2.4

Volume 2, Chapter 4:

The Proposed Development

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4. The Proposed Development

4.1 Introduction

Overview

4.1.1 This chapter provides an overview of Rampion 2, hereafter referred to as the 'Proposed Development', and it sets out the main components of the offshore wind farm, associated substations and energy transmission infrastructure. It also describes the key activities that will be undertaken during construction, operation and maintenance and decommissioning, and includes key assessment assumptions along with indicative timescales.

4.1.2 At this stage, the description of the Proposed Development is indicative and a 'design envelope' approach has been adopted which takes into account Planning Inspectorate (PINS) Advice Note Nine: Rochdale Envelope, July 2018 (PINS, 2018). The provision of a design envelope is intended to identify key design assumptions to enable the environmental assessment to be carried out whilst retaining enough flexibility to accommodate further refinement during detailed design. Further details on the use of the Rochdale Envelope as recommended by the National Policy Statement for Renewable Energy (EN-3) (DECC, 2011b) are provided in **Chapter 2: Policy and legislative context**.

4.1.3 Assessing the Proposed Development using this assumption-based design envelope approach means that the assessment will consider a maximum design scenario which allows flexibility to make design decisions in the future that cannot be finalised at the time of submission of the Development Consent Order (DCO) Application. Such design decisions may include the precise models and dimensions of wind turbine generators (WTG) which will be available at the time of placing orders for the Proposed Development, or the final optimised layout taking into account detailed engineering factors and wind energy optimisation. The use of this approach has been adopted for this Preliminary Environmental Information Report (PEIR) and will also enable the Environmental Impact Assessment (EIA) to be based on a description of the location, design and size of the Proposed Development that is suitable to allow a preliminary assessment of its likely significant environmental effects, and includes the information reasonably required to enable a properly informed response to the consultation.

4.1.4 The current proposal is for Rampion 2 to have an installed capacity of up to 1,200 MW, with the offshore components comprising:

- offshore wind turbine generators (WTGs), associated foundations and inter-array cables, with the wind farm generating an installed capacity of up to 1,200MW but not exceeding the number of WTGs installed at Rampion 1 (116No.);
- up to three offshore substations;
- up to four offshore export cables, each in its own trench within the overall cable corridor; and

- up to two offshore interconnector export cables between the offshore substations.

4.1.5 The key onshore elements of the Proposed Development will be as follows:

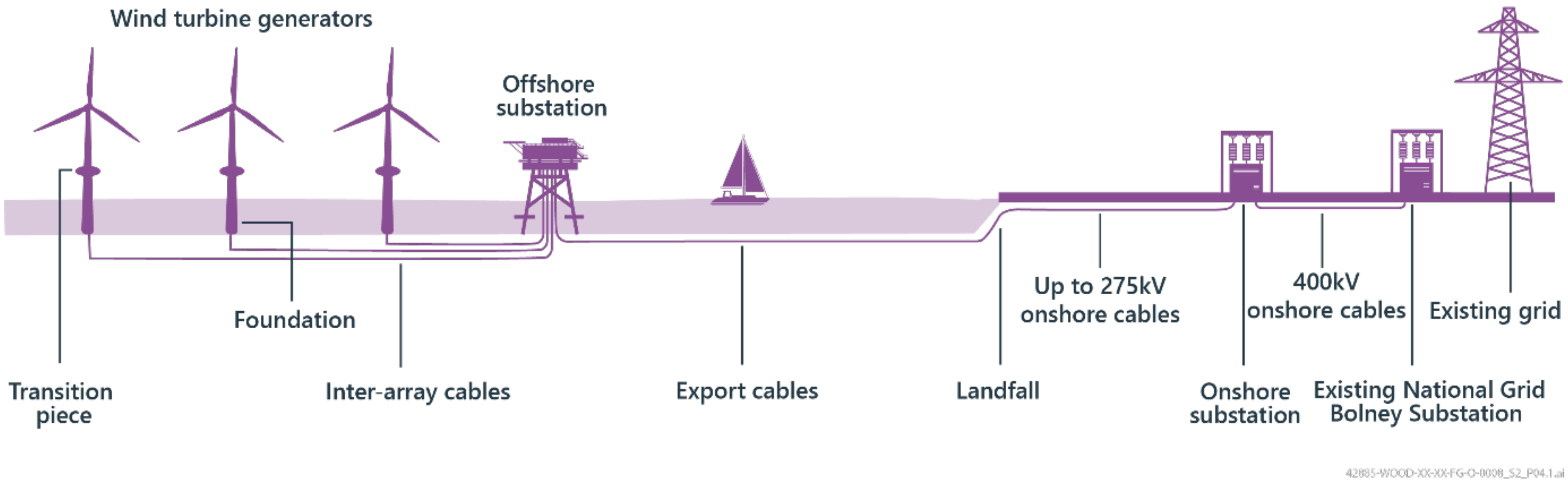
- a single landfall site using Horizontal Directional Drilling (HDD) installation techniques;
- buried onshore cables in a single corridor approximately 36km in length; and
- a new onshore substation that will connect to the existing National Grid Bolney substation, Mid Sussex, via buried onshore cables.

4.1.6 For the purposes of the PEIR, the key components of the Proposed Development are separated into offshore and onshore elements and are illustrated in **Graphic 4-1.** Where possible at this stage, this includes the design assumptions, which are described in accordance with the Rochdale Envelope approach. The description of the Proposed Development will be refined as the design continues to evolve through the key subsequent stages of the design, consultation and EIA process culminating in the Environmental Statement (ES) that will accompany the DCO Application.

4.1.7 **Chapter 3: Alternatives** describes the other key locations and technologies that have been considered by RED to date, and the reasons why the proposed design has been chosen instead of the alternative options.

4.1.8 The description of the Proposed Development also includes embedded environmental measures, to avoid or reduce environmental effects, which have been directly incorporated into the design. **Chapter 5: Approach to the EIA** explains the approach to environmental measures that has been applied in the PEIR. The environmental assessments presented in **Chapters 6** to **28** provide details of how the embedded environmental measures are proposed to avoid or reduce environmental effects.

Graphic 4-1 Key components of the Proposed Development



Structure of the chapter

4.1.9 The remainder of this chapter is structured as follows:

- **Section 4.2**: Description of the Proposed Development;
- **Section 4.3**: Offshore elements of the Proposed Development;
- **Section 4.4**: Onshore elements of the Proposed Development;
- **Section 4.5**: Construction programme;
- **Section 4.6**: Operation and maintenance;
- **Section 4.7**: Decommissioning;
- **Section 4.8**: PINS Scoping Opinion responses relevant to the description of the Proposed Development;
- **Section 4.9**: Glossary of terms and abbreviations; and
- **Section 4.10**: References.

4.2 Description of the Proposed Development

The PEIR Assessment Boundary

4.2.1 The PEIR Assessment Boundary (illustrated in **Figure 1.1, Volume 3**) used to inform this PEIR combines the search areas for the offshore and onshore infrastructure associated with the Proposed Development. It is defined as the area within which the Proposed Development and associated infrastructure will be located, including the temporary and permanent construction and operational work areas.

4.2.2 The offshore part of the PEIR Assessment Boundary has been refined through multidisciplinary workshops, which took stakeholder feedback into account, and are further detailed in **Chapter 3: Alternatives**.

4.2.3 The offshore elements of the Proposed Development are situated within an Area of Search adjacent to the south, east and west of the existing Rampion 1 project site comprising seabed areas extending between 13km and 25km offshore (as shown on **Figure 4.1, Volume 3**). The offshore part of the PEIR Assessment Boundary comprises the following:

- a wind farm array Area of Search of approximately 270km^2 to include the WTGs, WTG foundations, offshore substations and associated foundations, and inter-array cables;
- a marine cable link area to adjoin the southeast area and the west area wind farm array zones, which is located at the south west corner of the Rampion 1 site. This cable link area has been included in the Area of Search to enable cabling requirements across the full area. For clarity, no WTGs or substations will be located in the cable link area; and

- the offshore export cable Area of Search of approximately 59km^2, which will connect the offshore wind farm area to the shore. The nearest coastal ports are Littlehampton, Worthing, Shoreham-by-Sea, Brighton and Newhaven.

4.2.4 The onshore part of the PEIR Assessment Boundary as illustrated on **Figure 4.2, Volume 3** comprises the following:

- a landfall area at Climping;
- an onshore cable corridor, approximately 36km in length and approximately 50m in width (25m either side of a centreline) within the 100m PEIR Assessment Boundary, with route options in specific locations at Warningcamp, Bolney Road and Wineham Lane; and
- two search area options for a new substation that will connect to the existing National Grid Bolney substation, mid Sussex, via buried onshore cables.

4.2.5 The onshore part of the PEIR Assessment Boundary has been refined through multidisciplinary workshops, which took stakeholder feedback into account, and are further detailed in **Chapter 3: Alternatives.** The boundary is illustrated in **Figure 4.2, Volume 3**.

4.2.6 Options are intentionally included within the PEIR Assessment Boundary to allow for further design refinement which will take into account engineering information, environmental information and stakeholder feedback. The intention is to refine the onshore cable corridor options to a single corridor and to reduce the substation search area options to a single location for the DCO Application. The key characteristics of the PEIR Assessment Boundary are summarised in **Table 4-1**.

