 4-17**, and details of the methods are in the following sub-sections.

Table 4-17 Project Design Envelope - Cable Burial Techniques

Parameter	Value		
	Jet-Trenching	Ploughing	Mechanical Trenching
Offshore Export Cables			
Target cable burial depth (m)	3.5		
Trench width (m)	5		
Width of disturbance (m)	15	15	15
Area of disturbance (km^2)	8.28	3.6	1.92
Inter-Array Cables			
Target cable burial depth (m)	3.5m		
Trench width (m)	5		
Width of disturbance (m)	10	15	10
Area of disturbance (km^2)	3.2	2.4	1.6

4.8.7.6.1 Jet-Trenching (Jetting)

112. This method involves using high-pressure water jets into the seabed to fluidise and displace the seabed sediment. It often forms a rectangular trench into which the cable will settle under its own weight. Jetting is suitable for use in sands and low to medium strength clays, but coarse gravels and high strength clays are likely to limit the performance of the tool. The cover is provided by means of natural backfill, and multiple passes may be required in order to achieve the target depth of lowering or depth of cover requirements.

4.8.7.6.2 Ploughing

113. This method uses a forward blade to cut through the seabed and displace the sediment to create a trench and is suitable for high strength clays. The cable can be laid into the trench for later backfilling or laid onto the seabed before being ploughed into position; however, simultaneous lay and burial is the most common approach.

4.8.7.6.3 Mechanical Trenching (Jet-Assisted)

114. This method involves the mechanical cutting of a trench whilst temporarily placing the excavated sediment adjacent to the trench. The cable is then laid, and the trench is backfilled using the sediment. This approach is most suitable for high strength cohesive clay sediments and weak rock, and significant quantities of sand and gravel are likely to hinder the performance of the tool as it relies on the ripping action of cohesive soils. The cutter is often fitted with a depressor which guides the cable through fluidised material.

4.8.7.7 Inter Array and Export Cable Protection

115. In some areas it may not be possible to achieve full burial of the cable for example, due to hard geology, dense boulder fields or cable crossings. In these instances, cables will be laid on the surface upon which cable protection will be installed to minimise the risk of snagging and other hazards. Cable protection will also likely be required where the inter-array cables enter the wind turbines and offshore export cables enter the offshore platform(s) via a J-tube. There will likely be a Cable Protection System (CPS) installed around the cable before it is pulled into the structures to protect it, although secondary protection may also be required.

116. Cable protection may consist of one or more of the following methods:

- Rock placement;
- Concrete mattresses;
- Rock bags;
- Flow dissipation devices; and
- Protection with cast iron shells.

117. Illustrations showing cable protection methodologies are shown in **Plate 4-9** and **Plate 4-10**.

118. The amount of cable protection that will be required will be determined upon further site investigations into the ground conditions, prior to construction. The assumed quantity required is based on 20% of the offshore export cable route (160km) and 10% of the inter-array cable (40km) requiring protection. The Project Design Envelope for inter-array and offshore export cable protection measures, excluding protection required at cable crossings or CPS, is provided in **Table 4-18**.

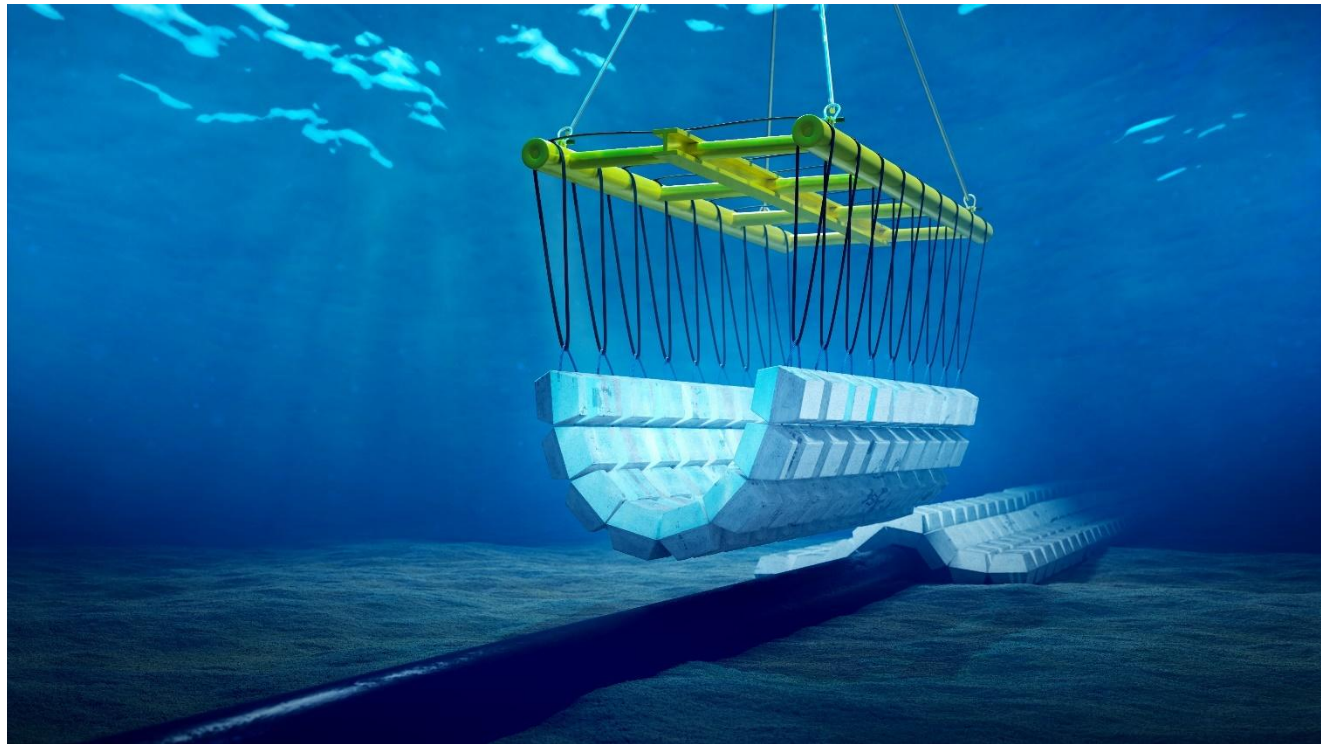

Plate 4-9 Cable Protection - Concrete Mattresses

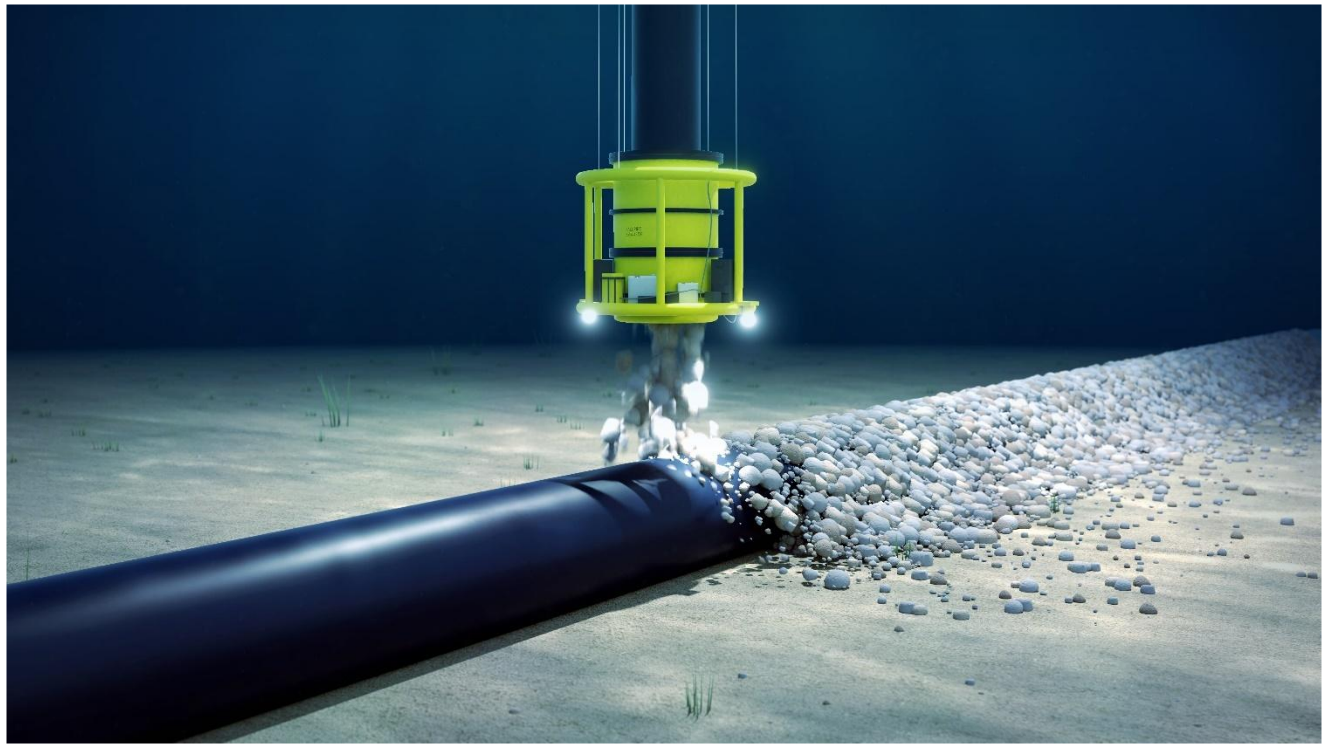

Plate 4-10 Cable Protection - Rock Placements

Table 4-18 Project Design Envelope - Cable Protection

Parameter	Value
Width of rock berm protection (m)	10
Height of rock berm protection (m)	1.5
Offshore Export Cables	
Total length of cables requiring protection (km)	160
Total footprint of protection (m^2)	1,600,000 (based on two trenches of 800,000m^2 each)
Total volume of protection (m^3)	1,320,000
Inter-Array Cables	
Total length of cables requiring protection (km)	40
Total footprint of protection (m^2)	400,000
Total volume of protection (m^3)	330,000

119. There are several existing cable and pipeline assets (and others planned) that cross the Offshore ECC. The crossing methodology and design will be confirmed post-consent in a proximity agreement with the asset owners; however, it is anticipated that pre-lay concrete mattresses would be used at crossings. Mattresses are expected to be 6m in length and 3m in width, laid lengthwise on the cable route and centred on the crossing point. No crossings with existing assets are anticipated with the inter-array cable route, but a maximum of five possible internal crossings with DBD assets have been considered.

120. The Project Design Envelope for cable and pipeline crossings is provided in **Table 4-19**.

Table 4-19 Project Design Envelope – Cable and Pipeline Crossings

Parameter	Value
Length of cable crossing (m)	100
Width of cable crossing (m)	10
Length of pipeline crossing (m)	300
Width of pipeline crossing (m)	16
Export Cables	
Total number of cable & pipeline crossings	38 (19 per cable)
Total footprint of protection for all crossings (m^2)	60,800
Total volume of protection for all crossings (m^3)	24,100
Inter-Array Cables	
Total number of cable crossings	5
Total footprint of protection for all crossings (m^2)	5,000
Total volume of protection for all crossings (m^3)	4,125

4.8.8 Use of Oils, Fluids and Materials – Offshore Infrastructure

121. Offshore infrastructure contains a number of oils, fluids and other substances, used during construction and operation. Oils within the wind turbines will be biodegradable where possible and all chemicals will be certified to the relevant standard. The following substances are typical in offshore wind farm infrastructure, although this list is not considered exhaustive:

- Hydraulic and gear oil;
- Nitrogen;
- Ester oil;
- Diesel fuel
- Sulphur hexafluoride; and
- Glycol.

4.8.9 Construction Vessels

122. During the construction of the Project, a variety of vessels will be used for the installation, support and transport of equipment and infrastructure to the Array Area, Offshore ECC, and landfall. The exact number and specification of vessels will not be known until nearer construction. An indication of the number of each type of vessel on site at any one time during the construction phase and the number of round trips between port and the Offshore Development Area (defined as port to site and back to port) is summarised in **Table 4-20**. Due to construction sequencing, not all vessel types will be on site at the same time, but it is anticipated that there may be a maximum of 90, although this is highly conservative.

Table 4-20 Project Design Envelope – Indicative Construction Vessels

Vessel Type	Peak Vessels (On-Site at the Same Time)	Round Trips
Site preparation vessels (boulder clearance vessel, Construction Support Vessel (CSV), survey vessels including Uncrewed Surface Vehicles (USV), geotechnical survey, and Jack-Up Vessel (JUV))	18 (not including USVs)	243
Wind turbine foundation vessels (including for foundation installation, support and transport)	30	1,921
Wind turbine vessels (including for scour protection, wind turbine installation, support, transport and commissioning)	33	2,825
Offshore platform vessels (including for foundation and topside installation, support, transport and commissioning	38	146
Inter-array cable vessels (including for cable installation, support and commissioning)	13	1,884
Offshore export cable vessels (including for cable installation, support and landfall)	23	376
Other vessels	4	132

4.8.9.1 Jack-Ups and Anchoring

123. The methodology for several of the construction phases will involve the use of a Jack-Up Vessel (JUV) for anchoring. JUVs are installation vessels that lower three or more legs onto the seabed and lift themselves out of the water to provide a stable platform to conduct works. This is particularly useful for the construction of heavy infrastructure, such as craning of the wind turbines or offshore platform topside. The legs of the JUV directly impact the seabed through the 'jacking-up' process. The Project Design Envelope for the use of JUVs is provided in **Table 4-21**.