Table 4-1 PEIR Assessment Boundary characteristics

Characteristic	Area
Wind farm array Area of Search for Rampion 2	270km^2
Export cable corridor Area of Search	59km^2
Closest distance to shore of wind farm array Area of Search	13km
Water depth range in wind farm Area of Search	15m to 65m below LAT
Onshore cable corridor length	Approximately 36km
Width of onshore cable PEIR Assessment Boundary	100m

Environmental measures

4.2.7 As part of the Rampion 2 design process, a number of embedded environmental measures have been adopted to reduce the potential for environmental impacts and effects. These embedded measures will evolve over the design development process as the EIA progresses and in response to consultation. They will be fed iteratively into the assessment process. As there is a commitment to implementing these environmental measures, and also to various standard sectoral practices and procedures, they are considered inherently part of the design of Rampion 2 and are set out in this PEIR. The measures are presented in full in **Appendix 4.1: Commitments register, Volume 4**.

4.2.8 **Chapter 5** explains the approach to embedded environmental measures that has been applied in the PEIR. The environmental assessments presented in **Chapters 6** to **28** provide details of how specific embedded measures are proposed to reduce environmental effects. The measures presented in this PEIR will be updated for inclusion in the ES as the design of the Proposed Development evolves.

4.2.9 RED will adopt good construction and management practices, and will apply the waste hierarchy. This will ensure that waste arising during the construction, operation and maintenance, and decommissioning of the Proposed Development is minimised as far as possible and that the storage, transport and eventual disposal of waste have no significant environmental effects. The volume of waste produced in all phases of the Proposed Development is anticipated to be low and that it can be accommodated by local facilities. An Outline Site Waste Management Plan (SWMP will be prepared and submitted as part of the DCO Application.

4.3 Offshore elements of the Proposed Development

Introduction

4.3.1 The offshore elements of the Proposed Development refer to works seaward of Mean High Water Springs (MHWS) and will comprise the following key components:

- WTG;
- WTG foundations and any required scour protection;
- substations and associated foundations and any required scour protection;
- inter-array cables and any required cable protection; and
- export cables, and any required cable protection, to interconnect the offshore substations to each other and to the landfall.

4.3.2 The offshore part of the PEIR Assessment Boundary is illustrated in **Figure 4.1, Volume 3**. The offshore components of the Proposed Development are assumed to mainly be fabricated off-site, stored at a suitable port facility and transported directly offshore as needed during construction. The key offshore component assessment assumptions that are confirmed for PEIR are provided in the following sections.

Seabed preparation

4.3.3 Following the completion of all preconstruction activities, including satisfying pre-construction statutory consent conditions, engineering, design and procurement and detailed site surveys, seabed preparation is one of the first elements of the offshore construction process.

4.3.4 Requirements for seabed preparation will vary according to the specific ground conditions and the type of infrastructure being installed. Detailed geophysical surveys will be carried out pre-construction to provide further detail and to clarify the presence of boulders, unexploded ordnance (UXO) and other obstructions on the seabed.

4.3.5 **Table 4-2** provides detail of the maximum assessment assumptions for the seabed preparation works for the Proposed Development. The table identifies the use of both a pre-lay plough and a subsea grab for boulder clearance. Pre-lay ploughs are designed to be pulled along the seabed in areas of high densities of boulders or where large boulders are present. They clear the corridor ready for cable installation and can also have the capability to concurrently form a cable trench. Sub-sea grabs are operated from vessels (e.g. multicats) and are able to pick-up and relocate boulders in areas where low densities of boulders are present.

4.3.6 Until the array layout is finalised, and the associated geophysical data is analysed in detail, it will not be known if sand waves will be affected by the works. Estimates are provided of sand wave clearance quantities for the maximum design scenario for PEIR assessment purposes.

Table 4-2 Seabed preparation maximum assessment assumptions

Assessment Assumption	Maximum value
Unexploded Ordnance clearance	
Avoidance buffer: Foundation Exclusion Zone Radius	200m
Avoidance buffer: Cables Exclusion Zone Radius	40m
Avoidance buffer Jack-up leg Exclusion Zone Radius	15m
Boulder clearance in the Proposed Development array area	
Array cable corridor width: pre-lay plough	25m
Export interconnector cable clearance corridor width: pre-lay plough	25m

Assessment Assumption	Maximum value
Clearance corridor width: subsea grab	15m
Clearance for foundations: radius	15m
Clearance for jack-up legs: radius	15m
Total clearance impact area: pre-lay plough for cables	7,500,000m^2
Total clearance impact area: subsea grab for cables	4,500,000m^2
Total clearance impact area: foundations and jack-up legs	1,100,000m^2
Boulder clearance in the Proposed Development offshore export cable corridor	
Clearance corridor width: pre-lay plough	25m
Clearance corridor width: subsea grab	15m
Total clearance impact area: pre-lay plough	1,900,000m^2
Total clearance impact area: subsea grab	1,140,000m^2
Sandwave clearance in the Proposed Development array area[1]	
Sandwave clearance impact width: array and interconnector cables	10m
Length of array cables affected by sandwaves	60km
Sand-wave clearance: array cables	900,000m^3
Sand-wave clearance: foundations	475,000m^3
Sand-wave clearance: total in array area (export cables, array cables, interconnector cables and foundations)	1,375,000m^3

[1] Note no sandwaves are expected on the export cable route.

Wind turbine generators (WTG)

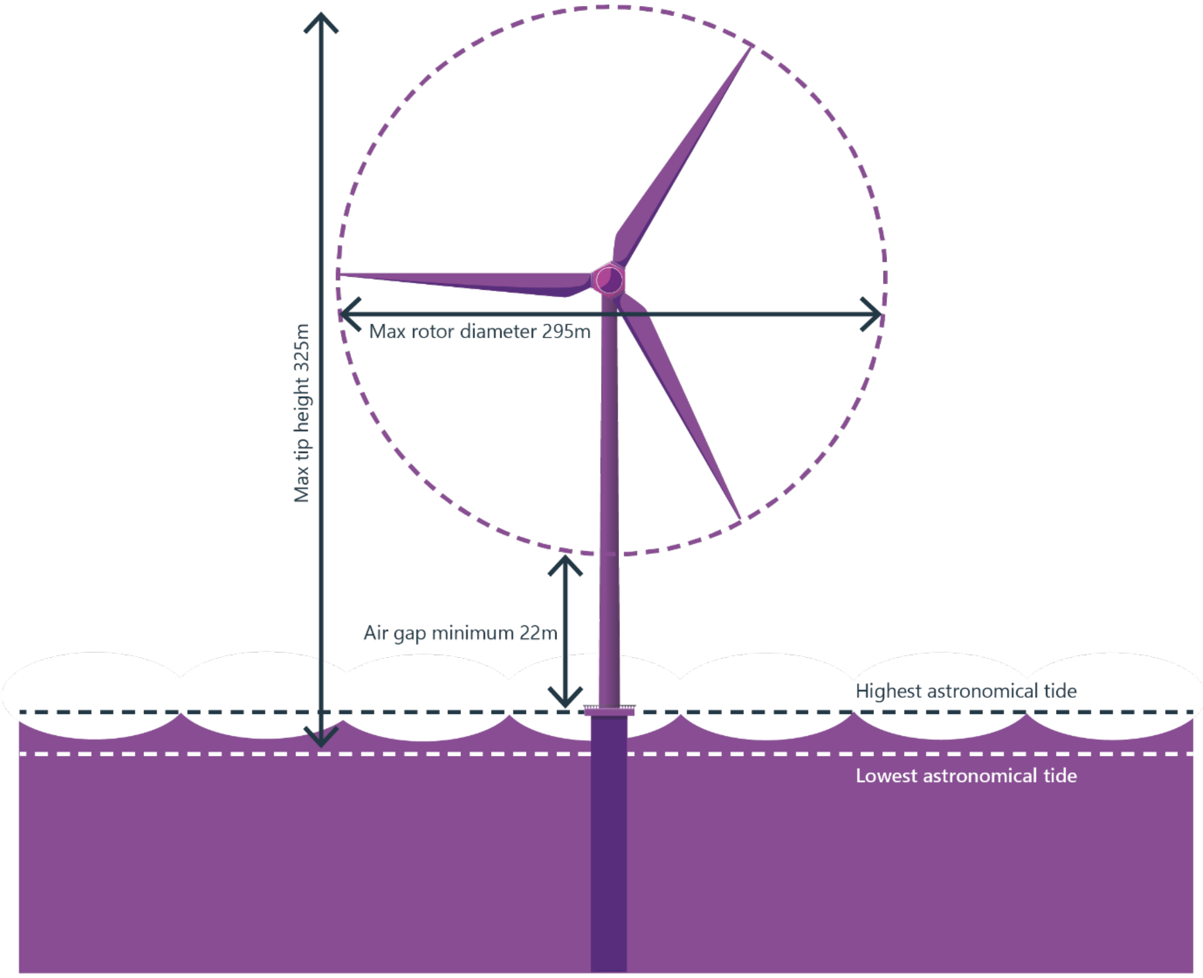
Design

4.3.7 The WTGs will comprise three turbine blades linked to a horizontal rotor axis and attached to a nacelle which houses a gearbox, generator, and transformer. This will be placed at the top of a tower which may be assembled in sections. The nacelle will be able to rotate or 'yaw' on the vertical axis in order to face the oncoming wind direction. The WTGs will include appropriate lighting and markers for aviation and navigation.

4.3.8 Inside the nacelle, the transformer will convert the electricity from approximately 690V to 33kV or 66kV (depending on the WTG model selected), for transmission to the offshore substations. The WTG transformer steps up generated electricity to a higher voltage to reduce losses during transmission over the longer distances to the substation.

4.3.9 As WTG technology is continually evolving, it is difficult to definitively predict the generating capacity and size of WTG that will be commercially available at the point of procurement for construction, which is expected to be at least four years on from the date of this report. As such, the size and capacity of the WTGs for the Proposed Development will be determined during the final design stage prior to construction. The final turbine design will be selected in accordance with the parameters set out in the Development Consent Order (DCO). The maximum design scenario for the WTG is as follows, and as illustrated in **Graphic 4-2**.