Table 4-21 Project Design Envelope - Jack-Up Vessels

Parameter	Value
Combined leg footprint (m^2)	2,400
Total JUV operations for wind turbines and OPs	575
Total area impacted by JUVs over construction period (m^2)	1,380,000

124. In some instances, anchoring is a suitable alternative to JUVs during construction. There are still direct impacts on the seabed as a result of the multiple anchors dropped to secure the vessel, but it is less commonly used because Dynamic Positioning (DP) is a more efficient means to position the vessel.

125. The Project Design Envelope for anchoring (for all construction activities where it is considered) is provided in **Table 4-22**. The footprint for deployment and recovery of one anchor is assumed to be $100m^2$.

Table 4-22 Project Design Envelope - Anchoring

Vessel Type	Parameter	Value
Array infrastructure vessels	Total footprint of anchoring operations (m^2)	201,160
Offshore export cable vessels	Total footprint of anchoring operations (m^2)	21,600
Total	Total footprint of anchoring operations (m^2)	222,760

4.8.10 Helicopter Movements

126. There will be a requirement for helicopters to travel to and from the Offshore Development Area to assist with construction activities. The indicative helicopter type for construction will be a medium sized offshore transport helicopter and the maximum number of round trips during construction is 2,730.

4.8.11 Safety Zones

127. Safety zones help to ensure a safe distance is maintained between the wind farm structures (wind turbines and offshore platform(s)) and vessels. Safety zone applications will be made post-consent under The Electricity (Offshore Generating Stations) (Safety Zones) (Applications Procedures and Control of Access) Regulations 2007 and will be subject to approval prior to the start of construction (refer to the design commitments made in **Table 4-1**). The safety zones that may be applied are summarised in **Table 4-23**. Further information on safety zones is provided in **Chapter 15 Shipping and Navigation**.

Table 4-23 Expected Safety Zones

Project Stage	Potential Safety Zone
Construction and Commissioning	During the construction phase, a safety zone radius of 500m while construction vessels are present will be required, which typically reduces to within 50m of an asset whilst no construction vessels are present, returning to 500m if a vessel returns.
Operation	During the operation and maintenance phase, safety zones are not generally required but may be subject to ongoing monitoring and review.
Maintenance (Major)	A safety zone radius of 500m while major maintenance is in progress (i.e. during the use of jack-up vessel or similar).
Decommissioning	During decommissioning a safety zone radius of up to 500m at the end of the working life of a wind turbine foundation or platform when it is being removed will be required.

4.8.12 Offshore Operation and Maintenance

128. The Operations and Maintenance (O&M) phase of the Project is anticipated to be 35 years, during which a number of routine, and potentially unplanned, activities will be required. An outline O&M plan will be submitted with the DCO application that will contain further detail on the activities expected to be required and how they will be licenced. The O&M strategy will be finalised once the technical specification of the wind farm is known. The O&M strategy will ensure that all infrastructure is maintained in safe working order and to maximise operational efficiency throughout the lifetime of the project.

129. O&M activities are grouped into two categories:

- Preventative maintenance – planned activities such as scheduled maintenance of the wind turbines, offshore platform(s) and foundations, geophysical, benthic and other surveys; modifications and retrofit campaigns; and
- Corrective maintenance – activities such as repairs, replacements and remedial works to the wind turbines, offshore platform(s), foundations, scour protection and cables.

4.8.12.1 Operation and Maintenance Port

130. It is likely that the existing Dogger Bank O&M facility at the Port of Tyne will be used (and expanded if necessary) as the base of operations for the Project. However, if this is not the case, a suitable alternative will be selected in the north-east of England.

4.8.12.2 Vessel Operations

131. In order to perform the O&M activities, a variety of vessels and helicopters will be required to transport personnel and equipment to enable the execution of the works. These can also be grouped into two categories:

- Routine – vessels and helicopters that are permanently assigned to the wind farm or visiting in a planned, routine manner; and
- Ad-hoc – vessels and helicopters, normally specialised in their nature, to perform specific tasks usually linked to corrective maintenance.

132. It is likely that the Service Operation Vessels (SOV) will be operated from the Port of Tyne where the existing Dogger Bank O&M facility is. However, this is subject to a detailed review and if this is not feasible a suitable alternative in the north-east of England will be selected. All other vessels are unlikely to be operated from the Port of Tyne, but rather any port in the North Sea basin.

133. The anticipated types and quantities of vessels used for the routine maintenance activities are provided in **Table 4-24**.

Table 4-24 Project Design Envelope – Indicative O&M Vessel and Helicopter Use

Vessel Type	Use	Value
SOVs (including daughter crafts)	Preventative and corrective maintenance on wind turbines, foundations and offshore platform(s)	Three vessels at any one time. Permanently stationed on site (excluding crew changes). 26 trips of two-week duration to the Array Area per year. Maximum of 39 visits of shorter duration.
Platform Supply Vessels (PSVs) / Offshore Supply Vessels (OSVs)	Preventative and corrective maintenance on offshore platform(s)	One vessel at any one time. 12 trips of two-week duration to the Array Area per year.
Survey vessels such as OSVs, Offshore Construction Vessels (OCVs) and/or Unmanned Surface Vessels (USVs)	Various surveys of seabed assets to assess integrity	Two vessels at any one time (maximum of six USVs at any one time). Annual trips to the array area and export cable of three-month duration (35 trips over the lifetime).
Wind turbine installation vessel, JUV, HLV, OCV	Corrective maintenance – major component repair or replacement	Ad-hoc requirement – one vessel at any one time. Up to seven visits per wind turbine over life (two-week duration). Up to 10 visits to offshore platform over life (two-week duration).
Cable Lay Vessel (CLV) with OCV/OSV in support	Corrective maintenance – cable repair or replacement	Ad-hoc requirement – one to three vessels at any one time. Up to 15 visits to Array Area and 35 visits to export cable corridor over life (three-month duration).
OSV and OCVs	Corrective maintenance of foundations – anode replacement, J-tube replacement	Ad-hoc requirement – One vessel at any one time. Up to two visits to Array Area over life (four-week duration)

Vessel Type	Use	Value
Fall Pipe Vessel, OSV, OCV	Corrective maintenance – cable remedial burial, cable protection replacement, scour protection rectification	Ad-hoc requirement – one vessel at any one time. Up to two visits to Array Area and export cable corridor per year (four-week duration).
Crew change helicopter	Preventative and corrective maintenance, crew change activities, urgent return to shore	24 return trips per year.

4.8.13 Decommissioning

134. At the end of the operational life of the Project, it is anticipated that all infrastructure above the seabed will be completely removed. Decommissioning will typically occur through a reverse methodology to construction and involve similar quantities of vessels and equipment. In many cases throughout the environmental assessment, the impacts during the decommissioning phase are scoped out as they will be equivalent to or less than the impacts during construction.

135. The submission of a decommissioning programme is expected to be required pre-construction, as this is conditional under Section 106 of the Energy Act 2004. The initial decommissioning programme will be signed off by the relevant authority prior to construction and will then be updated throughout the lifetime of the Project. A final decommissioning programme will also require approval from the MMO prior to any decommissioning works actually taking place.

4.8.13.1 Repowering

136. Repowering may be considered once the Project reaches the end of its design life. If repowering is taken forward and if the specifications and design of the new infrastructure fall outside the consent parameters of this Project, it will be considered a new Project and outside the scope of this document.

4.9 Onshore Components

4.9.1 Landfall Components

137. The landfall components include a TJB and associated underground link box to enable the connection between the offshore and onshore export cables. The offshore export cables will come ashore on land south-east of Skipsea and will be jointed to the onshore export cables at the TJB, which will be located at the landward extent of the landfall.

138. Due to the cliff height, coastal erosion rates and environmental sensitivities at the landfall, the cable ducts will be installed using a trenchless technique (Commitment ID CO23) (see **Section 4.9.5.3.10** for details on the trenchless techniques included in the Project Design Envelope). The ducts will be installed from the TJB to a subtidal exit location on the seabed located below MLWS, and the offshore export cables will be pulled ashore through these pre-installed ducts.

139. It is proposed that up to three cable ducts would be installed to accommodate the two offshore export cables brought ashore. It is likely that two cable ducts would be required, but an allowance for a spare duct has been made for contingency purposes.

140. **Plate 4-11** provides an indicative cross-section of landfall trenchless installation works. Given that no open cut trenching is proposed for landfall construction, and a trenchless installation exit in the subtidal zone will be used, there is no requirement for dewatering or temporary water exclusion using cofferdams or other similar temporary structures in the intertidal zone (Commitment ID CO23).

141. A number of trenchless installation trajectories are currently being considered in the Project Design Envelope. The final design will exit in the subtidal zone but could potentially exit within or outside of the Holderness Inshore Marine Conservation Zone (MCZ). The interface between the Offshore and Onshore Development Areas at the landfall has been defined to include the intertidal zone and allow for the onwards routeing of offshore and onshore export cables.

142. The final landfall design and construction methodology, including the trenchless installation trajectory, will be subject to further pre-construction surveys, engineering studies and offshore vessel considerations and confirmed at detailed design stage post-consent.

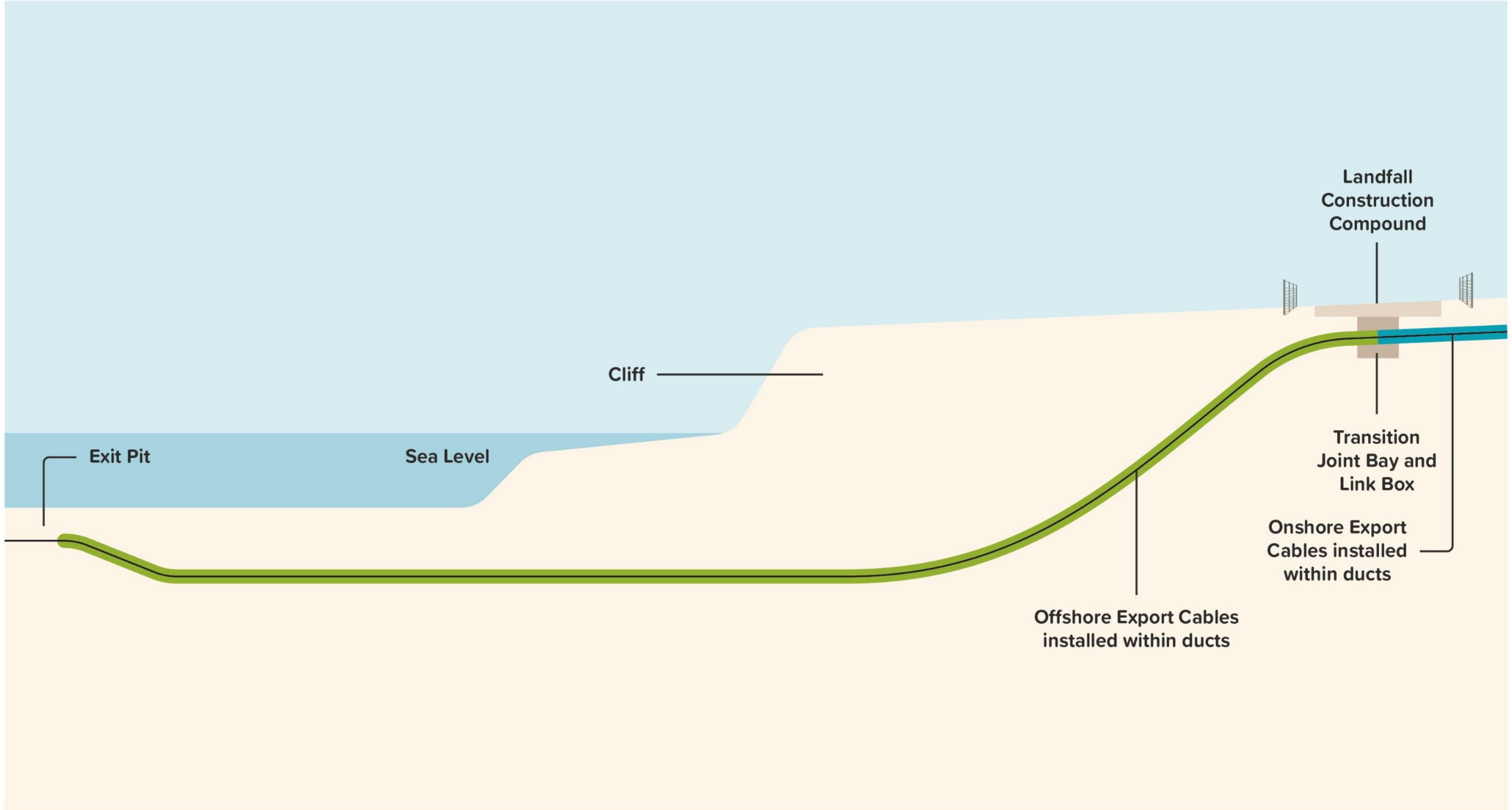

Plate 4-11 Indicative Cross-Section of Landfall Trenchless Installation Works

143. The TJB is an underground structure where the offshore and onshore export cables are joined in a clean, dry environment (Commitment CO61). The TJB is constructed using reinforced concrete slabs and may either have reinforced concrete walls with a reinforced concrete cover or comprise of the slab only with cement bound sand and other suitable soils used as backfill to protect the cable joints.

144. The TJB will be sited inland with a sufficient setback distance from the cliff top to provide space for temporary construction logistics and account for natural coastal erosion plus climate change allowance, ensuring that the installed cable ducts remain buried throughout the Project's operational lifetime.

145. An underground link box will be installed in proximity to the TJB to allow inspection and monitoring of cable joints during operation (Commitment CO61). The link box at the landfall comprises a similar reinforced concrete enclosure to the TJB but will be smaller in footprint. The link box will be installed with a manhole cover at ground level to provide access and are typically marked / protected by bollards, fences or similar of approximately 1.2m to 2m in height (where required and agreed with the relevant landowners).