Graphic 4-2 Illustration of a WTG including maximum dimensions



4.3.10 The Proposed Development will have a generating capacity in excess of 100MW, with an indicative capacity based on turbine models that are currently available of up to 1,200MW. As is common for all offshore wind farms, the final choice of WTG and therefore the final capacity of the Proposed Development will be subject to a procurement exercise carried out post-consent. This assessment therefore considers two WTG typologies based on the characteristics of turbine models which are expected to be available at that future stage. These are described throughout this PEIR as a “smaller WTG type” and “larger WTG type”, and the assessment considers two design scenarios based on a maximum number of up to 116 smaller WTG type turbines or 75 larger WTG type turbines. The number of WTGs utilised for the Proposed Development will not exceed those at Rampion 1 (i.e. 116), and the maximum rotor diameter and blade tip height quoted in **Table 4-3** for the larger WTG type will not be exceeded, regardless of the choice of WTG in the final Proposed Development. Other assessment assumptions derived from these scenarios are described out in this chapter and the DCO/DML will ensure that these are not exceeded.

Table 4-3 WTG maximum design assessment assumptions

Assessment assumption	Smaller WTG Type	Larger WTG Type
Total capacity	1,200MW	1,200MW
Maximum number of WTG	116	75
Rotor diameter	172m	295m
Minimum air gap above Highest Astronomical Tide (HAT)	22m	22m
Maximum blade tip height above Lowest Astronomical Tide (LAT)	210m	325m
Maximum Chord (blade width)	5.4m	11m
Maximum RPM	10.5 RPM	6.5 RPM
Minimum to Maximum Blade pitch	-4 to 90 degrees	-4 to 90 degrees
Minimum turbine spacing	860m	1,720m

4.3.11 Depending on the WTG, each is expected to contain the indicative maximum oil and fluid quantities outlined in **Table 4-4*.***

Table 4-4 WTG oils and fluids

WTG oils and fluids	Smaller WTG Type	Larger WTG Type
Grease	599 litres (l)	1,137l
Hydraulic oil	1,317l	2,502l
Gear oil	2,22 l	4,217l
Total lubricants	4,135l	7,856l
Nitrogen	59,950l	113,905l
Transformer silicon/ester oil	8,113l/kg	15,415l/kg
Diesel fuel	1,000l	1,000l
SF6	180kg	180kg
Glycol/Coolants	15,694l	29,819l

WTG control systems

4.3.12 WTG operate within a set wind speed range:

- approximately 3m/s: the WTG will start to generate electricity;
- approximately 15m/s: the WTG reach maximum output; and
- approximately 25m/s: the WTG output starts to reduce towards zero allowing the WTG to shut down in high wind speeds.

4.3.13 Each WTG will have its own control system to carry out functions such as yaw control and ramp down in high wind speeds. The WTG must shut down in high winds to protect the WTG and foundation however the gradual reduction at 25m/s ensures a gradual ramp-down of the power output to support the operation of the National Grid.

4.3.14 All the WTG will be connected to a central Supervisory Control and Data Acquisition (SCADA) system for control of the wind farm remotely. This allows functions such as remote WTG shutdown if faults occur. The SCADA system will communicate with the wind farm via fibre optic cables, microwave, or satellite links. Individual WTGs can also be controlled manually from within the WTG nacelle or tower base in order to control the WTG for commissioning or maintenance activities.

WTG installation

4.3.15 The WTG towers, nacelles and blades will be transported from a port to the Proposed Development array area on the installation vessel or on a separate transport vessel. Further assessment of traffic movements and port selection are covered in **Chapter 24: Transport** and **Chapter 18: Socio-economics**. The WTG installation vessel is likely to be a jack-up vessel with up to four legs, each taking up an area of 250m^2. The jack-up vessel can transport multiple WTG sets per trip. (**Graphic 4-3** and **Graphic 4-4**). The installation vessel will transit to the Rampion 2 array area and the components will be lifted onto the foundation substructure, by a crane situated on the installation vessel. Each WTG will be assembled on site with technicians fastening components together after they are lifted into place. The exact methodology for the assembly is dependent on WTG type and installation contractor and will be defined in the pre-construction phase after grant of consent.

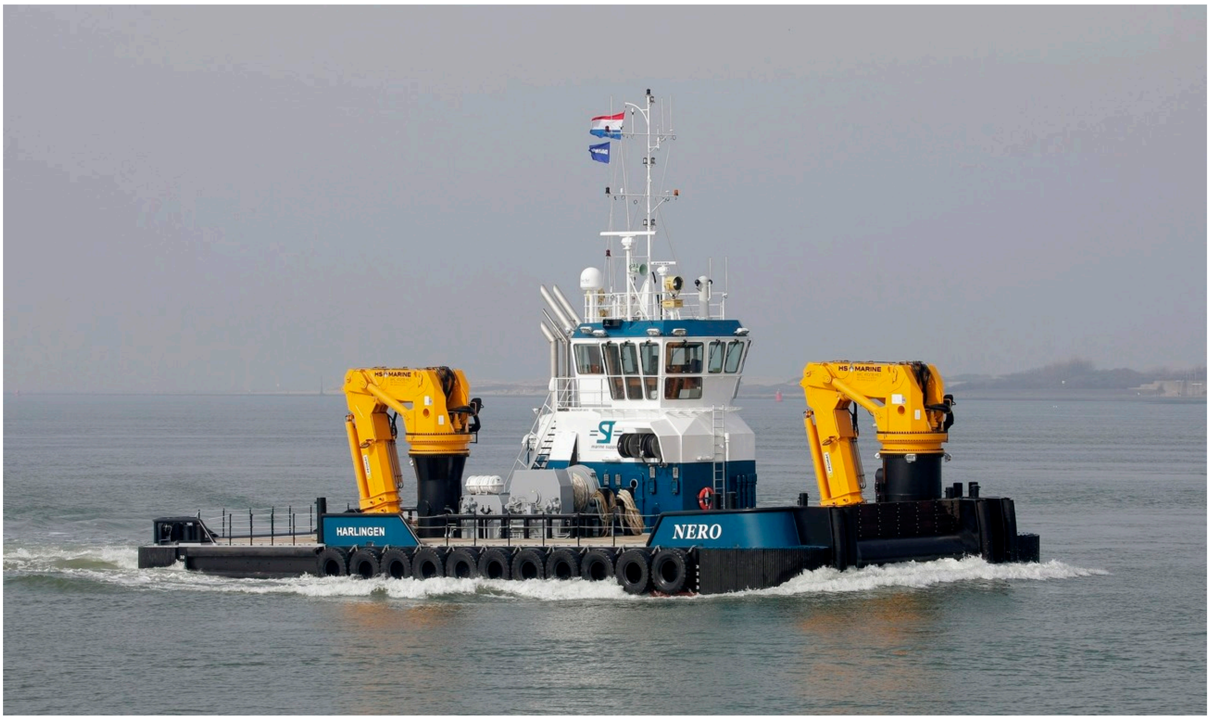
Graphic 4-3 Example jack-up vessel installing a WTG monopile foundation (Rampion 1 offshore wind farm)

Graphic 4-4 Example jack-up vessel installing a wind turbine (Rampion 1 offshore wind farm)

4.3.16 The total duration for WTG installation is expected to be around 12 months. **Section 4.5: Construction programme** provides further detail.

4.3.17 Vessels for WTG installation may require support vessels such as crew transfer vessels (CTV), tugs and multicats. Multicats are multifunctional all-purpose vessels, usually equipped with a winch and/or cranes on a flat deck (see **Graphic 4-5**).

Graphic 4-5 Typical multicat utility vessel



4.3.18 Further details on the maximum number of vessel trips for WTG installation are included in **Table 4-5**.

Table 4-5 Maximum vessel assessment assumptions for WTG installation

Assessment assumption	Smaller WTG Type	Larger WTG Type
Jack-up area per leg	$250m^2$	$250m^2$
Jack-up number of legs	4	4
Installation vessel - maximum number of vessels	2	2
Installation vessel - total number of return trips	40	25
Support vessels - maximum number of vessels	10	10

Assessment assumption	Smaller WTG Type	Larger WTG Type
Support vessels - total number of return trips	100	100
Crew transfer vessels - maximum number of vessels	10	10
Crew transfer vessels - total number of return trips	1,200	750
Helicopters - maximum number	2	2
Helicopters - total number of return trips	500	300
Vessel anchor footprint area for installation of WTG jacket foundations, export cable and offshore substations	20,050m^2 (based on the sum of export cable installation 11,300m^2; offshore substation installation 325m^2; and jacket foundation installation 8,425m^2).	

WTG foundations

Introduction

4.3.19 The type of WTG foundation to be installed will be determined from the results of geotechnical investigations, existing environmental sensitivities and final WTG selection. It is anticipated that more than one type of foundation may be used across the Proposed Development. The results of preliminary engineering investigations indicate that several design options for the WTG foundations could be considered for the Proposed Development including:

- monopiles;
- jacket foundations with pin piles; and
- jacket foundations with suction buckets.

4.3.20 The foundations will be fabricated offsite, stored at a suitable port facility and transported to site as needed. Specialist installation vessels will be needed to transport and install foundations. The foundations will include access facilities and appropriate lighting and markers for aviation and navigation.

Seabed preparation

4.3.21 Each foundation type may require some form of seabed preparation which may include seabed levelling and removing surface and subsurface debris. Consent for boulder clearance and unexploded ordnance (UXO) removal will be sought in a separate future Marine Licence application, when geophysical survey data of suitable spatial resolution is available to identify and quantify UXO. The maximum design assumptions for the seabed preparation are presented in **Table 4-2** and described in **paragraphs 4.3.3** to **4.3.6**.