146. The final design and location of the TJB and associated underground link box will be determined during detailed design post-consent. Where agreed with the relevant landowners and subject to detailed design and construction requirements, the link box at the landfall will be located at or as close to field boundaries as reasonably practicable (Commitment ID CO110). An example TJB and link box arrangement at the landfall is shown on **Plate 4-12**.

147. **Table 4-25** provides the key design parameters for the landfall infrastructure which form part of the Project Design Envelope.

Table 4-25 Project Design Envelope – Landfall Infrastructure Parameters

Parameter	Value
Maximum number of landfall cable ducts	3 (including 1 spare)
Maximum number of exit pits	3 (including 1 spare)
Indicative drill exit location (m LAT)	5 to 10 (subtidal exit below MHWS)
Maximum horizontal length of trenchless installation (m)	2,000
Indicative minimum depth of trenchless installation at cliff (m)	5
Maximum number of TJB at landfall	1
Maximum permanent TJB area (m^2)	30
Maximum number of underground link box at landfall	1
Maximum permanent underground link box area (m^2)	10
Maximum TJB and underground link box burial depth (m)	3
Maximum number of landfall construction compound	1
Indicative temporary landfall construction compound area (m^2)	12,500 (including construction footprint of TJB and underground link box)
Indicative haul road width at landfall (m)	7
Indicative height of protective bollards, markers or fences	1.2m to 2m (where required and agreed with the relevant landowner)

Plate 4-12 Example TJB during Construction (Left) (Source: Dogger Bank C) and Example Underground Link Box during Operation (Right, Note: Only manhole cover to the underground link box, and demarcation posts (where required) will be visible at ground level) (Source: Dogger Bank A & B)

4.9.2 Landfall Construction Activities

148. To enable the connection of the offshore and onshore export cables at the TJB, the main landfall construction activities are likely to include:

- Pre-construction activities and surveys;
- Topsoil stripping;
- Construction of the landfall construction compound;
- Construction of accesses and temporary haul road to enable site access and movement of plant, equipment and personnel;
- Trenchless duct installation works, including excavation of entry and exit pits, drilling operations and pull-in of cable ducts from barges or vessels offshore (alternatively, ducts may be pushed from onshore);
- Excavation and construction of the TJB and underground link box;
- Pull-in of the offshore export cables through the pre-installed ducts;
- Jointing of the onshore and offshore export cables at the TJB;
- Backfilling of the TJB;
- Cable testing and commissioning; and
- Site demobilisation and reinstatement works.

149. General construction practices, including construction drainage, fencing and signage, lighting, vegetation clearance and soil handling, for the onshore landfall construction works are expected to be similar to those undertaken for onshore export cable works, which are presented in **Section 4.9.5.3.4** to **Section 4.9.5.3.8**.

150. Offshore, landfall construction vessels (including but not limited to jack-up barges, multi-cat vessels and other small work boats) will be used to excavate or dredge the exit pits in the subtidal zone prior to trenchless installation works at the landfall. Following from this, vessels will be positioned at the exit pits to assist with installation activities such as handling the drill head, connecting the offshore export cables for pull-in and dive support, as well as onwards laying and burial of the offshore export cables.

151. Based on the indicative construction programme (see **Section 4.7**), the duration of landfall construction works is anticipated to be approximately three years, which would include one year of trenchless installation works. There may be a gap in the construction programme between the installation of the cable ducts and cable pull-in and jointing activities at the landfall to allow flexibility and account for variations in the timings of offshore and onshore export cable installation works. This gap will not alter the nature and sequencing of offshore and onshore construction activities required at the landfall. Therefore, the duration and scale of disturbance impacts at the landfall as assessed in the relevant technical chapters in the PEIR (**Chapter 8 Marine Physical Processes** to **Chapter 31 Climate Change**) remain the same regardless of the gap in the construction programme.

4.9.2.1 Landfall Construction Compound and Construction Accesses

152. A temporary landfall construction compound will be established onshore to accommodate construction plant and equipment such as the trenchless installation equipment, cable ducts (if installed by pushing from onshore) and welfare facilities (Commitment CO76). The compound will be used for trenchless duct installation, TJB and link box construction, cable pull-in and jointing activities. The landfall construction compound will be in place for the entire duration of landfall construction works.

153. Access to the landfall construction compound will be via Hornsea Road (B1242) (Commitment CO75), and a haul road of up to 7m wide will be constructed to provide safe vehicular access to the site. **Plate 4-13** provides an example of a typical landfall construction compound, its indicative location is shown on **Figure 4-2**.

154. There will be no direct access to the beach from the compound. The only access to the beach being via an emergency access route. This will be located along the beach running south to the landfall from an emergency laydown area at the end of North Turnpike Road (as shown on **Figure 4-2**). No permanent access improvement works will be undertaken along the beach, but temporary works to extend North Turnpike Road to connect to the beach and maintain ramp access in the event of coastal erosion may be required. This access and laydown area will only be in place for the duration of landfall construction works and used in the event of emergencies such as in response to a drilling fluid frac-out event. Further details on proposed construction accesses at the landfall are provided in **Chapter 26 Traffic and Transport**.

Plate 4-13 Example of a Landfall Construction Compound (Note: Compound will be dependent on the selected trenchless installation technique at landfall) (Source: Dogger Bank A & B)

4.9.2.2 Trenchless Duct Installation

155. Prior to trenchless installation works, a temporary working platform will be established, and entry pits will be excavated within the landfall construction compound to allow the trenchless installation equipment to be positioned in place. Exit pits will be excavated or dredged in the subtidal zone to capture drill arisings, drilling fluid and the drill head when it emerges from the seabed.

156. Trenchless installation of cable ducts will involve drilling a bore through which the ducts will be pulled into position from the exit pit. Alternatively, installation of cable ducts may involve pushing the ducts into the bore from land. Trenchless installation will start from the entry pits and travel underneath the beach before emerging from the seabed at the exit pits.

157. Trenchless installation operations may involve the use of drilling fluid, which is typically a mixture of water, bentonite and other additives. Drilling fluid would be continuously pumped through the installation equipment to the entry pit to facilitate the removal of spoil, stabilise the bore and lubricate the installation of cable ducts. A drilling fluid management system will be implemented at the landfall construction compound to control the volume of drilling fluid used, process and recycle returned drilling fluid and monitor the risk of frac-out events. Steps will be taken to control the volume of drilling fluid entering the marine environment at the point of drill head punch-out. This may include reducing the concentration of additives / drilling fluid, as the drill head approaches the exit pits and installation of a return line to recover and recycle the drilling fluid from the exit pits (Commitment ID CO38). An alternative drilling fluid management system may be installed on offshore vessels.

158. Once the bore is in place, the cable ducts will be assembled off-site, floated into position at the drill exit location from vessels and pulled into the bore from the exit pits towards the entry pits. Alternatively, the cable ducts could be assembled onshore at the landfall construction compound and pushed into the bore from the entry pits towards the exit pits. Should there be a gap in the construction programme between the duct installation and the pull-in of the offshore export cables, the duct ends may be capped and buried to prevent sediment ingress, and the exit pits may be temporarily backfilled. Once installed, the ducts will be pigged using compressed air or water to remove any debris, and a messenger wire will also be installed within the ducts to facilitate cable installation. In the event of failure during duct installation, the bore would be filled, and a further attempt made at another bore.

159. Due to the trenchless nature of duct installation, prolonged periods of access restrictions or closures to the beach will not be required, but emergency landfall works may be required to be performed on the beach, which in those circumstances would involve short periods of restricted access.

4.9.2.3 Transition Joint Bay and Link Box Construction

160. The TJB and associated underground link box will be constructed within the landfall construction compound behind the entry pits. A pull-in winch and ancillary equipment will be installed for the cable pull-in operations. The TJB and link box may either be constructed during the completion of trenchless installation works or prior to the cable pull-in.

161. Construction activities will likely involve:

- Topsoil stripping;
- Subsoil excavation;
- Dewatering of the excavation using pumps (if required);

- Installation of the reinforced concrete slab base for the TJB (and if required, installation of reinforced concrete walls and roof structure following cable pull-in and jointing operations);
- Installation of the reinforced concrete chamber, manhole cover and bollards, fences or similar (if required) for the link box in proximity to the TJB; and
- Temporary backfill and subsequent re-excavation of the TJB using suitable backfill material (should there be a gap between TJB construction and cable pull-in and jointing).

4.9.2.4 Cable Pull-In and Jointing

162. Upon the arrival of offshore export cable installation vessels at the drill exit location, the exit pits and TJB will be re-exposed (as required), and the cable duct ends will be uncapped. The messenger wire pre-installed within the ducts will be retrieved and connected to the onshore cable winch. The winch wire will then be pulled through the ducts to the offshore cable installation vessel where the winch wire will be connected to the offshore export cable pull head. The pull-in winch at the landfall construction compound will be used to pull the offshore export cables through the pre-installed ducts towards the TJB. The offshore and onshore export cables will then be jointed at the TJB, and cable testing and commissioning will be undertaken.

4.9.2.5 Reinstatement and Site Demobilisation

163. Following cable pull-in and jointing operations, the cable ducts will be surrounded with bentonite or another suitable material, and both ends of the cable ducts will be sealed using flanges. The TJB will be backfilled with cement bound sand and excavated subsoil, and the exit pits will be backfilled with side-cast material or left to naturally backfill. Once installation is complete, the export cables will be buried at both ends.

164. Upon completion of landfall construction works, construction plant and equipment and vessels will be demobilised, and topsoil at the landfall construction compound (including the TJB) and along the haul road will be reinstated to pre-construction conditions as far as practicable (Commitment ID CO61).

4.9.3 Landfall Operation and Maintenance

165. Routine non-intrusive inspection works at the landfall is anticipated to consist of a visit to the TJB and associated underground link box every six months for cable joint inspection and monitoring. Personnel access would be taken from the manhole cover installed on top of the link box. As the haul road will not be in place during operation, suitable off-road vehicles will be used for access.

166. Maintenance of landfall infrastructure during operation is expected to be minimal. Unplanned emergency maintenance works to address faults will be undertaken as and when necessary and, depending on the nature of the repair, may involve intrusive works such as excavation of the TJB and removal and replacement of the faulty equipment with spare parts.

4.9.4 Landfall Decommissioning

167. The final decommissioning strategy of the Project’s landfall infrastructure has not yet been decided. Where appropriate, the export cables and other buried infrastructure at the landfall, such as the TJB, underground link box and cable ducts, may be left in-situ. If the infrastructure is considered unsuitable to be left in-situ at the time of decommissioning, these components will be excavated and removed from the ground, and the land above will be reinstated. Where practicable, materials and components would be recovered and recycled.

168. The final decommissioning methodology will adhere to regulatory requirements and industry best practice at the time of decommissioning and outlined in the relevant decommissioning management plans for offshore and onshore works (i.e. Offshore Decommissioning Programme (Commitment ID CO21) and Onshore Decommissioning Plan (Commitment ID CO56)), which will be submitted and agreed with the relevant authorities prior to offshore construction works and prior to onshore decommissioning works respectively.

4.9.5 Onshore Export Cable Corridor

169. The onshore export cable works includes all the electrical transmission infrastructure required to connect the onshore export cables from the TJB at landfall to the OCS zone and onwards to the grid connection point at Birkhill Wood Substation.

170. For the purposes of the PEIR assessment, the Onshore Development Area includes a broad onshore ECC, approximately 200m in width. At certain locations, the corridor width varies to account for specific environmental, land or engineering constraints. The temporary and permanent land requirements for the onshore export cable infrastructure will be accommodated within this broad onshore ECC.

171. The onshore ECC will be further refined through site selection, consideration of stakeholder feedback and further engineering and environmental information and confirmed in the ES for the DCO application. The corridor width presented at ES stage will be sufficient to allow flexibility for micro-siting infrastructure within the onshore ECC during detailed design post-consent.

4.9.5.1 Description of Onshore Export Cables

172. Two types of onshore export cable systems will be required for the Project. These are up to 500kV High Voltage Direct Current (HVDC) cables and 400kV High Voltage Alternating Current (HVAC) cables[3]. The primary method of cable installation for both types of cables will be ducted cable installation. The onshore export cables will be buried along the entire length of the onshore ECC (Commitment ID CO60).

173. The HVDC export cable system will consist of a maximum of a single circuit[4] laid in two trenches from the TJB at landfall to the OCS zone. The circuit will contain two HVDC power cables and one fibre optic cable. The HVAC export cable system will consist of a maximum of four circuits laid in four trenches from the OCS zone to Birkhill Wood Substation. Each circuit will contain three HVAC power cables and one fibre optic cable.

174. The power cables will be used for electricity transmission, while the fibre optic cables will enable communications between infrastructure components and performance monitoring during operation. The final cable system design for the HVDC and HVAC export cables will be determined during detailed design post-consent.

175. During construction, the standard corridor width for the HVDC export cable system will be approximately 32m and 55m for the HVAC export cable system. The temporary construction corridor will consist of the cable trenches, working areas for the jointing bays and link boxes, soil storage areas, temporary construction compounds, haul roads and other temporary infrastructure such as construction drainage. At trenchless crossing locations and where additional land is required for engineering flexibility, the corridor width would extend to approximately 50m for the HVDC export cable system and 60m for the HVAC export cable system.

176. The majority of export cable works within the onshore ECC will be undertaken using open cut trenching. Where this method is not suitable, trenchless installation techniques will be adopted. For both HVDC and HVAC export cable systems, power and fibre optic cables will be pulled into pre-installed ducts laid within trenches where open cut trenching is used or bores where a trenchless installation technique is used.