Scour protection

4.3.22 Scour protection material may be required around the base of some or all WTG foundations to protect from current and wave action ensuring structural integrity. Scour protection types currently being considered are rock filter layers with a rock armour layer or rock/stone filled geotextile bags. Key scour protection assessment assumptions are provided in **Table 4-6**, **Table 4-7**, and **Table 4-8**. A Scour Management Plan will be developed including details of the need, type, quantity and installation methods for scour protection and agreed with the relevant stakeholders.

Safety Zones

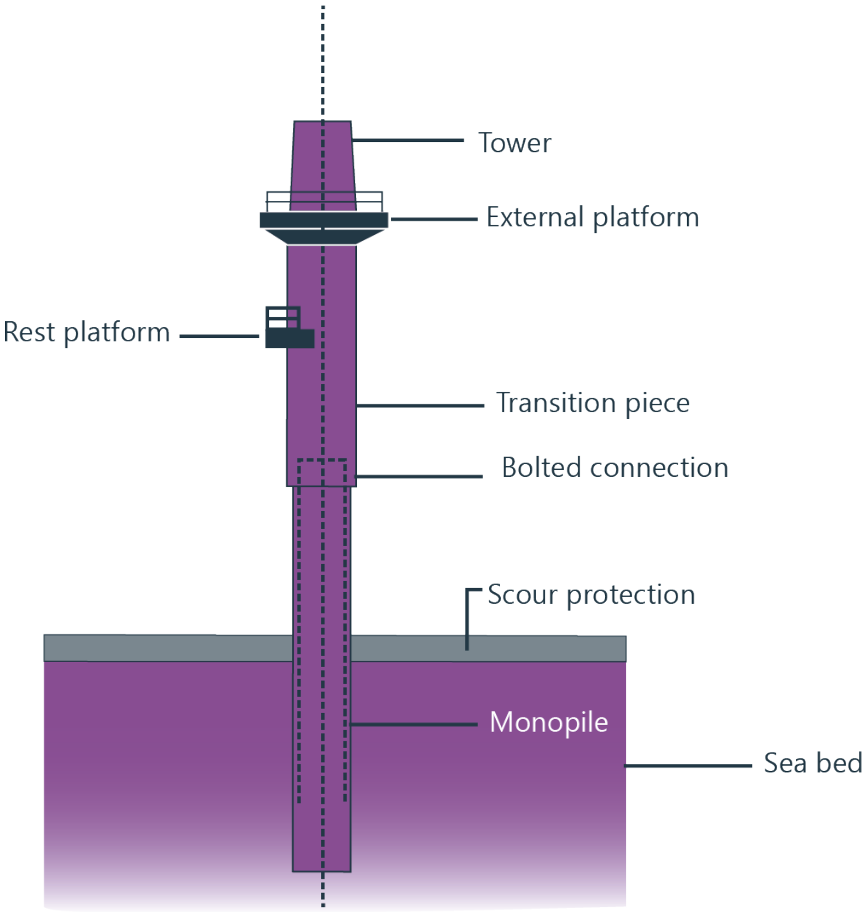
4.3.23 During construction, safety zones of 500m radius will be sought around each WTG, offshore substation and their associated foundations structures whilst construction is undertaken, as clearly indicated by the presence of installation vessels. Several installation activities may take place simultaneously and consequently, safety zones will be sought to each of these activities as they take place within the wind farm site. Prior to commissioning, a 50m radius safety zone will be sought around each constructed WTG, offshore substation and their associated foundations structures.

Monopile foundations

4.3.24 Monopile foundations are welded tubular steel foundations with a large diameter. Monopiles are installed vertically into the seabed by either driving (use of a pile-driving hammer), or a combination of driving and drilling techniques where harder ground conditions are present. Other appropriate alternative methods may be used as they become available and practicable.

4.3.25 The dimensions of the monopiles that may be used for the Proposed Development will depend on the size of the WTG, hydrodynamic forces, and ground conditions. It is estimated that the monopile diameter will be of 13.5m maximum with a maximum embedment depth of up to 60m. A tubular transition piece is bolted or grouted onto an installed monopile, and comprises the WTG tower flange, boat landings, work platforms and other ancillary structures. A typical monopile foundation schematic is provided in **Graphic 4-6**.

Graphic 4-6 Monopile foundation schematic



4.3.26 The monopile foundation assessment assumptions for the smaller and larger WTG types are provided in **Table 4-6**.

Table 4-6 Maximum WTG monopile foundation assessment assumptions

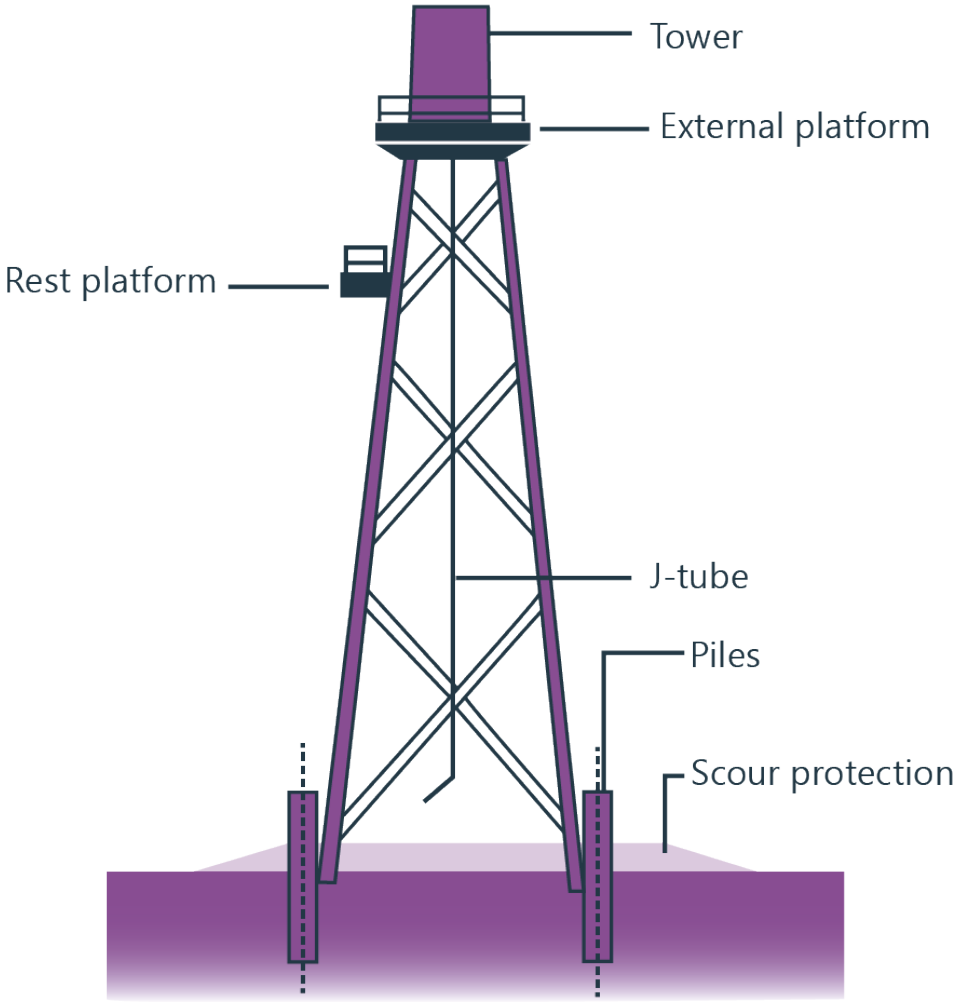
Monopile foundation	Smaller WTG Type	Larger WTG Type
Diameter of monopile	10m	13.5m
Diameter of transition piece	6.5m	8m
Typical embedment depth (below seabed)	30m to 60m	30 to 60m
Hammer energy	Up to 4,400kJ	Up to 4,400kJ
Total number of structures	Up to 116 WTGs	Up to 75 WTGs
Area of seabed take for foundation alone	80m^2	143m^2

Monopile foundation	Smaller WTG Type	Larger WTG Type
Scour protection type	Rock filter layer and armour layer or stone filled geotextile bags	Rock filter and armour layer or stone filled geotextile bags
Total area of seabed take for foundation and scour protection	5,100m^2	9,200m^2
Spoil volume per foundation from drill arisings	4,000m^3	5,800m^3
Jack-up spud can gravel bed volume	4,000m^3	4,000m^3
Scour protection volume	15,000m^3	27,600m^3
Monopile/TP grout volume	20m^3	25m^3

Jacket foundations with pin piles

4.3.27 Jacket foundations are typically lattice structures comprising of steel tubulars to support the WTG. The jacket is secured to the seabed by small diameter pin piles which are driven into the seabed through pile sleeves at each leg. Alternatively, the pin piles may be pre-installed into the seabed through a template, prior to the arrival of the jacket structure. The pin piles are connected to the jacket legs via a grouted or deformed connection. Three or four-legged jacket foundations will be considered for the Proposed Development's WTG. A typical jacket foundation with piles schematic is provided in **Graphic 4-7**.

Graphic 4-7 Jacket foundations with pin piles schematic



4.3.28 The jacket with pin piles foundation assessment assumptions for the smaller and larger WTG types are provided in **Table 4-7**.

Table 4-7 Maximum WTG jacket with pin piles foundation assessment assumptions

Jacket foundation with pin piles	Smaller WTG Type	Larger WTG Type
Number of legs per jacket	3 or 4	3 or 4
Separation of adjacent legs at seabed level	20m to 30m	20m to 30m
Separation of adjacent legs at LAT	10m to 20m	10m to 20m
Height of platform above LAT	15m to 25m	15m to 25m

Jacket foundation with pin piles	Smaller WTG Type	Larger WTG Type
Leg diameter	Up to 2.5m	Up to 3m
Number of pin piles per jacket	3 or 4	3 or 4
Pin pile diameter	1.5m to 3m	1.5m to 3m
Embedment depth (below seabed)	Up to 60m	Up to 60m
Hammer energy	Up to 2,500kJ	Up to 2,500kJ
Spoil volume per foundation from pin pile drill arisings	1,600m^3	1,700m^3
Scour protection type	Rock filter and armour layer or stone filled geotextile bags	Rock filter and armour layer or stone filled geotextile bags
Area of seabed take including scour protection	8,800m^2	8,800m^2
Scour protection volume	26,400m^3	26,400m^3

Jacket foundations with suction buckets

4.3.29 Suction buckets may be used as an alternative to pin piles for securing the jacket to the seabed. Suction buckets comprise a large steel cylinder that is sealed at the top. The suction bucket is embedded into the seabed by creating a negative (suction) pressure inside the bucket. The difference in pressure across the top plate as a result further pushes the bucket into the seabed. The jacket with suction buckets foundation assessment assumptions for the smaller and larger WTG types are provided in **Table 4-8.**

Table 4-8 Maximum WTG jacket with suction buckets foundation assessment assumptions

Jacket foundation with suction buckets	Smaller WTG Type	Larger WTG Type
Number of legs per WTG	3 or 4	3 or 4
Suction bucket diameter	Up to 15m	Up to 15m
Suction bucket penetration	Up to 25m	Up to 25m

Jacket foundation with suction buckets	Smaller WTG Type	Larger WTG Type
Suction bucket height above seabed	Up to 10m	Up to 10m
Separation of adjacent legs at seabed level	20m to 30m	20m to 30m
Separation of adjacent legs at LAT	10m to 20m	10m to 20m
Height of platform above LAT	15m to 25m	15m to 25m
Scour protection type	Rock filter and armour layer or stone filled geotextile bags	Rock filter and armour layer or stone filled geotextile bags
Area of seabed take including scour protection	8,800m^2	8,800m^2
Scour protection volume	26,400m^3	26,400m^3

4.3.30 Vessel installation assessment assumptions for jacket foundation (with pin piles and suction buckets options) for the smaller and larger WTG types are provided in **Table 4-9.**

Table 4-9 Maximum vessel assessment assumptions for the WTG foundation installation

Assessment assumption	Maximum - monopiles	Maximum – jacket foundations with pin piles	Maximum – jacket foundations with suction buckets
Foundation for smaller WTG type			
Jack-up area per leg	250m^2	250m^2	250m^2
Jack-up number of legs	6	6	6
Number of installation vessels	3	3	3
Number of return trips (installation vessels)	60	60	60

Assessment assumption	Maximum - monopiles	Maximum – jacket foundations with pin piles	Maximum – jacket foundations with suction buckets
Number of support vessels	10	10	10
Total number of return trips (support vessels)	60	60	40
Number of transport vessels	6	6	6
Total number of return trips (transport vessels)	40	40	40
Number of crew transfer vessels	6	6	6
Total number of return trips (crew transfer vessels)	500	500	500
Foundation for larger WTG type			
Jack-up area per leg	$250m^2$	$250m^2$	$250m^2$
Jack-up number of legs	6	6	6
Number of installation vessels	3	3	3
Total number of return trips (installation vessels)	40	40	40
Number of support vessels	10	10	10
Total number of return trips (support vessels)	50	50	50
Number of transport vessels	4	4	4

Assessment assumption	Maximum - monopiles	Maximum – jacket foundations with pin piles	Maximum – jacket foundations with suction buckets
Total number of return trips (transport vessels)	40	40	40
Number of crew transfer vessels	6	6	6
Total number of return trips (crew transfer vessels)	300	300	300

Offshore substations

Introduction

4.3.31 It is anticipated that there will be up to three offshore substations associated with the Proposed Development. The substations will transform generated electricity from the WTGs to a higher voltage for transmission to shore via export cables. The location and extent of the offshore substations will be confirmed through the detailed design process but will be located within the PEIR Assessment Boundary.

4.3.32 It is anticipated that each substation will likely comprise a multiple-tier topside platform installed on a foundation, typically a monopile or jacket type foundation. The substation platform will likely include components including transformers, batteries, generators, switchgear, fire systems, and modular facilities for operational and maintenance activities, similar to the offshore substation for Rampion 1. The substations will include appropriate lighting and markers for aviation and navigation.

4.3.33 The substation topside, with plan dimensions of up to 80m by 50m, will be situated at maximum 65m above LAT. The height of the lightning protection mast and ancillary structures (e.g. maintenance crane) is expected to be a maximum 115m above LAT.

4.3.34 The offshore substation foundation options being considered include monopile and four or six legged jackets (see **Graphic 4-8** and **Graphic 4-9**). **Table 4-10** provides the key assessment assumptions for the offshore substation.

Graphic 4-8 Example offshore substation with monopile foundation (London Array offshore wind farm)

Graphic 4-9 Offshore substation with four-legged jacket piled foundation example

Table 4-10 Maximum offshore substation assessment assumptions

Assessment assumption	Maximum value
Offshore substation	
Topside: main structure length and width	80m x 50m
Topside: height (excluding helideck or lightning protection) (LAT)	65m above LAT
Height of lightning protection & ancillary structures (LAT)	115m above LAT
Topside: area	4,000m^2
Topside (including ancillaries) area	4,000m^2
Transformer oil - per substation	340,000kg
Diesel Fuel - per substation	20,000 l
SF6 – per substation	5,000kg
Batteries (lead acid gel) – per substation	4,000kg
Grey water	5,000 l
Black water	3,000 l

Assessment assumption	Maximum value
Total surface area of introduced hard substrate from foundations in the water column	$38m^2$ per m of water depth (total surface area of subsea portions of foundations in contact with the water column)
Offshore substation - Monopile foundation	
Total number of substation structures	Up to 3
Diameter of monopile	12m
Hammer energy	4,400kJ
Seabed take of foundation alone	$120m^2$
Scour protection type	Rock filter layer with armour layer or rock filled geotextile bags
Area of seabed take including scour protection (per substation)	$7,300m^2$
Spoil volume (per substation)	$6,000m^3$
Jack-up spud can gravel bed volume	$4,000m^3$
Scour protection volume (per substation)	$22,000m^3$
Pile-structure grout volume	$40m^3$
Offshore substation - Jacket with pin piles foundation	
Total number of substation structures	Up to 3
Number of legs per jacket	4 or 6
Separation of adjacent legs at seabed level	20m to 35m
Separation of adjacent legs at LAT	20m to 35m
Height of jacket above LAT	15m to 25m
Leg diameter	Up to 4m
Number of pin piles per jacket	Up to 12
Pin pile diameter	1.5m to 3.5m
Embedment depth below seabed	Up to 60m
Hammer energy	Up to 2,500kJ
Seabed take of foundation alone	$4,000m^2$

Assessment assumption	Maximum value
Scour protection type	Rock filter and armour layer or rock/stone filled geotextile bags
Area of seabed take including scour protection (per substation)	8,800m^2
Spoil volume (per substation)	12,000m^2
Jack-up spud can gravel bed volume	4,000m^3
Scour protection volume (per substation)	26,400m^3
Pile-structure grout volume	360m^3

Offshore substation installation

4.3.35 The offshore substation foundations will be transported offshore using a jack-up vessel or transportation barge. The foundations will then be installed using a similar approach to the WTG foundations (see **paragraph 4.3.28**).

4.3.36 The majority of the electrical equipment and associated components will be installed into the substation topsides at a fabrication facility onshore. The assembled topsides will be transported from a port or harbour local to the fabrication facility to the Proposed Development array area using a transportation barge. The substation topsides will be lifted off the barge and installed onto its pre-installed foundations using a floating crane vessel. A jack-up vessel may be stationed alongside the substation structure to facilitate commissioning activities (see **Graphic 4-10**).

Graphic 4-10 Example offshore substation during installation (Rampion 1 offshore wind farm)

4.3.37 The vessel assessment assumptions for the installation of the offshore substation are provided in **Table 4-11**.

Table 4-11 Maximum offshore substation vessel installation assessment assumptions

Assessment assumption	Maximum value
Number of installation vessels	**3**
Number of total return trips (installation vessels)	**12**
Jack-up area per leg	**125m^2**
Jack–up number of legs	**6**
Number of support vessels	**20**
Number of total return trips (support vessels)	**12**
Number of transport vessels	**6**
Number of total return trips (transport vessels)	**12**

Assessment assumption	Maximum value
Number of crew transfer vessels	**6**
Number of total return trips (crew transfer vessels)	**60**
Number of helicopters	**2**
Number of total return trips (helicopters)	**30**

Offshore cables

Array cables

4.3.38 Subsea array cables will connect the WTGs to each other in strings. The array cable strings will connect the WTGs to the offshore substations. The array cable profile will likely be a three core, armoured cable with copper or aluminium conductors covered in insulation material. The array cables will be 33kV or 66kV and the length of cable will be dependent on the distance between the WTG. The total maximum array cable length is expected to be 250km. **Table 4-12** presents the key assessment assumptions for the array cables.

Table 4-12 Maximum array cable assessment assumptions

Assessment assumption	Maximum value
Total array cable length	250km
Array cable depth	1m target depth
Cable diameter	220mm
Total length of cable	250km
Export cable trench width	2m
Voltage	33kV or 66kV

Interconnector export cables

4.3.39 The Proposed Development may use two offshore interconnector export cables to link together the offshore substations in the array area. This provides the transfer of generated power from the east side of the site to the west side where the landfall is located. These cables also ensure that in the event of one cable failing, the flow of electricity to the landfall can continue through the other cable.