177. Cable circuits are typically installed in a trefoil (cables bunded together in a triangular shape) or flat (cables laid adjacent and horizontally) arrangement. **Plate 4-14** provides indicative cross-sectional drawings to illustrate the typical layout of the temporary construction corridor for the HVDC and HVAC export cable systems, noting that the arrangement of the cable circuits are also indicative. The final design and layout of the temporary construction corridor and circuit arrangement of the HVDC and HVAC export cable systems will be subject to further pre-construction surveys and engineering studies and confirmed during detailed design post-consent.

[3] HVDC and HVAC are two types of electricity transmission technologies. HVDC uses direct current and is suited for transmitting electricity over long distances to minimise transmission losses. HVAC uses alternating current to transmit electricity over short to medium distances and is used to ensure compatibility for grid connection into the national electricity transmission and distribution network.

[4] Within this chapter, a cable circuit refers to a collection of cables, which for the onshore export cables, comprise power and fibre optic cables.

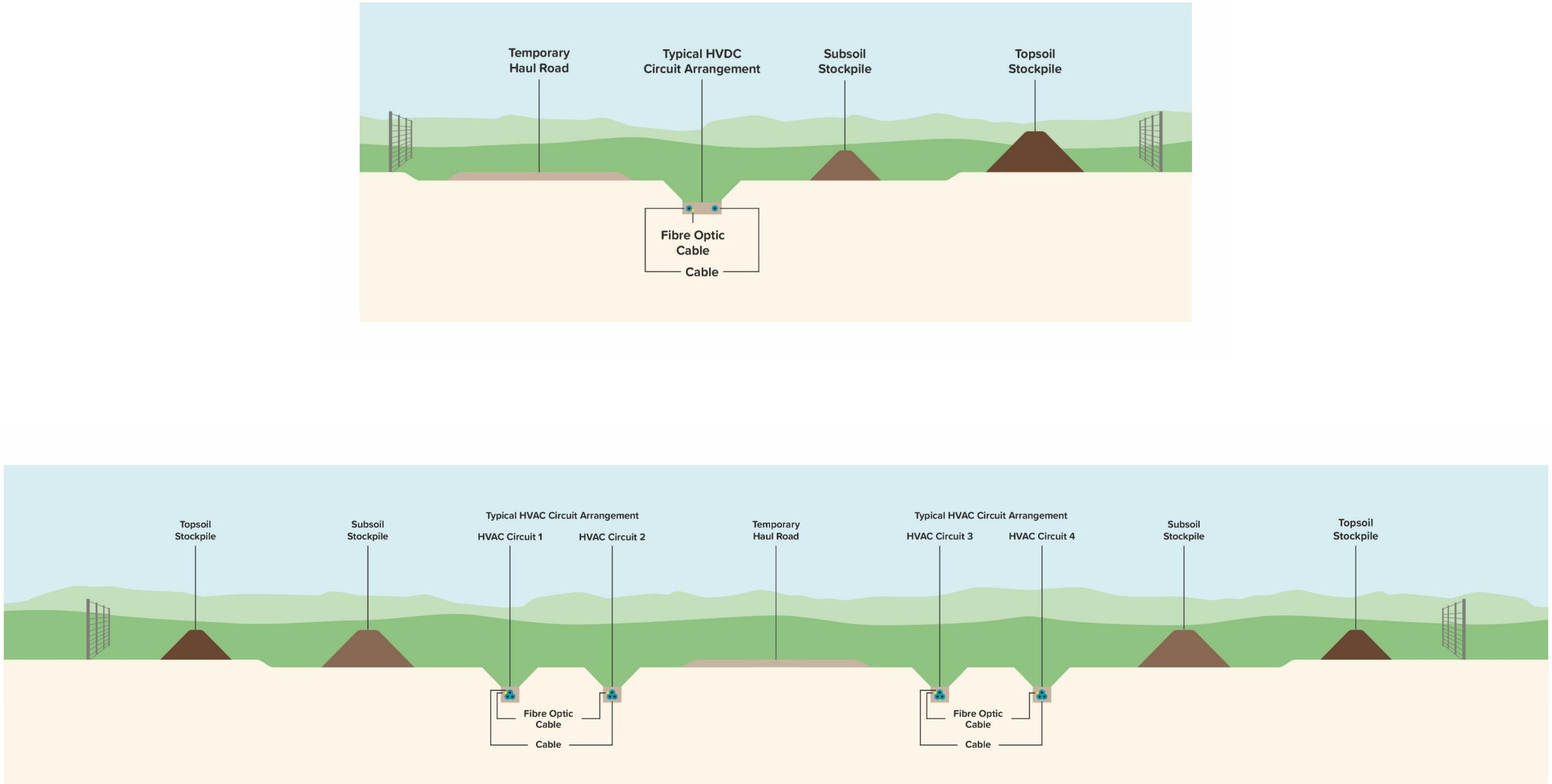

Plate 4-14 Indicative Cross-Sections of Temporary Construction Corridor for the HVDC Export Cables (top) and HVAC Export Cables (bottom)

178. **Table 4-27** provides the key design parameters for the onshore export cables.

Table 4-26 Project Design Envelope – Onshore Export Cable Parameters

Parameter	Value
Maximum length of HVDC export cable corridor (km)	50 (from landfall to OCS zone)
Maximum length of HVAC export cable corridor (km)	5 (from OCS zone to Birkhill Wood Substation)
Maximum number of HVDC export circuits	1
Maximum number of HVAC export circuits	4
Maximum number of cable ducts for HVDC export cables	3 (including 2 power cable ducts and 1 fibre optic duct)
Maximum number of cable ducts for HVAC export cables	16 (including 12 power cable ducts and 4 fibre optic ducts)
Maximum number of trenches of HVDC onshore export cables	2
Maximum number of trenches of HVAC onshore export cables	4
Indicative width of trench at surface (m)	3
Target minimum cable burial depth using open cut trenching (m)	1.2
Target minimum cable burial depth using trenchless installation techniques (m)	3.5
Target maximum cable burial depth using trenchless installation techniques (m)	20
Indicative temporary construction corridor width for HVDC onshore export cables (m)	32 (50 at trenchless crossing locations)
Indicative temporary construction corridor width for HVAC onshore export cables (m)	55 (60 at trenchless crossing locations)
Indicative haul road width within temporary construction corridor (m)	6 (8.5 where passing places are required)
Indicative haul road passing place frequency (m)	250
Indicative number of main construction compounds for onshore export cable works	4
Indicative main construction compound area (m^2)	20,000 (per compound)
Indicative number of intermediate construction compounds for onshore export cable works	8
Indicative intermediate construction compound area (m^2)	5,625 (per compound)
Indicative number of trenchless crossing locations	70
Indicative trenchless installation compound area for HVDC export cables (m^2)	300 (5,625 for non-HDD techniques) (per compound)
Indicative trenchless installation compound dimensions for HVAC export cables ((m^2)	800 (5,625 for non-HDD techniques) (per compound)
Maximum land area temporarily disturbed during construction (m^2)	1,700,000
Indicative width of operational easement for HVDC export cables (m)	20
Indicative width of operational easement for HVAC export cables (m)	25

4.9.5.2 Description of Jointing Bays and Link Boxes

179. Along the onshore ECC, jointing bays will be constructed at regular intervals to enable cable pull-in and jointing of discrete sections of onshore export cables. Jointing bays are underground reinforced concrete structures and are buried at depth, allowing land to be reinstated and returned to pre-construction conditions as far as practicable following completion of construction (Commitment ID CO61). Jointing bays are constructed using a cast in-situ concrete slab and may either have reinforced concrete walls with a reinforced concrete cover or comprise of the slab only with cement bound sand and other suitable soils used as backfill to protect the cable joints. Jointing bays along the onshore ECC are similar in appearance to the TJB at landfall (as illustrated on **Plate 4-15**).

180. Link boxes will be installed at regular intervals in proximity to jointing bays to allow for inspection and monitoring of cable joints during operation. Along the onshore ECC, link boxes may either be installed underground with a manhole cover at ground level to provide access or as above-ground structures (Commitment ID CO61). Underground link boxes comprise a similar reinforced concrete enclosure to the jointing bay but with a smaller footprint. Above ground link boxes will be constructed as metal or glass-reinforced plastic kiosks laid on concrete pads. Link boxes will be typically marked / protected by bollards, fences or similar of approximately 1.2 to 2m in height (where required and agreed with the relevant landowners). An example underground and above-ground link box are shown on **Plate 4-15**.

Plate 4-15 Example of an Underground Link Box (Left) ((Source: Dogger Bank A & B) and an Above-Ground Link Box (Right) (Note: This includes temporary fencing during construction) (Source: Dogger Bank B)

181. For the purposes of the PEIR assessment, it is assumed that at approximately 20 (see **Table 4-27**) link box locations for the HVDC export cables and all link box locations for the HVAC export cables will involve the use of above-ground link boxes.

182. **Table 4-27** provides the key design parameters for jointing bays and link boxes within the onshore ECC. The final design, number and locations of the jointing bay and associated link boxes will be determined during detailed design post-consent. Where agreed with the relevant landowners and subject to detailed design and construction requirements, link boxes along the onshore ECC will be located at or as close to field boundaries as reasonably practicable (Commitment ID CO110).

Table 4-27 Project Design Envelope – Jointing Bay and Link Box Parameters

Parameter	Value
Indicative number of jointing bay locations along onshore ECC	62
Maximum permanent jointing bay area (m^2)	30 (per jointing bay)
Maximum jointing bay burial depth (m)	2.5
Indicative number of link box locations along onshore ECC	56
Maximum permanent underground link box area (m^2)	4 (per link box)
Maximum permanent above-ground link box area (m^2)	3 (per link box)
Maximum underground link box burial depth / above-ground link box height (m)	2
Maximum jointing bay and link box temporary construction area for HVDC export cables (m^2)	660 (per location)
Maximum jointing bay and link box temporary construction area for HVAC export cables (m^2)	1,040 (per location)

4.9.5.3 Onshore Export Cable Construction Activities

183. The main construction works within the onshore ECC will be similar for both HVDC and HVAC export cables and are likely to include:

- Pre-construction activities and surveys;
- Topsoil stripping;
- Construction of temporary construction compounds;
- Construction of accesses and temporary haul roads to enable site access and movement of plant and equipment and personnel along the corridor;
- Installation of other temporary infrastructure such as drainage, culverts and bridges to facilitate site access and construction works or where mitigation measures are required due to close proximity or crossing of sensitive receptors;
- Excavation of cable trenches and installation of cable ducts using open cut trenching;
- Installation of cable ducts using trenchless installation techniques to avoid obstacles;
- Backfilling of cable trenches;
- Excavation and construction of jointing bays and link boxes;
- Pull-in of the onshore export cables and jointing at jointing bay locations;
- Backfilling of jointing bays;
- Cable testing and commissioning; and
- Reinstatement and site demobilisation.

184. Prior to the commencement of construction, pre-construction surveys, such as ground investigations, geophysical, UXO, utility, drainage, topographical and environmental surveys, will be undertaken to inform the detailed design and construction methodology of onshore export cable works and ensure required mitigation works are in place. Pre-construction activities will also be undertaken to secure and prepare the site for construction works. Further details of pre-construction surveys and activities are provided in the **Outline Code of Construction Practice** (document reference 8.9) (Commitment ID CO39) provided with the PEIR.

185. The onshore ECC will be segmented into corridor sections, with each section constructed separately. Works will be undertaken concurrently at multiple sections at any given time to ensure construction efficiency. In any given section, the sequence of construction activities will be similar, as presented above, but the duration of construction at each section will depend on resource availability, length of section, weather and site conditions and other engineering challenges that may arise.

186. Based on the indicative construction programme (see **Section 4.7**), the duration of export cable works along the onshore ECC is anticipated to be approximately four years.

4.9.5.3.1 Temporary Construction Compounds

187. Three types of temporary construction compounds (shown on **Plate 4-16, Plate 4-17** and **Plate 4-18**) will be required for construction works within the onshore ECC:

- Main construction compounds will be positioned at strategic locations along the onshore ECC with suitable vehicular access from the public highway. These compounds will enable overall construction management throughout the duration of onshore export cable works and will serve as logistics hubs for activities such as controlling deliveries to site.
- Intermediate construction compounds will be positioned between the main construction compound locations and will be smaller in size than the main construction compounds. These compounds will serve as localised support bases for the main construction compounds as works in a corridor section pass through an area and will have direct access to the temporary construction corridor.
- Trenchless installation compounds will be established at each location where a trenchless installation is undertaken at the entry and exit pits.

188. Main and intermediate construction compounds are anticipated to remain in place for approximately three years at each location. Trenchless installation compounds will be in place for the duration of trenchless installation works (approximately two years at each location).

Plate 4-16 Example Main Construction Compound for Onshore Export Cable Works (Source: Dogger Bank C)

Plate 4-17 Example Intermediate Construction Compound for Onshore Export Cable Works (Source: Dogger Bank C)

Plate 4-18 Example Trenchless Installation Compound for Onshore Export Cable Works (Note: Compound dependent on the selected trenchless installation technique at each crossing) (Source: Dogger Bank C)

189. The main construction compounds are likely to include laydown areas for construction materials and plant and equipment, storage areas for construction waste, bunded storage areas, vehicle parking areas, welfare facilities, wheel washing facilities, workshops and offices.

190. Intermediate construction compounds may house welfare facilities, workshops and offices, smaller laydown areas for construction materials and plant and equipment and storage areas for construction waste.

191. Trenchless installation compounds will house the trenchless installation equipment (such as HDD drilling rig), control room, power packs and generators, drilling fluid management system, laydown area for construction materials and plant and equipment, storage areas for construction waste, welfare facilities, workshops and offices.

192. Where there is no existing hardstanding, temporary construction compounds will be constructed by stripping and storing the topsoil for reinstatement, laying a geotextile membrane or similar directly on top of the subsoil and spreading crushed stone or other aggregates to create a suitable hardstanding area.

193. All temporary construction compounds for the onshore export cable works will be located within the Onshore Development Area. Indicative locations for the main and intermediate construction compounds which are considered at this stage are shown on **Figure 4-2**. The final location, micro-siting and layout of each temporary construction compound within the compound areas identified in the ES will be determined during detailed design post-consent.

4.9.5.3.2 Construction Accesses

194. Construction accesses are required to allow construction traffic to access and egress from the haul road and temporary construction compounds onto the public highway (Commitment ID CO72).

195. Where practicable, construction accesses have been identified using existing field accesses or other suitable access points from the public highway. Indicative construction access points to the onshore ECC are shown on **Figure 4-2**. These will be subject to further refinement for the DCO application and presented in the ES.

196. Construction accesses will comprise an area of concrete, asphalt or other suitable hardstanding material. To allow the accesses to be constructed and subsequently removed, a working area of approximately 10m has been included within the Onshore Development Area around each access and crossing point.

197. To allow construction traffic to egress safely from each access or crossing point, visibility splays have been identified to allow drivers to see oncoming traffic from both directions at a junction. Where visibility splay works are required, a working area with an offset of approximately 5m to the rear of the splay has been included within the Onshore Development Area to allow space for construction plant and equipment to operate.

198. Temporary modifications works to the public highway may be required to enable construction access at specific locations. These modifications may include:

- Localised road or junction widening;
- New or improved passing places and bellmouths;
- Upgrades to the surfacing of existing farm tracks;
- Relocation of street signs and furniture; and
- Creation of new junctions off existing highways.

199. Traffic management measures to facilitate construction access are further detailed in the **Outline Construction Traffic Management Plan** (document reference 8.15) (Commitment ID CO73) provided with the PEIR.

200. Further details on proposed construction accesses for the onshore ECC are provided in **Chapter 26 Traffic and Transport**. The final locations of construction access points, outline access design and details on the temporary modification works required will be confirmed for the DCO application and presented in the ES, with detailed access design to be determined post-consent.

4.9.5.3.3 Haul Road

201. A temporary haul road will be installed along the entire length of the onshore ECC (Commitment ID CO75) to allow construction access to the temporary construction corridor, construction compounds and enable the movement of construction plant and equipment and personnel. The haul road will run parallel to the cable trenches with drainage and verges on either side. Passing places will be provided at regular intervals to allow safe two-way movements of vehicular traffic, plant and equipment.

202. Construction of the haul road will involve:

- Topsoil stripping;
- Placement of a geotextile membrane, or similar protective matting, onto the subsoil; and
- Placement of suitable graded aggregates to form hardstanding.

203. The final material specification and design of the haul road will be determined during detailed design post-consent and will be informed by ground investigations, load bearing requirements and any necessary protection of underground utilities and other third-party assets. Alternative design considerations will be considered as appropriate during detailed design stage such as the use of temporary metal trackways and geogrid reinforcement to reduce the thickness of hardstanding aggregates.

204. Where trenchless installation techniques are being used to bypass an obstacle, there may still be a requirement for the haul road to cross the obstacle. In these cases, temporary culverts or bridges may be installed to enable continuous access along the onshore ECC. At major obstacle crossings and sensitive locations such as main rivers, there will be a break in the haul road, which will continue on either side of the obstacle (Commitment ID CO35).

205. It is likely that the haul road will be removed and land reinstated as construction activities in each corridor section are completed. However, some sections of the haul road may be retained to maintain access for cable pull-in and jointing operations at remote jointing bay locations that could not be accessed from the public highway or due to other construction requirements. As a worst-case scenario, it is assumed within the PEIR that the haul road along the entire length of the onshore ECC may need to be retained until the completion of all onshore export cable construction activities. The extent of the haul road required to be retained will be determined upon completion of the duct installation works, with the intention to reinstate as much haul road as practicable.

206. Following the completion of onshore export cable works, the entire length of the haul road within the onshore ECC will be removed, and the land reinstated to its previous condition as far as practicable (Commitment ID C100).

4.9.5.3.4 Construction Drainage

207. A temporary drainage system will be installed to manage surface water run-offs and flows during construction and connect into the local drainage network (Commitment ID CO43). Prior to construction, temporary drainage measures will be installed along the length of the temporary construction corridor. Post-construction, land drainage within the corridor will be reinstated to pre-construction conditions as practicable, including replacing any drains that were damaged or altered during construction.

208. The final temporary drainage design for onshore export cable works will be developed post-consent, taking into account existing land drainage, outfalls and other drainage features. The design will include a pre-construction and post-construction drainage scheme and detail works required where the temporary construction corridor intercepts land drainage during construction. Further details of temporary surface water management measures and approaches to the reinstatement and maintenance of land drainage to be adopted during construction are set out in the **Outline Code of Construction Practice** (document reference 8.9) (Commitment ID CO73) provided with the PEIR.

209. Drainage ditches and watercourses which are expected to be encountered along the onshore ECC during construction have been assessed in **Chapter 21 Water Resources and Flood Risk**. The assessment includes details on how watercourses and land drainage are to be managed or diverted where interactions with the onshore export cable works are identified. Watercourses and drainage ditches will be identified, and their locations recorded during pre-construction topographical surveys of the onshore ECC.

4.9.5.3.5 Construction Fencing and Signage

210. Suitable demarcation fences will be established along the length of the temporary construction corridor and around temporary construction compounds to separate the works area from the general public. The type of temporary fencing will be dependent on the ground conditions and location requirements along the corridor and the nature of construction activities.

211. Discrete temporary works area such as at jointing bays and along construction accesses from the public highway may also be fenced off as required. Appropriate security measures such as gated access and signage will be implemented to ensure the public is aware of the construction activities within the area.

212. Further details of construction fencing and signage are set out in the **Outline Code of Construction Practice** (document reference 8.9) (Commitment ID CO73) provided with the PEIR.

4.9.5.3.6 Vegetation Clearance

213. Where vegetation (such as hedgerows and trees) is present within the temporary construction corridor, vegetation clearance such as removal or strimming may be required. Ecological and landscape mitigation such as adherence to seasonal constraints, pre-construction surveys and root protection areas will be adhered to as appropriate. Vegetation clearance will be limited to the required working width or area to enable construction activities within the temporary construction corridor and access to the corridor. Where hedgerows and trees can be avoided by micro-siting during detailed design, vegetation will be retained as practicable (Commitment ID CO59). Further details on ecological and landscape mitigation measures to be implemented during vegetation clearance works will be provided in the Outline Ecological Management Plan (EcoMP), Outline Landscape Management Plan (LMP) and Outline Arboricultural Method Statement (Commitment ID CO81) which will be developed at the ES stage.

4.9.5.3.7 Soil Handling

214. Soil handling activities will be required within the temporary construction corridor to provide suitable ground for construction activities. Stripped topsoil and excavated subsoil will be stored as stockpiles within designated areas along the temporary construction corridor and adjacent to where it is removed where practicable to facilitate reinstatement once construction activities are complete (Commitment ID CO47).

215. Soil stockpiles will be created by:

- Clearing the area of any vegetation and waste arisings before forming stockpiles;
- Stripping topsoil for areas to be used for subsoil storage;
- Storing topsoil and subsoil layers separately;
- Locating stockpiles away from trees, hedgerows, drains, watercourses or excavations;
- Managing the site so that soil storage periods are kept as short as practicable;
- Using tracked equipment wherever practicable to reduce soil compaction; and
- Protecting stockpiles from erosion by sealing, seeding or covering them.

216. Stored topsoil and subsoil will be used for reinstatement at the site where it originated. Excess soil arisings will be used on site where practicable for earthworks and landscaping, with unsuitable material being removed from site for suitable recycling or disposal.

217. Further details of soil management measures to be adopted during construction are set out in the **Outline Code of Construction Practice** (document reference 8.9) (Commitment ID CO73) provided with the PEIR.

4.9.5.3.8 Construction Lighting

218. Temporary lighting within the temporary construction corridor and temporary construction compounds will be dependent on the season, timing of works and the nature of construction activities. Construction activities will be typically undertaken during daylight hours, but construction lighting may be required where night time or continuous working is proposed or in low light conditions during normal working hours.

219. When lighting is necessary, directional task lighting will be used to minimise glare and nuisance (Commitment ID CO85). Temporary construction lighting will be designed and positioned to ensure the necessary levels for safe working and site security, minimise light spillage and prevent disturbance to surrounding residents, wildlife and passing drivers on railways and the public highway. Specific construction lighting measures will be determined during detailed design post-consent.

220. Further details of construction lighting are set out in the **Outline Code of Construction Practice** (document reference 8.9) (Commitment ID CO73) provided with the PEIR.

4.9.5.3.9 Open-Cut Trenching Duct Installation

221. During excavation of the cable trenches, topsoil will be stripped from the temporary construction corridor, and the subsoil will be excavated to form trenches of the required dimensions. The depth of the trench will depend on the required cable burial depth based on locational constraints and will therefore vary along the onshore ECC and will be determined during detailed design post-consent (Commitment ID CO41). To prevent collapse of the trench side walls while the trench remains open, installation of appropriate shuttering or similar temporary support may be required. **Plate 4-19** provides an illustration of a typical open cut trench.

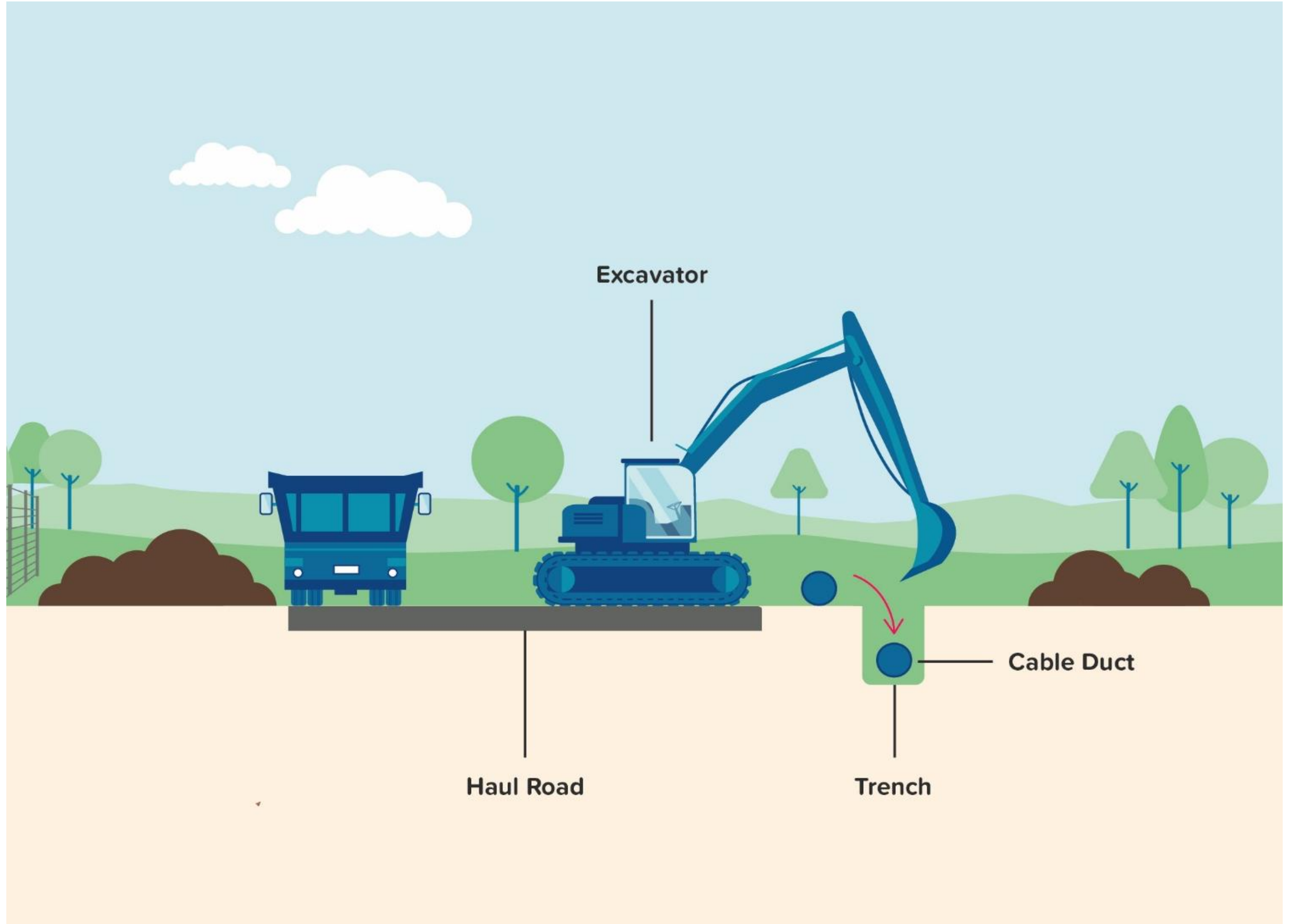

Plate 4-19 Indicative Cross-Section of Open Cut Trenching Duct Installation

222. The base of the cable trench will be prepared by removing obstructions such as rocks and depositing a layer of stabilised backfill (likely to be cement bound sand) as bedding material to provide protection under the cable ducts. During duct installation, dewatering of the trench using pumps may be required to provide a dry working environment. Cable ducts will be laid within the excavated trenches.