4.3.40 The interconnector export cables are likely to be armoured and have three core cables with copper or aluminium conductors and cross linked polyethylene (XLPE) insulation, with a voltage up to 275kV. **Table 4-13** provides the assessment assumptions for the offshore interconnector cables.

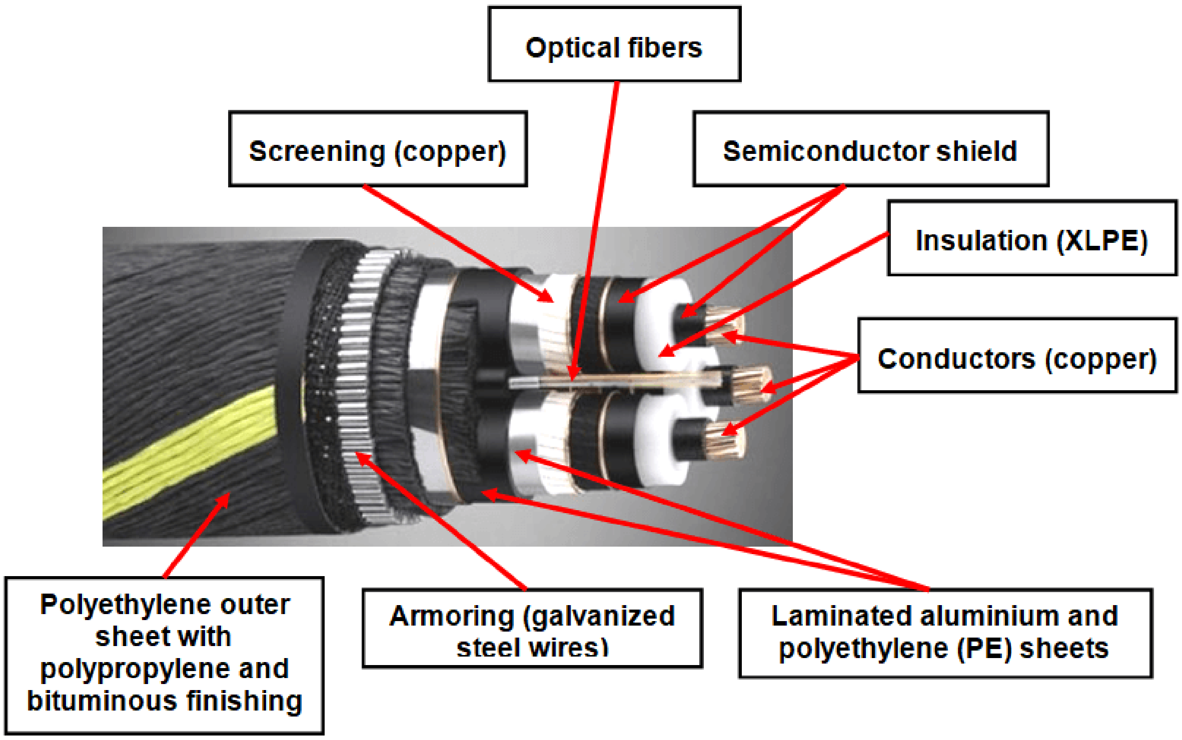
Table 4-13 Maximum offshore interconnector cable assessment assumptions

Assessment assumption	Maximum value
Number of cables	2
Total cable length	50km (25km/cable)
Voltage	up to 275kV

Export cables

4.3.41 The main export cables will connect the offshore substations to the shore. They are likely to be armoured and have three core cables with copper or aluminium conductors and XLPE insulation, at a voltage up to 275kV. The cross-section of a typical 132kV XLPE insulated three copper core export cable is shown in **Graphic 4-11.** The cables will also contain fibre-optic cores that will be used for protection, control and communications systems.

Graphic 4-11 Typical cross-sectional details through a three core HV export cable



4.3.42 Electricity from the offshore substation(s) will be transmitted via a maximum of four export cables to the transition joint bays located at the landfall near Climping Beach. It is anticipated the cables will be laid in separate trenches at different times and installed via either ploughing, jetting, trenching, or post-lay burial techniques. The choice of technique will be dependent on ground conditions along the specific cable routes.

4.3.43 The export cables will be typically buried at a target burial depth of 1m below the seabed surface depending on the outcome of the cable burial risk assessment. The exact routing of the export cables within the cable corridor will be determined during the detailed design of the Proposed Development, with consideration of seabed conditions and environmental sensitivities. There are no known third-party cables within the export cable area of search for the Proposed Development.

4.3.44 The Aquind cross channel interconnector cable is currently in the planning process. If approved and built, the Aquind interconnector cable is proposed to cross the western part of the PEIR Assessment Boundary. In the eventuality that cable crossings are required for this cable or any other potentially unknown subsea cables/pipelines, then a methodology will be agreed in collaboration with the relevant infrastructure owners. **Table 4-14** provides the assessment assumptions for the offshore export cables.

Table 4-14 Maximum export cable assessment assumptions

Assessment assumption	Maximum value
Export cables	
Export cable rated capacity	Up to 275kV
High voltage alternating current (HVAC) offshore cables	4
Export cable trenches	Up to 4
Fibre optic cables	Bundled into export cable
Export cable trench depth	1m to 1.5m
Export cable trench width	2m
Export cable corridor Area of Search	59km^2
Number of cable circuits (HVAC)	4
HVAC Voltage	Up to 275kV
Cable diameter	Up to 350mm
Export cable corridors	
Length of offshore cable corridor, link to shore	19km (4 x 19km cables in corridor)
Width of offshore cable corridor, link to shore	2km

Assessment assumption	Maximum value
Length of interconnector export cable corridor within the array areas	25km (2 x 25km cables in corridor)
Width of interconnector export cable corridor within the array area	1km
Total length of export cables	140km

Overview of cable installation

4.3.45 Cables will be buried below the seabed wherever possible. The installation method and target burial depth will be defined post consent based on a cable burial risk assessment considering ground conditions as well as the potential for impacts upon cables such as from trawling and vessel anchors.

4.3.46 It is anticipated that the offshore cables will be installed via either ploughing, jetting, trenching, or a combination of these techniques, depending on ground conditions along the specific cable route. An example cable installation vessel is shown in **Graphic 4-12**.

Graphic 4-12 Example export cable installation vessel (Rampion 1 offshore wind farm)

Ploughing

4.3.47 This method involves a blade, which cuts through the seabed and the cable is laid behind. Ploughs are generally pulled directly by a surface vessel or, they can be mounted onto a self-propelled tracked vehicle which runs along the seabed. Cable ploughs are usually deployed in simultaneous 'lay and trench' mode although it is possible to use the plough to cut a trench for the cable to be installed at a later date provided the ground conditions are suitable. When installing the cable in simultaneous lay and trench operation the plough may use cable depressors to push the cable into position at the base of the cut trench; as the plough proceeds the trench is backfilled to provide immediate burial.

4.3.48 Ploughs can be used in seabed geology ranging from very soft mud through to firm clays but, in general, ploughs are not suited to harder substrates such as boulder clay. Some ploughs are fitted with water jet assist options and/or hydraulic chain cutters to work through patches of harder soils. A typical plough design is shown in **Graphic 4-13.**

Graphic 4-13 Typical marine cable installation plough

Jetting

4.3.49 This method involves directing water jets towards the seabed to fluidise and displace the seabed sediment. This forms a typically rectangular trench into which the cable generally settles under its own weight.

4.3.50 The water jets are usually deployed on jetting arms beneath a remotely operated vehicle (ROV) system that can be free-swimming or based on passive skids or active tracks. There are also towed jetting skids available for the installation of cables.

4.3.51 During the formation of the trench the displaced sediment is forced into suspension and settles out at a rate determined by the sediment particle size, density and ambient flow conditions. The jetting process is not intended to displace sediment to an extent that it is totally removed out of the trench; moreover, it requires that the fluidised sediment is available to fall back into the trench for immediate burial through settling. It is only the finer fractions of sediments that are likely to be held in suspension long enough to become prone to dispersal away from the trench as a plume.

4.3.52 A key benefit of a jetting tool is that it can operate close to structures and it is also possible to use jetting tools for remedial burial if required. Typically, there are two methods of water jetting available: ‘Seabed Fluidisation’ and ‘Forward Jetting a Trench’.

4.3.53 Seabed Fluidisation involves first laying the cable on the seabed and afterwards positioning a jetting sledge above the cable. Jets on the sledge flush water beneath the cable fluidising the soil whereby the cable, by its own weight, sinks to the depth set by the operator.

4.3.54 Forward Jetting a Trench uses water jets to jet out a trench ahead of cable lay. The cable can typically be laid into the trench behind the jetting lance. An example of the equipment used to jet cables into the seabed is shown in **Graphic 4-14** and **Graphic 4-15.**

Graphic 4-14 Example cable array installation vessel (Rampion 1 offshore wind farm)

Graphic 4-15 Typical marine cable jetting seabed fluidiser

Trenching

4.3.55 Trenching involves the excavation of a trench whilst temporarily placing the excavated sediment adjacent to the trench. The cable is then laid, and the displaced sediment used to back-fill the trench, covering the cable. This is most commonly used where the cable must be installed through an area of rock or seabed composed of a more resistant material. Trenching is a difficult, time-consuming and expensive method to use compared to other methods and will only be used in exceptional circumstances.