223. Following duct installation, the cable trenches will be backfilled with an imported thermally stabilised backfill (likely to be cement bound sand), ensuring that the ducts are encased within a consistent structural and thermal environment. Protective cable tiles or slabs and warning marker tape will be placed on top of the cable ducts to clearly demarcate the location of installed cables and reduce the risk of damage during future excavation works.

224. Backfilling of the cable trenches will be undertaken in stages using the stored subsoil, followed by the topsoil, to reinstate the trench to pre-construction conditions as practicable. As trenches will be backfilled and land reinstated as soon as practicable following completion of duct installation activities within each corridor section, the duration of open excavations along the onshore ECC will be minimised.

4.9.5.3.10 Obstacle Crossings

225. A draft Onshore Crossing Schedule is provided in **Volume 2, Appendix 4.3 Crossing Schedule - Onshore** to identify the locations of obstacle crossings along the onshore ECC and the proposed crossing methodologies at each location based on the design information available at this stage. Where flexibility is retained to either undertake duct installation using open cut trenching or a trenchless installation technique, the worst-case scenario will be assumed within the PEIR. The Onshore Crossing Schedule will be updated in the ES, considering stakeholder feedback and further engineering and environmental information, for the DCO application.

226. Each obstacle crossing will be individually reviewed during detailed design post-consent to confirm the crossing methodology based on pre-construction surveys and engineering design studies.

4.9.5.3.10.1 Trenchless Duct Installation Techniques

227. Where open cut trenching is not suitable due to major obstacle crossings, trenchless installation techniques will be used to install the cable ducts by drilling underneath the surface constraints. The use of a trenchless installation technique will include, but are not limited to, the following crossing locations:

- Environment Agency's Main Rivers and any associated flood defence structures and Internal Drainage Board (IDB) owned or maintained drains (Commitment ID CO32);
- Railway lines (Commitment ID CO77);
- Major roads (e.g. motorways, A roads and B roads) (Commitment ID CO78);
- Internationally, nationally and locally designated ecological sites and other sensitive ecological / landscape features such as woodland areas (Commitment ID CO59); and
- Major third party assets (e.g. national gas mains, pipelines and onshore transmission assets associated with other energy infrastructure developments) (Commitment ID CO58).

228. It is likely that Horizontal Directional Drilling (HDD) will be used at each trenchless crossing where practicable. However, several trenchless installation techniques are considered within the Project Design Envelope (as illustrated on **Plate 4-20** and **Plate 4-21**) to retain engineering flexibility. The specific type and crossing design at each trenchless crossing will be determined during detailed design post-consent based on ground investigations and other pre-construction surveys.

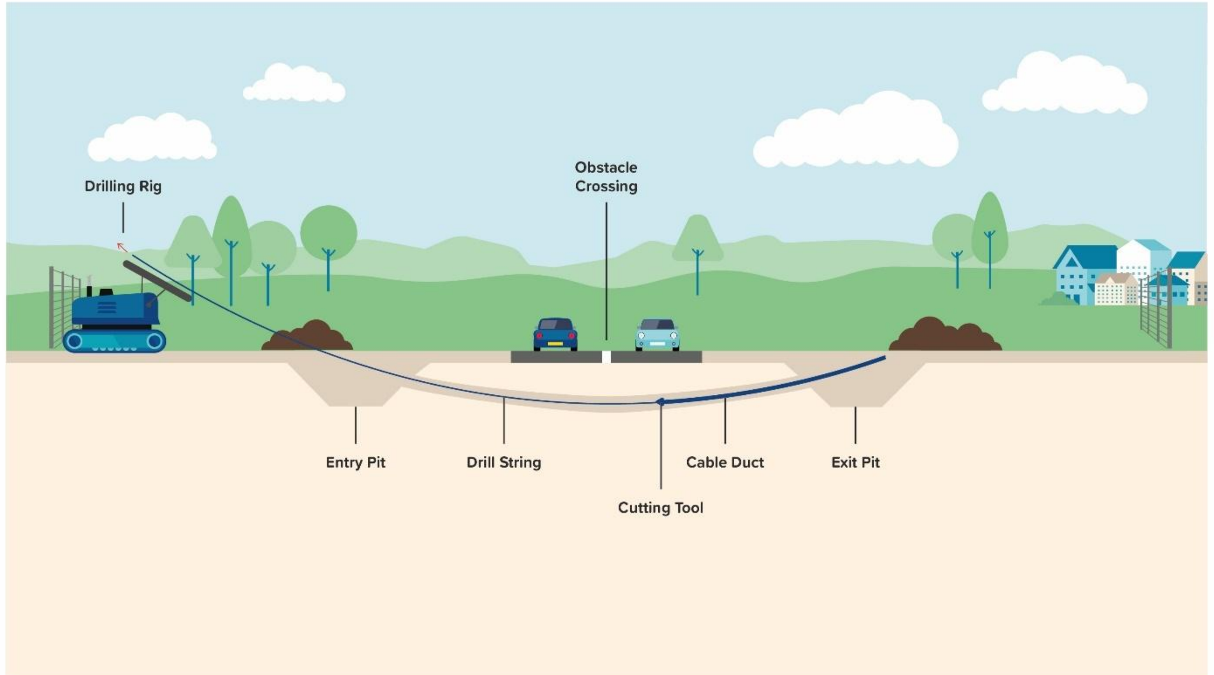

Plate 4-20 Indicative Cross-Section of Trenchless Duct Installation (Showing HDD, anticipated to be the most common technique for trenchless obstacle crossings.)

229. Prior to installation works, trenchless installation compounds will be established at the entry and exit pits on either side of the crossing. Trenchless installation of cable ducts will utilise a suitable trenchless installation equipment to drill a bore through which the ducts will be pulled into position from the exit pit, or alternatively, the drilling and installation of cable ducts can occur simultaneously by pushing the ducts forward as the bore is drilled from the entry pit.

230. Trenchless installation will start from the entry pit and travel underneath the surface constraint before emerging at the exit pit. At specific crossings, trenchless installation works may require continuous working, depending on the length of the crossing and locational constraints. The following trenchless installation techniques are currently being considered:

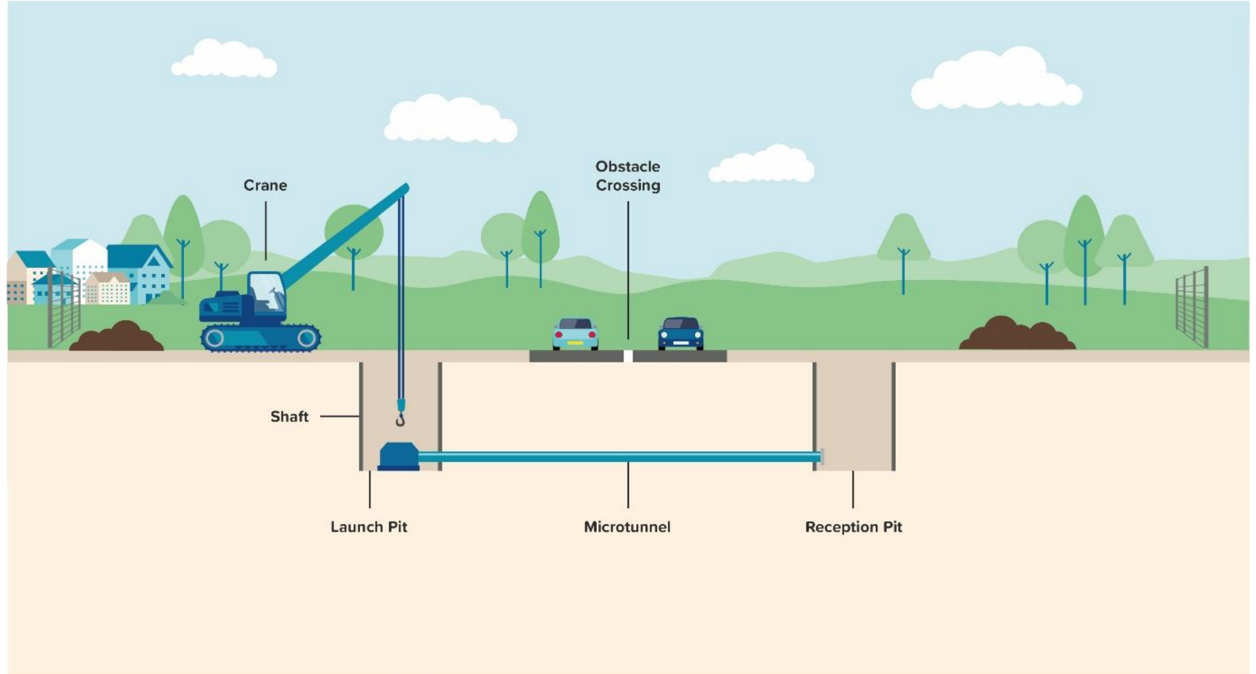

Plate 4-21 Indicative Cross-Section of Trenchless Duct Installation (showing alternative techniques to HDD such as micro-tunnelling or pipe-jacking.)

- HDD involves using a guided drilling rig to bore an initial narrow diameter pilot hole, followed by passing a larger cutting tool through to progressively enlarge the bore to the required diameter for duct installation. Once the drilling operation is complete, ducts are installed into the bore by pulling from the exit pit. HDD does not typically require the construction of deep temporary supported pits or shafts on either side of the crossing, and the entry and exit pits tend to be relatively small.
- Auger boring involves using a guided rotating auger head to bore a hole through the ground, with cutting spoil removed to the entry pit by auger flights rotating within a steel casing. Steel casing sections are welded together and pushed forward from the entry pit using a jacking system. Auger boring is suitable in most ground conditions, with the exception of sandy soil or where obstructions such as cobbles or boulders are present. Auger boring will require the construction of deep temporary supported pits or shafts on either side of the crossing and therefore the use of piling equipment.

- Micro-tunnelling involves using a tunnel boring machine that bores itself through the ground conveying spoil to the entry pit via conveyers. Pipe sections are jointed together and immediately follow the machine, which are installed into the bore by pushing from the entry pit using a jacking system. Micro-tunnelling can be used in most ground conditions, as the tunnel boring machine can be configured to suit the prevailing ground condition. Micro-tunnelling will require the construction of deep temporary supported pits or shafts on either side of the crossing and therefore the use of piling equipment.
- Pipe jacking or ramming involves the use of hydraulic jacks or a pneumatic pipe ramming hammer to drive forward pipe sections through the ground by physical force. Pipe sections are jointed together and placed behind a rotating cutting head or shield. Pipe jacking or ramming will require the construction of deep temporary supported pits or shafts on either side of the crossing and therefore the use of piling equipment.
- Direct pipe involves a hybrid method between HDD and micro-tunnelling. Direct pipe does not typically require the construction of deep pits on either side of the crossing, but temporary supports may be required at the entry pit and therefore the use of piling equipment.

231. Depending on the technique, trenchless installation operations may involve the use of drilling fluid. Drilling fluid would be continuously pumped through the installation equipment to the entry pit to facilitate the removal of drill arisings, stabilise the bore and lubricate the installation of cable ducts. If drilling fluid is required, a drilling fluid management system would be implemented at the trenchless installation compound to control the volume of drilling fluid used, process and recycle returned drilling fluid and monitor the risk of frac-out events (Commitment ID CO38).

4.9.5.3.10.2 Minor Watercourse Crossings

232. Where minor watercourses such as field drains are to be crossed for duct installation works, this will be undertaken using open cut trenching combined with temporary damming and diversion of the watercourse.

233. The watercourse will be temporarily dammed at either side of the crossing point, typically using sandbags, straw bales or ditching clay, and water will be pumped across the dammed area for the duration of the duct installation works to maintain flow within the watercourse. The dammed area will be dewatered to provide a dry environment for open cut trenching as described in **Section 4.9.5.3.9**, and the excavated channel bed materials will be stored separately from the subsoil. Cable ducts will be installed at a depth that would avoid impacts to the active channel bed. **Plate 4-22** provides a typical illustration of culvert structures required for watercourse crossings (Commitment ID CO35).

Plate 4-22 Example Culvert Installation for Water Crossings (Source: Dogger Bank C)

234. The specific methodology for minor watercourse crossing at each location will be confirmed during detailed design post-consent and agreed with the relevant authority or asset owner. Further details on measures to protect surface watercourses during construction are provided in the **Outline Code of Construction Practice** (document reference 8.9) (Commitment ID CO39) provided with the PEIR.

235. Upon completion of duct installation works, reinstatement of the cable trenches will be undertaken to the pre-construction depth of the watercourse as practicable using the excavated subsoil and channel bed materials in the order they were removed. The temporary dams and diversions will then be removed to restore natural flow within the watercourse.

236. Haul road crossings of minor watercourses may also be required, which would involve installation of temporary culverts or bridges for the duration that the haul road is required. Construction of culverts and bridges will require temporary damming and diversion as per the methodology described above for duct installation works (Commitment ID CO35).

4.9.5.3.10.3 Minor Road and Public Rights of Way Crossings

237. Where minor roads, such as access tracks and unclassified roads, are to be crossed for duct installation works or the haul road, appropriate traffic management measures, which are fully detailed within the **Outline Construction Traffic Management Plan** (Commitment ID CO73) (document reference 8.15) provided with the PEIR, will be implemented for the duration of works.

238. Where the temporary construction corridor crosses minor roads, temporary traffic crossing measures will be implemented to allow safe operation of construction vehicles and plant and equipment moving along the haul road. Single lane traffic management with signal controls to manage traffic movement will be used during duct installation works where appropriate. Where the width of the road does not allow for single lane traffic management, alternative methods such as temporary road closures or diversions for the duration of works may be used.