Cable protection

4.3.56 There is likely to be a requirement for cable protection to be installed around the inter-array cables as they transition from the seabed to enter the WTG via internal or external J-tubes or I-tubes (hollow tubes hung from the foundation that are in the shape of an "I" or "J"). The exact amount of cable protection required on each cable end will depend on the burial depths achieved by the inter-array cable installation and assessment of the scour and movement that could occur during the operating life of the wind farm.

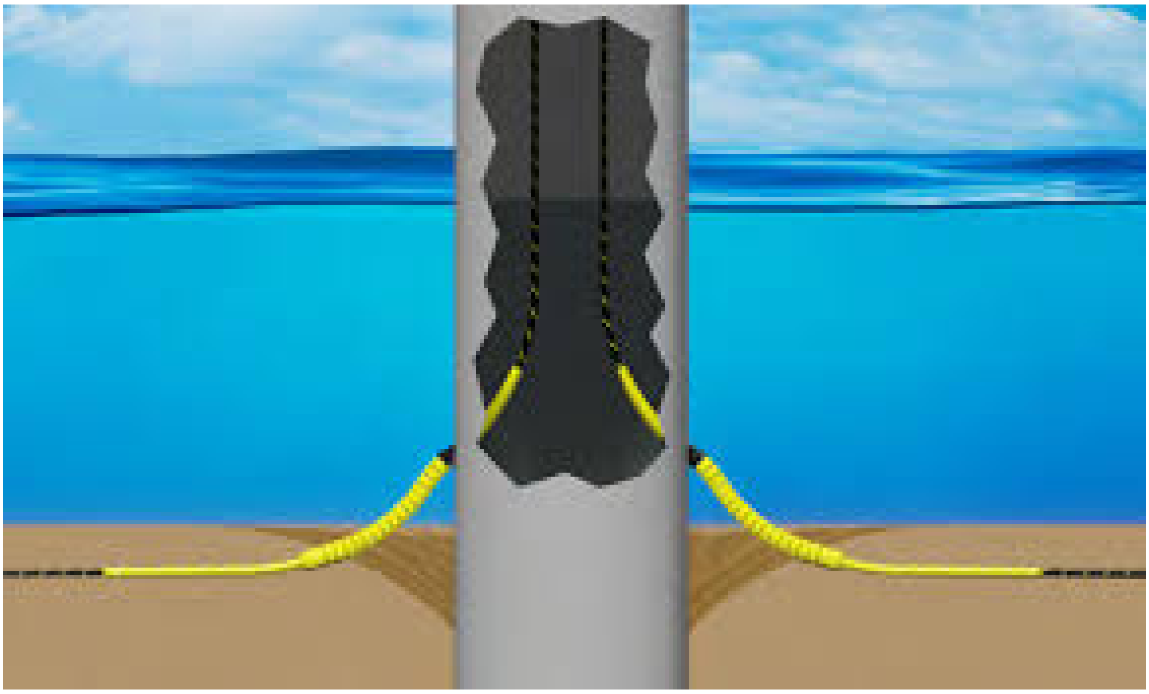
4.3.57 Cable protection will also be required where cable burial depth is not achieved or possible due to ground conditions and at third party cable crossings which may occur on the cable routes. It is estimated that approximately 20% of the array cable may require protection measures.

4.3.58 The exact form of cable protection used will depend upon local ground conditions, hydrodynamic processes and the selected cable protection contractor. However, the final choice will include one or more of the following:

- concrete 'mattresses';
- rock placement;
- geotextile bags filled with stone, rock or gravel;
- polyethylene or steel pipe half shells, or sheathes; and
- bags of grout, concrete, or another substance that cures hard over time.

4.3.59 If rock placement, or filled bags are used to protect cables, they are typically used to construct a berm on the seabed on top of the cable. The rock placement method of cable protection involves placing rocks of different grade sizes from a fall pipe vessel over the cable. Initially smaller stones are placed over the cable as a covering layer. This provides protection from any impact from larger grade size rocks, which are then placed on top. The rock berm will be up to 1m in height and a maximum of 5m wide. A typical cable protection system is shown in **Graphic 4-16**.

Graphic 4-16 Typical cable protection at entry into the foundation at seabed (Tekmar system)



Installation of array cables

4.3.60 The array cables will typically be buried at a target burial depth of 1m below the seabed surface depending on the outcome of the cable burial risk assessment. The final depth of the cables will be dependent on the seabed geological conditions and the risks to the cable (for example from anchor drag damage). Cable installation may require some form of seabed preparation which may include a Pre-Lay plough, boulder relocation and possibly sandwave clearance.

4.3.61 The array cables will be manufactured at a specialist supplier's factory. The manufactured cables will be spooled from the factory onto cable carousels situated on a transport vessel or directly onto the installation vessel itself, moored at an adjacent quayside. If a transport vessel is used, the cables will be subsequently transpooled onto the installation vessel at a port local to the factory before it transits to the Proposed Development site for installation.

4.3.62 It is anticipated that the installation of the array cables will take place over two spring/summer seasons of up to six months each. **Table 4-15** presents the key assessment assumptions for the array cable installation.

Table 4-15 Maximum array cable installation assessment assumptions

Assessment assumption	Maximum value
Array cable installation	
Installation methodology	Plough, trencher or jetter (using pre- or post-lay burial techniques)

Assessment assumption	Maximum value
Target burial depth	1m
Width of seabed affected by installation	25m
Total seabed disturbance	6,250,000m^2
Burial spoil: ploughing	500,000m^3
Duration: per array link (hours) - Jetting	12hrs
Duration: per array link (hours) – Ploughing	30hrs
Duration: total (months)	12 months
Jetting excavation rate - soft soil	300m/hr
Jetting excavation rate - loose soil	125m/hr
Ploughing excavation rate - medium soil	125m/hr
Ploughing excavation rate - hard soil	50m/hr
Array cable installation - rock placement	
Height of rock berm	1m
Width of rock berm	5m
Proportion of array cable requiring protection	20%
Replenishment during operations (% of construction total)	25%
Cable rock protection: maximum rock size	0.3m
Rock protection area	260,000m^2
Rock protection volume	130,000m^3
Number of crossings (estimate)	4
Cable/pipe crossings: total impacted area	10,000m^2
Cable/pipe crossings: pre-lay rock berm volume	10,000m^3
Cable/pipe crossings: post-lay rock berm volume	10,000m^3
Array cable installation – vessel requirements	

Assessment assumption	Maximum value
Number of main laying vessels	3
Number of main burial vessels	3
Number of crew boats or SOVs	6
Number of service vessels for pre-rigging of towers	2
Number of diver vessels	2
Number of vessels for Pre-Lay plough	2
Number of dredging vessels	1
Main laying vessels (total number of return trips)	12
Main burial vessels (total number of return trips)	6
Support vessels (total number of return trips)	300

Installation of interconnector export cables

4.3.63 Like the installation of array cables, the installation of the interconnector export cables is expected to require either ploughing, trenching, jetting, or a combination of these techniques. **Table 4-16** provides the assessment assumptions for the installation of the offshore interconnector cables.

Table 4-16 Maximum offshore interconnector cable installation assessment assumptions

Assessment assumption	Maximum value
Installation methodology	Plough, trencher or jetter
Target burial depth	1m
Total seabed disturbance	1,250,000m^2
Burial spoil – jetting	100,000m^3
Burial spoil - ploughing / trenching	100,000m^3
Rock protection area	40,000m^2
Rock protection volume	25,000m^3
Jetting excavation rate - soft soil	300m/hr

Assessment assumption	Maximum value
Jetting excavation rate - loose soil	125m/hr
Ploughing excavation rate - medium soil	125m/hr
Ploughing excavation rate - hard soil	50m/hr

Export cable installation

4.3.64 The installation of the export cables is likely to involve the burial of the cables below the seabed using ploughing, trenching, or jetting. It is anticipated that a combination of these three methods may be used depending on seabed conditions.

4.3.65 Duct extensions may be required to enable the landfall HDD ducts (see **paragraph 4.3.71**) to be extended further offshore to facilitate cable installation from an installation vessel situated offshore. These duct extensions will be of a similar diameter to the HDD ducts and installed in their own trench at a similar depth of cover to the export cables. The duct extensions will be backfilled before the arrival of the cable installation vessel.

4.3.66 In shallow water sections of the cable route, where the ground conditions are not suitable to ground-out the export cable installation vessel on the seabed, the construction of temporary flotation pits may be required. These pits will allow the installation vessel to remain floating at low tide whilst pulling and installing the cable. Once the export cables are installed under the seabed these floatation pits will be backfilled. High resolution bathymetric data will be gathered over the proposed construction area of the flotation pits. A post remediation bathymetric survey will be carried out to determine the seabed levels of the re-filled flotation pits. Once the “as-left” seabed level is determined a monitoring program of regular seabed surveys will be proposed to check the re-worked seabed status. The methodologies for these surveys will be agreed with the Marine Management Organisation (MMO) and Natural England and the results provided to them. In addition, drop down video footage of selected sites may be undertaken.

4.3.67 Up to four floatation pits may be required per export cable. The first floatation pits will be located at the offshore end of the landfall HDD or end of the duct extension if provided. The other pits will be located at regular intervals along the cable route until the water depths are suitable for the installation vessel to float and operate without interacting with the seabed.

4.3.68 Excavated spoil from the floatation pits may need to be taken to a temporary offshore storage location (or disposal site). It is intended that the excavated spoil will be reused to backfill the floatation pits on completion of cable installation works.

4.3.69 The cables will be manufactured at a specialist supplier’s factory. The manufactured cables will be spooled from the factory to cable carousels situated on a transport vessel or directly onto the installation vessel itself, moored at the adjacent quayside. If a transport vessel is used, the cables will be subsequently transpooled onto the installation vessel at a port local to the factory before it transits to the Proposed Development site for installation.