239. The road crossing methodology will be confirmed at detailed design stage post-consent and agreed with the relevant authority or asset owner. Should standard traffic management measures be considered unsuitable at the minor road crossing, a trenchless installation technique may be used instead.

240. Where Public Rights of Way (PRoW) are to be crossed for duct installation works or the haul road, appropriate temporary management measures such as temporary closures or diversions will be implemented to ensure continued and safe access by walkers, cyclists and horse riders, as described in the **Outline Public Rights of Way Management Plan** (document reference 8.9.1) (Commitment ID CO57) provided as part of the **Outline Code of Construction Practice** (document reference 8.9) (Commitment ID CO39) with the PEIR. The PRoW crossing methodology will be confirmed at detailed design stage post-consent and agreed with the relevant authority or asset owner.

241. Open cut trenching of minor roads and PRoW will be undertaken as described in **Section 4.9.5.3.9**. Reinstatement of cable trenches will follow the same process of reinstating stored subsoil followed by topsoil but may also require reinstatement of the paved surface, such as laying of asphalt, tarmac or other paving material, to the specification agreed with the relevant authority or asset owner (Commitment ID CO100).

4.9.5.3.10.4 Third Party Asset Crossings

242. Where third party assets are to be crossed for duct installation works or the haul road, construction works will be undertaken in accordance with industry standard practice and safety guidance. The crossing methodology will be confirmed at detailed design post-consent and agreed with the relevant asset owner / operator to ensure their protection and continued operation (Commitment ID CO58).

4.9.5.3.11 Jointing Bay and Link Box Construction

243. In parallel to the duct installation works, jointing bays and associated link boxes will be constructed at locations along the onshore ECC where jointing of cable sections will occur.

244. Construction activities will likely involve:

- Topsoil stripping;
- Subsoil excavation;
- Dewatering of the excavation using pumps (if required);
- Installation of the reinforced concrete slab base for the jointing bay (and if required, installation of reinforced concrete walls and roof structure following cable pull-in and jointing operations); and
- Installation of the reinforced concrete enclosure for an underground link box or a kiosk overlying a concrete pad for an above-ground link box and bollards, fences or similar (if required) in proximity to the jointing bay.

4.9.5.3.12 Cable Pull-In and Jointing

245. Following the completion of duct installation works and construction of jointing bays and link boxes, onshore export cable sections will be pulled into the pre-installed ducts from jointing bay locations. Access to and from jointing bays via construction accesses off the public highway or the haul road will be required during this phase of works.

246. Prior to cable pull-in operations, a cable drum will typically be delivered to designated jointing bay locations, with the cable tethered to a winch cable from the adjacent jointing bay. Once cable sections from both directions have been installed within each jointing bay, cable jointing will be undertaken. Cable testing will be undertaken for each section of installed onshore export cables along the entire length of the onshore ECC.

4.9.5.3.13 Reinstatement and Site Demobilisation

247. Construction within the onshore ECC will be undertaken concurrently at multiple corridor sections. However, works within each section will be considerably shorter in duration than the total onshore export cable construction programme. This allows for rolling reinstatement whereby land within the temporary construction corridor between jointing bay locations will be reinstated, where practicable, as soon as construction within each section is completed (Commitment ID CO100).

248. Reinstatement of the cable trenches are outlined in **Section 4.9.5.3.9**, as they can be undertaken following duct installation works. Following cable pull-in and jointing operations, the cables will be tested, and the jointing bays will be backfilled with cement bound sand and excavated subsoil, and topsoil will be reinstated above the jointing bay.

249. Upon completion of all onshore export cable works, construction plant and equipment will be demobilised. Temporary construction compounds, construction accesses, haul road and other temporary infrastructure along the length of the onshore ECC will be removed, and topsoil will be reinstated within these areas.

250. All areas within the temporary construction corridor will be reinstated to pre-construction conditions as practicable. Reinstatement works will also include as appropriate:

- Reinstating any land drainage removed or altered;
- Reinstating any watercourse, minor road, PRoW or third party asset temporarily diverted or disturbed; and
- Replanting / replacement planting of hedgerows and trees removed (or relocation of trees to a suitable location if planting restrictions over the installed cables prevent replanting at the original location).

4.9.6 Onshore Converter Station Zone

251. The OCS zone contains all the electrical transmission infrastructure required to stabilise and convert electricity generated by the Project into a suitable voltage for grid connection and auxiliary energy storage and balancing equipment.

252. Within the PEIR assessment, the Onshore Development Area includes two broad zones (OCS Zones 4 and 8) of approximately 50ha and 60ha respectively, which will accommodate the construction and permanent footprint of the OCS and co-located ESBI, including any ancillary works such as drainage, access and parking, welfare facilities, lighting, fencing, landscaping and environmental mitigation / enhancement. Both zones remain under consideration (see **Chapter 5 Site Selection and Consideration of Alternatives**), but only one zone will be taken forward to development.

253. At this stage, layout configurations of infrastructure within both OCS zones are still under consideration, and both zones are therefore assessed within the PEIR, with relevant realistic worst-case scenarios outlined in each onshore and project-wide technical chapters (**Chapter 19 Geology and Ground Conditions** to **Chapter 31 Climate Change**). The OCS zones will be further refined through site selection, considering stakeholder feedback and further engineering and environmental information and one OCS zone confirmed in the ES for the DCO application.

254. The Project Design Envelope with respect to the OCS and co-located ESBI has been defined based on the maximum land and infrastructure requirements from the range of design and technology options under consideration. This is to provide a realistic worst-case assessment of their environmental impacts (e.g. spatial footprint and building massing) within the PEIR. The final layout of the OCS and co-located ESBI will vary within the selected zone and optimised to meet technical and operational requirements, and the final design and technology specification will be determined post-consent following detailed design and procurement decisions.

4.9.6.1 Description of Onshore Converter Station

255. The OCS will comprise a fenced compound to house electrical equipment for converting the electricity generated by the Project from HVDC to 400kV HVAC, as required to meet the UK Grid Code for connection into the National Grid electricity transmission network. **Plate 4-23** provides an illustration of an example OCS (in construction).

256. The OCS is likely to include the following key components:

- A valve hall to house DC to AC converter equipment;
- A service building to support operation and maintenance activities;
- A storage building;
- A DC and AC yard containing switch gear and harmonic filters to connect the OCS to the HVDC and HVAC onshore export cables respectively;
- An outdoor transformer area containing transformers to control the voltage level with concrete fire walls between each transformer;
- An outdoor reactor yard containing current limiting, voltage control, harmonic filtering, smoothing current and reactive power compensation equipment;
- A cooling fan assembly to ensure all heat generated by electrical equipment is safely dissipated;
- Lightning protection masts; and
- Emergency diesel generators and associated storage / bunkering (as required)

257. **Table 4-28** and **Table 4-29** provide the key design parameters for the OCS.

Plate 4-23 Example Onshore Converter Station (in construction) (Source: Dogger Bank C)

258. The largest building within the OCS will be the valve hall. The converter equipment within the valve hall requires a controlled environment for safe operation, requiring the valve hall building to be designed to be weathertight and meet airtightness standards. Operational working clearance requirements around the converter equipment within the valve hall will determine the footprint and height of the building. The tallest height of any outdoor electrical equipment within the OCS will be the lightning protection masts.

4.9.6.2 Description of Energy Storage and Balancing Infrastructure

259. The ESBI will comprise a fenced compound(s) and will be co-located with the OCS to provide a storage solution for energy generated from the wind farm and allow flexibility during intermittent wind generation output. The ESBI will discharge energy to the electricity transmission system during times of system need, including provision of low carbon balancing, peaking and ancillary services, thus enhancing the resilience of the Project's power supply.

260. The ESBI will be connected to the OCS via electrical cabling and / or to the National Grid electricity transmission network via HVAC onshore export cables which will run to Birkhill Wood Substation. **Plate 4-24** shows an example of an ESBI under construction.

261. The ESBI is likely to include the following key components:

- Battery blocks, each containing:
  - Battery units;
  - Power conversion system (PCS) units to convert electricity between AC and DC during electricity import and export processes;
  - Heating, ventilation and air conditioning (HVAC) system;
  - Battery management system
  - Fire suppression system;
  - Energy management system;
  - Other monitoring and control systems;
- An outdoor substation containing transformers, busbars, switchgear and concrete fire walls;
- Harmonic filters;
- A service building to support operation and maintenance activities;
- Storage buildings;
- Switch rooms and auxiliary transformers;
- Lightning protection masts; and
- Firefighting water tanks and pumps

262. The largest buildings within the ESBI will be the switch room buildings. The electrical equipment within the switch room buildings will collect and distribute the power to and from the battery units. The tallest outdoor electrical equipment associated with the ESBI will be the lightning protection masts. Battery blocks are typically provided in containerised solutions and arranged in rows with appropriate separation retained between individual battery units to ensure operational working clearances.

263. In ensuring the safety of the ESBI during both construction and operation, a number of measures will be considered through the design and development process. Indicative safety measures for the ESBI are provided below, which will be confirmed in the Outline Battery Safety Management Plan (Commitment ID CO79) developed at the ES stage:

- Selection of battery units which promote safety in design through:
  - Battery chemistry;
  - Alarms and monitoring:
    - Fire alarms – monitoring battery 'failure state' and smoke detectors;
    - Temperature;

- Humidity compliance with relevant engineering standards;
- Fire rating and firewalls;
- Ventilation and cooling systems;
- Deflagration panels;

- Implementation of separation distances both between individual battery blocks (indicatively 3.1m) and between groups of battery blocks to provide a fire break (indicatively 6.1m); and
- Provision of appropriate firefighting water reserves and other containment measures.

Plate 4-24 A Battery Storage site under construction in Ferrybridge, West Yorkshire (Source: SSE Renewables)

264. **Table 4-28** and **Table 4-29** provide the key design parameters for the ESBI.

Table 4-28 Project Design Envelope – Onshore Converter Station and Energy Storage and Balancing Infrastructure Parameters

Parameter	Value
OCS	
Maximum number of OCS	1
Indicative number of OCS buildings	3 (excluding smaller shed structures)
Maximum OCS building height (m)	25
Maximum OCS outdoor electrical equipment height (m)	30
Indicative number of OCS temporary construction compound	1
ESBI	
Indicative number of battery block and composition	50 (each block with up to 24 battery units and 2 PCS units)
Indicative battery unit dimensions (m) (length-width-height)	20 x 5 x 4
Indicative PCS unit dimensions (m) (length-width-height)	6.1 x 2.5 x 4
Indicative number of Ancillary ESBI buildings	6 (excluding smaller shed structures)
Maximum ESBI building height (m)	20
Maximum ESBI outdoor electrical equipment height (m)	25
Indicative number of ESBI temporary construction compound	1
Combined (OCS and ESBI)	
Indicative access road width (m) (including site access road from the public highway and internal tracks within the site)	7.3
Indicative quantity of topsoil excavated during combined construction works (m^3)	100,000
Indicative quantity of topsoil removed off-site during combined construction works (m^3)	50,000

Table 4-29 Project Design Envelope – Onshore Converter Station and Energy Storage and Balancing Infrastructure Areas

Parameter	Value
Maximum OCS platform footprint (ha)	5.5
Maximum permanent OCS area (ha)	9.5*
Maximum ESBI platform footprint (ha)	8.5

Parameter	Value
Maximum permanent ESBI area (ha)	11*
Total permanent area (ha)	**20.5***
Indicative OCS temporary construction compound area (ha)	2.5
Indicative ESBI temporary construction compound area (ha)	2
Total temporary area (ha)	**4.5**
Maximum developable area for OCS and ESBI (ha)	**25***

*Note: These areas include, but not limited to, the platform footprint, landscaping, access, drainage and attenuation but exclude areas for ecological mitigation / enhancement.

4.9.6.3 Onshore Converter Station and Energy Storage and Balancing Infrastructure Construction Activities

265. The main construction works within the OCS zone are likely to include:

- Pre-construction activities and surveys;
- Topsoil stripping;
- Construction of temporary construction compounds;
- Construction of access roads to enable site access and movement of plant and equipment and personnel within the zone;
- Land forming and earthworks, including cut and fill (if required);
- Excavation of trenches and installation of underground electrical cabling, utilities and drainage, including termination of HVDC and HVAC onshore export cables within the zone;
- Formation of foundations for buildings and outdoor equipment;
- Construction of building superstructures;
- Installation of electrical and auxiliary equipment;
- Equipment testing and commissioning; and
- Landscaping and site demobilisation.

266. Prior to the commencement of construction, pre-construction surveys, such as ground investigations, geophysical, UXO, utility, drainage, topographical and environmental surveys, will be undertaken to inform the detailed design and construction methodology of OCS and co-located ESBI construction works and ensure required mitigation works are in place. Pre-construction activities will also be undertaken to secure and prepare the site for construction works. Further details of pre-construction surveys and activities are provided in the **Outline Code of Construction Practice** (document reference 8.9) (Commitment ID CO39) provided with the PEIR.

267. General construction practices, including construction drainage, fencing and signage, lighting, vegetation clearance and soil handling, for the OCS and co-located ESBI construction works are expected to be similar to those undertaken for onshore export cable works, which are presented in **Section 4.9.5.3.4** to **Section 4.9.5.3.8**.

268. It is assumed that site establishment and enabling works will be undertaken on a site-wide basis. Construction and installation of the OCS and co-located ESBI will likely be undertaken in parallel, but staggering of works may be required. Based on the indicative construction programme (see **Section 4.7**), the duration of combined OCS and co-located ESBI construction works is anticipated to be approximately five years.

4.9.6.3.1 Temporary Construction Compounds

269. Two temporary construction compounds will be required to serve the OCS and co-located ESBI construction works. These compounds are likely to include laydown areas for construction materials and plant and equipment, storage areas for construction waste, bunded storage areas, vehicle parking areas, welfare facilities, wheel washing facilities, workshops and offices.

270. Where there is no existing hardstanding, temporary construction compounds will be constructed by stripping and storing the topsoil for reinstatement, laying a geotextile membrane or similar directly on top of the subsoil and spreading crushed stone or other aggregates to create a suitable hardstanding area.

271. Both compounds will be established within the footprint of the OCS zone and will be in place for the duration of OCS and co-located ESBI construction works. The final location and layout of the OCS and co-located ESBI temporary construction compounds will be determined during detailed design post-consent.

4.9.6.3.2 Construction Accesses

272. Construction accesses to the OCS zone will be established to allow construction traffic to access and egress from the public highway onto the site (Commitment ID CO72). The temporary construction accesses will be used for the duration of OCS and co-located ESBI construction works and may remain as the permanent O&M accesses to the site.

273. Construction of the access roads will involve topsoil stripping, laying of a geotextile membrane and reinforcing geogrid onto the subsoil and installation of suitable graded aggregates and paving material to form hardstanding. The material specification and design of the access roads will be determined during detailed design post-consent following ground investigations.

274. Further details on proposed construction accesses for the OCS zones are provided in **Chapter 26 Traffic and Transport**. The final location of the construction access points, outline access design and details on the modification works required will be confirmed for the DCO application and presented in the ES, with detailed access design to be determined post-consent.

4.9.6.3.3 Enabling Works

275. The construction site will be subject to topsoil strip, and the ground graded to the required levels, which will be determined during detailed design post-consent. The existing ground may be excavated from areas where the ground level needs to be lowered and relocated to areas that require elevation. This is known as cut and fill earthworks.

276. Where the ground does not have the required strength to support the proposed infrastructure, additional imported material may be used. Any excess material will be used on-site where practicable for earthworks, bunding and landscaping, with unsuitable material being removed from site for suitable recycling or disposal.

4.9.6.3.4 Formation of Foundations

277. After grading throughout the site is complete, subsoil excavations will be undertaken to facilitate the laying of foundations, trenches for internal underground electrical cabling, termination of the HVDC and HVAC onshore export cables, third party utility connections and site drainage. Where groundwater levels are high, dewatering of excavations may be required.

278. At this stage, it is not known whether the foundations would be shallow or piled and both options are included in the Project Design Envelope. As the worst-case scenario, it is assumed that piling may be required during construction of the foundations. Formation of foundations will typically require construction activities such as formwork, aggregate laying and concrete pouring. The foundation requirements will be dependent on the ground conditions and the electrical, mechanical and structural design requirements of the OCS and co-located ESBI, which will be determined during detailed design post-consent.

4.9.6.3.5 Building and Equipment Installation Works

279. Upon completion of the foundation works, building superstructures will be constructed. The building superstructures associated with the OCS and co-located ESBI will be predominantly composed of steel frame with cladding materials, although brick or block-built structures may be considered. The structural steelwork will likely be fabricated off-site and delivered to site for installation. The steelwork will be erected with the use of cranes, and cladding will be fitted once the formwork is in place.

280. Electrical equipment associated with the OCS and co-located ESBI will be delivered to site. Due to their size and weight of components such as the transformers and battery blocks, specialist delivery methods will be employed, and components will be offloaded at site and positioned onto foundations with the use of cranes. Installation of other electrical and auxiliary equipment will require the use of mobile plant and equipment and lifting apparatus. Other activities include internal fit-outs of buildings and installation of other ancillary infrastructure such as site fencing, lighting and access roads and parking.

4.9.6.3.6 Finishing Works and Site Demobilisation

281. As part of finishing works, landscaping and bunding measures will be established within the permanent footprint of the OCS and co-located ESBI to provide mitigation against environmental effects such as noise or landscape and visual effects, as identified through the EIA process. An outline design of soft and hard landscaping measures at the OCS zone will be presented in the Outline LMP which will be developed at the ES stage, with detailed landscaping design to be determined post-consent.

282. The Project is exploring opportunities to deliver at least 10% Biodiversity Net Gain BNG), where required under emerging regulatory requirements for Nationally Significant Infrastructure Projects. Ecological mitigation / enhancement areas will be established within the permanent footprint of the OCS and co-located ESBI, and where practicable, this will be incorporated as part of the landscaping design. Further details of BNG measures will be provided in the Outline BNG Strategy which will be developed at the ES stage. Habitat enhancement and creation may be provided off-site if required in order to meet the 10% BNG target.

283. Upon completion of all construction works, construction plant and equipment will be demobilised, and temporary construction compounds and other temporary infrastructure will be removed. Any temporary works area within the construction site will be reinstated using the stored topsoil to pre-construction conditions as far as practicable.

4.9.7 Grid Connection into Birkhill Wood Substation

284. Birkhill Wood Substation is not part of the Project and therefore does not fall within the scope of the DCO application. National Grid Electricity Transmission (NGET) will seek a separate planning permission under the Town and Country Planning Act 1990 to develop the new substation, with submission of the planning application planned for 2025.

285. The Onshore Development Area within the PEIR includes land around Birkhill Wood Substation for grid connection works. These works are likely to involve the installation of HVAC onshore export cables up to the boundary of Birkhill Wood Substation and termination of cables at user bays located close to or within the substation footprint.

4.9.8 Onshore Operation and Maintenance

286. The O&M phase of the Project's onshore infrastructure is anticipated to be 35 years long. The sections below provide an indicative description of likely O&M activities for onshore infrastructure.

4.9.8.1 Onshore Export Cables

287. An operational easement of approximately 20m width for the HVDC export cables and 25m width for the HVAC export cables will be in place along the onshore ECC throughout the Project's operational lifetime to restrict ground-penetrating activities that could affect the installed export cables. It is expected that normal agricultural activities will be able to continue. The width of the operational easement at specific locations will be determined at detailed design stage post-consent and may widen at trenchless crossing locations depending on the installation depth. In addition to the bollards, fencing or similar equipment around the link boxes (see **Section 4.9.5.2**), small marker posts of approximately 1 to 1.2m height will be installed along the operational easement to demark the location of the installed onshore export cables. Marker posts will, at a minimum, be required at field boundaries, on either side of obstacle crossings such as roads and watercourses and where there are significant directional changes in the cable route (see **Plate 4-15)**.

288. Onshore export cables will be remotely monitored to ensure good performance and determine the requirements for corrective maintenance. Routine non-intrusive inspection works is anticipated to consist of a visit to each jointing bay and associated link box location every six months for cable joint inspection and monitoring. Periodic testing of onshore export cables is likely to be required every six months, which would be undertaken at defined inspection points along the onshore ECC.

289. Personnel access would be undertaken either from the manhole cover installed on top of underground link boxes or via the installed kiosk for above-ground link boxes. As the haul road will not be in place during operation, access to the relevant sections of the onshore export cables and jointing bay locations will be gained using existing field accesses or other suitable accesses from the public highway.

290. Maintenance of the onshore export cables during operation is expected to be minimal. Unplanned emergency maintenance works to address faults would be undertaken as required, and depending on the nature of the repair, may involve intrusive works such as the excavation of two adjacent jointing bays, removal of the faulty cables and installation of replacement spare cables into the cable ducts. Alternatively, the length of faulty cables may be excavated and replaced with spare cables, and two new jointing bays installed within the affected area.

291. Further details on proposed O&M accesses for the onshore ECC are provided in **Chapter 26 Traffic and Transport**. No modifications to the public highway are anticipated to enable O&M access for routine inspection works and non-intrusive maintenance works.

292. No long-term operational lighting will be required within the onshore ECC. Routine inspection and non-intrusive maintenance activities will typically be undertaken during daylight hours, but temporary directional task lighting may be required where night time or continuous working is proposed or in low light conditions during normal working hours.

4.9.8.2 Onshore Converter Station and Energy Storage and Balancing Infrastructure

293. The OCS and co-located ESBI will be unmanned with no permanent on-site personnel presence and will be capable of operating 24 hours a day and year-round. Monitoring of the OCS and co-located ESBI will be undertaken using remote monitoring equipment to ensure good performance and determine the requirements for corrective maintenance. Site security will be provided using perimeter fencing and CCTV technology.

294. Routine inspections of the OCS and ESBI during operation is anticipated to consist of a monthly visit to the OCS and co-located ESBI for a duration of a few days.

295. Routine non-outage maintenance works of the OCS and ESBI are anticipated to consist of four annual visits to the OCS and co-located ESBI for a duration of one week, with outage maintenance works scheduled once every third year. End of life replacement of components associated with the OCS and co-located ESBI will be undertaken as required, the frequency of which will vary depending on the design life of each component.

296. Unplanned emergency maintenance works to address faults or redundancy loss will be undertaken as and when necessary, and depending on the nature of the repair, may involve deinstallation of faulty electrical equipment and installation of replacement spare parts.

297. Where practicable, O&M accesses to the OCS zone will be via the same access roads installed during construction, however, construction of new permanent access roads may also be required. O&M accesses will remain in place for the duration of the Project's O&M phase. Further details on proposed O&M accesses for the OCS zones are provided in **Chapter 26 Traffic and Transport**.

298. Operational lighting (with the exception of low-level, motion-sensor security lighting) at the OCS zone will only operate when required for operation and maintenance activities during low light conditions. Further details on operational lighting requirements for the OCS and co-located ESBI will be provided in the ES, with detailed lighting design determined post-consent (Commitment ID CO66).

299. Routine inspection and maintenance activities will be typically undertaken during daylight hours, but temporary directional task lighting may be required where night time or continuous working is proposed or in low light conditions during normal working hours.

300. An operational surface water drainage system will be installed for the OCS and co-located ESBI and will be designed to meet the technical requirements outlined in the National Planning Policy Framework (NPPF). This will include the use of Sustainable Drainage System (SuDS) whereby attenuation and infiltration techniques will be used before a controlled discharge. Further details on the operational surface water drainage strategy for the OCS and co-located ESBI will be presented in an Outline Drainage Strategy (Commitment ID CO44) to be developed at the ES stage.

301. Foul drainage will be collected through either a mains connection discharged to the existing local authority sewer system if available or a septic tank located within the OCS and co-located ESBI. The specific approach will be determined during detailed design post-consent.

4.9.9 Onshore Decommissioning

302. The final decommissioning strategy of the Project's onshore export cable infrastructure, OCS and co-located ESBI has not yet been decided. The final decommissioning methodology will adhere to regulatory requirements and industry best practice at the time of decommissioning and outlined in an Onshore Decommissioning Plan (Commitment ID CO56), which will be submitted and agreed with the relevant authorities prior to the commencement of onshore decommissioning works. The next sections provide a description of potential decommissioning activities for onshore infrastructure.

4.9.9.1 Onshore Export Cables

303. Where appropriate, onshore export cables and other buried infrastructure along the onshore ECC, such as jointing bays, underground link boxes and cable ducts, will be decommissioned and left in-situ. If considered unsuitable to be left in-situ at the time of decommissioning, these components will be excavated and removed from the ground, and the land above will be reinstated. Above ground link boxes will be removed during decommissioning. Where practicable, materials and components would be recovered and recycled.

4.9.9.2 Onshore Converter Station and Energy Storage and Balancing Infrastructure

304. Decommissioning works are likely to be undertaken in reverse to the sequence of construction works and involve similar levels of vehicles and plant and equipment and duration of works. Decommissioning activities for the OCS and co-located ESBI are expected to include the removal and removal of electrical equipment, removal of foundations, cables and other underground services, removal of buildings and other above-ground structures and landscaping (unless otherwise agreed with the respective landowner(s)) and site reinstatement. Where practicable, materials and components would be recovered and recycled. The site would be reinstated to its pre-construction conditions as practicable or made suitable for an alternative use.

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List of Acronyms

Acronym	Definition
AC	Alternating Current
ACE	Arup Concept Elevating
ACE	Arup Concept Elevating
AEZ	Archaeological Exclusion Zones
BNG	Biodiversity Net Gain
CAA	Civil Aviation Authority
CBRA	Cable Burial Risk Assessment
CLV	Cable Lay Vessel
CoCP	Code of Construction Practice (
CPS	Cable Protection System
CRA	Chemical Risk Assessment
CSV	Construction Support Vessel
CTMP	Construction Traffic Management Plan
DBD	Dogger Bank D
DC	Direct Current
DCO	Development Consent Order
ECC	Export Cable Corridor
EcoMP	Ecological Management Plan
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ES	Environmental Statement
ESBI	Energy Storage and Balancing Infrastructure

Acronym	Definition
ETG	Expert Topic Group
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicles
HLV	Heavy Lift Vessel
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
JUV	Jack-Up Vessel
LAT	Lowest Astronomical Tide
LMP	Landscape Management Plan
LWS	Local Wildlife Site
MCZ	Marine Conservation Zone
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MoD	Ministry of Defence
MPA	Marine Protection Area
MPCP	Marine Pollution Contingency Plan
NGET	National Grid Electricity Transmission
NPS	National Planning Statements
O&M	Operation and Maintenance

Acronym	Definition
OCS	Onshore Converter Station
OoS	Out-of-Service
PCS	Power conversion system
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PINS	Planning Inspectorate
PLGR	Pre-Lay Grapnel Run
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SAR	Search and Rescue
SPA	Special Protected Area
SSSI	Site of Special Scientific Interest
TJB	Transition Joint Bay
TP	Transition Piece
TSD	Trailing Suction Dredger
TSHD	Trailing Suction Hopper Dredger
UK	United Kingdom
UKHO	UK Hydrographic Office
USV	Uncrewed Surface Vehicles
UXO	Unexploded Ordnance
WCMS	Watercourse Crossing Method Statement