4.3.70 The maximum total seabed area that may be disturbed by the installation of export cables amounts to approximately 2,015,000m^2. **Table 4-17** provides additional details on installation assessment assumptions for the export cables and vessel requirements.

Table 4-17 Maximum export cable installation assessment assumptions

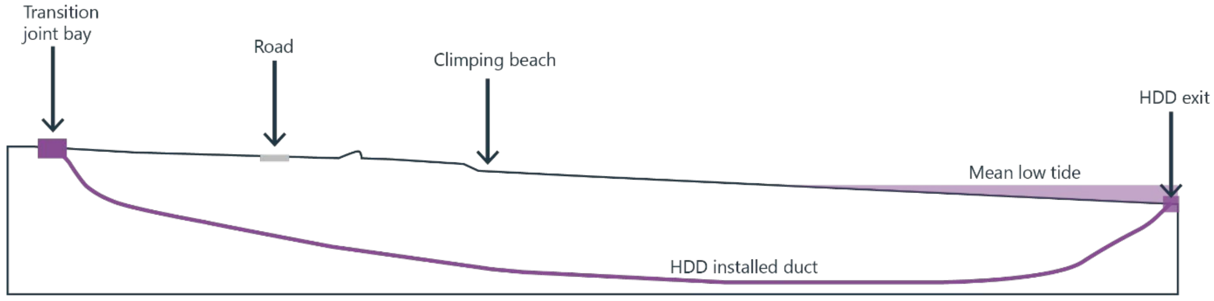
Assessment assumption	Maximum value
Export cable installation	
Installation methodology	Plough, trencher or jetter
Seabed disturbance	1,900,000m^2
Seabed disturbance – (16No.) Temporary Floatation Pits	115,000m^2
Total seabed disturbance	2,015,000m^2
Rock protection area	61,000m^2
Rock protection volume	38,000m^3
Burial spoil - jetting	155,000m^3
Burial spoil - ploughing/ trenching	155,000m^3
Spoil – (16No.) temporary floatation pits	275,000m^3
Duct extensions (total length)	4km total (one duct per cable from HDD exit pit to approximately 1km offshore)
Duration	4 months
Jetting excavation rate - soft soil	300m/hr
Jetting excavation rate - loose soil	125m/hr
Ploughing excavation rate - medium soil	125m/hr
Ploughing excavation rate - hard soil	50m/hr
Vessel requirements	
Jack-up area per leg	125m^2
Jack–up number of legs	6
Number of jack-ups per exit pit	1

Assessment assumption	Maximum value
Number of barge groundings per exit pit	4
Number of main laying vessels	1
Main laying vessels (total number of return trips)	6
Number of main jointing vessels	1
Main jointing vessels (total number of return trips)	6
Number of main burial vessels	2
Main burial vessels (total number of return trips)	6
Number of multicat-type vessels (for excavating floatation pits and duct extensions)	4
Multicat-type vessels (total number of return trips)	16
Number of spoil barges (for floatation pits)	4
Spoil barges (total number of return trips)	128
Number of support vessels	10
Support vessels (total number of return trips)	60

Export cable landfall

4.3.71 The offshore export cables will come ashore between Middleton on Sea and Littlehampton at Climping. To reduce the impact of the landfall, a trenchless solution, HDD, is to be used to install ducts that will house the cables under Climping beach. The ducts will run from the Transition Joint Bay (TJB), located in a field behind the beach to an offshore location. TJBs are permanent infrastructure where the offshore and onshore export cables are joined. A schematic diagram to illustrate how the ducts will be installed is shown in **Graphic 4-17**.

Graphic 4-17 Schematic of landfall crossing



4.3.72 The offshore export cables will be pulled ashore through these pre-installed HDD ducts and will interface with the onshore cables at the TJB.

4.3.73 Landfall works include:

- construction of access to the landfall compound;
- construction of the landfall compound;
- HDD works (24 hour working);
- construction of TJBs;
- pull-in of High Density Polyethylene (HDPE) duct from barge;
- pull-in of offshore high voltage cables from vessel;
- transition jointing offshore / onshore cables;
- backfilling of joint bays; and,
- reinstatement works.

4.3.74 Offshore works include:

- excavation of HDD exit area and trench (if required);
- assembly of HDPE duct whilst being pulled through the HDD to the landfall;
- laying of additional length of ducting in trench (if required); and,
- capping and burial of HDD duct end.

Access and construction compound

Overview

4.3.75 Main construction access to the landfall will be from the north through an existing road connecting into the A259. An existing field access point will be upgraded. A temporary access haul road will be constructed along the cable route to a landfall construction compound. This temporary road will allow movement of personnel and equipment to/from the compound.

4.3.76 A temporary construction compound will be located behind Climping beach. This compound will be used for the HDD activities, cable pulling and construction of the TJBs.

4.3.77 The compound (approximately 100m x 75m) will be set up with required storage for materials and equipment, facilities for personnel, and area for construction activities. The site and associated access will be in place from the start of construction through to completion of testing activities.

Construction

4.3.78 Prior to any construction, survey works and site clearance will be undertaken, this includes geotechnical, topographical, UXO and environmental surveys. The compound site will be cleared (topsoil removal etc.) in line with environmental requirements and the temporary access haul road will be prepared.

4.3.79 In the landfall compound four HDD pits will be dug to allow the HDD equipment to drill. Exit pits are required offshore and will be excavated by a shallow draft barge.

4.3.80 The export cable ducts will be installed underneath Climping beach using HDD. The drilling will start from the landfall construction compound for approximately 1km to exit below the mean low water spring tide (MHWS) mark. The location of the HDD exit point and therefore the length of the HDD is to be determined following survey, further engineering and offshore vessel considerations.

4.3.81 As part of the HDD activities, offshore activities include the excavating of the offshore HDD exit pits. A typical multicat vessel used for various offshore construction activities, such as excavation and dive support, is presented in **Graphic 4-5.** A shallow draft barge such as that illustrated in **Graphic 4-18**, or similar, will be located at the exit point for a period of approximately 10 to14 days while each HDD is completed and each duct installed.

Graphic 4-18 Example shallow draft barge

4.3.82 The ducts (with a messenger wire inside) will be pulled through to the landfall compound HDD pit from the barge. Once complete the seaward duct end will be capped with the messenger wire inside. A detailed construction plan for the HDD work will be produced for agreement with the regulatory authorities prior to work commencement.

4.3.83 The offshore export cable will be joined to the onshore cable within the TJB. The TJB provides a clean, dry environment where the onshore and offshore cables are joined, and to protect the joints once completed. Four pits will be dug into the ground and lined with concrete. Once the joint is completed, the TJBs are covered and the land above reinstated. Access will be required during operation to link boxes (associated with each TJB).

4.3.84 The export cables will be pulled shoreward through the installed ducts by winching equipment stationed in the landfall compound. A cable lay barge will be stationed at the seaward duct end during the cable pulling activities. The seaward duct will be raised onto the vessel. The cable is attached to the messenger wire and pulled through the duct to the TJB. Once the cable reaches the TJB the cable lay vessel will commence the offshore cable lay. Following completion of the offshore and onshore cable installation, the cables will undergo final testing and commissioning.

4.3.85 Individual landfall construction activities (compound setup, HDD, TJB construction etc.) have relatively short durations compared with the overall landfall construction window presented in **Graphic 4-25**. Due to the landfall works requiring offshore works the scheduling of the landfall works will allow for flexibility around the offshore schedule and sufficient time for all onshore activities to be performed so as not to delay the offshore works.

Reinstatement

4.3.86 Following successful testing of the cables at the TJB the landfall compound and access track will be removed. The site will be reinstated to the original condition and handed back to the landowner, this work will include the removal of all equipment and facilities, temporary fencing, haul road and reinstatement of topsoil.

4.4 Onshore elements of the Proposed Development

Overview

4.4.1 The onshore elements of the Proposed Development refer to works landward of MHWS and will comprise the following key components:

- a temporary onshore cable corridor, approximately 36km in length from the landfall at Climping to a new substation, and from the new substation to the National Grid Bolney substation, approximately 50m in width (25m either side of a centreline) within which the following will be located:
    - permanent infrastructure including transmission cables and associated joint bays; and
    - temporary infrastructure including HDD areas, construction compounds and the likely access requirements; and
- a new substation.

Some landfall works described in **paragraphs 4.3.72** to **4.3.86**, such as the temporary construction compound behind Climping beach, will also take place onshore.

4.4.2 The onshore part of the PEIR Assessment Boundary, is illustrated in **Figure 4.2, Volume 3**. Several options are included within the PEIR Assessment Boundary which are detailed in **paragraph 4.4.3** with regard to the onshore temporary cable corridor and **paragraph 4.4.44** with regard to substation search area options.

Onshore cable corridor

Introduction

4.4.3 The onshore cable corridor is routed from the landfall at Climping through to a proposed new substation, and then onto the existing National Grid Bolney substation. Design refinement of the onshore elements since the Scoping stage is described in **Chapter 3: Alternatives.** This has resulted in a number of onshore cable corridor options being considered within this PEIR assessment. The locations of these onshore cable corridor options are shown on **Figures 4.3** and **Figure 4.4, Volume 3** as follows:

- Warningcamp potential route options (see **Figure 4.3, Volume 3**); and
- onshore substation search area cable corridor options (see **Figure 4.4, Volume 3**).

4.4.4 The following sections present the maximum design assessment assumptions for the onshore elements of the Proposed Development.

Onshore cable design

4.4.5 A maximum of 20 buried cables will run along the length of the onshore cable route from the landfall at Climping through to the new substation. A maximum of 10 buried cables will subsequently run from the new substation to tie into the existing National Grid Bolney substation.

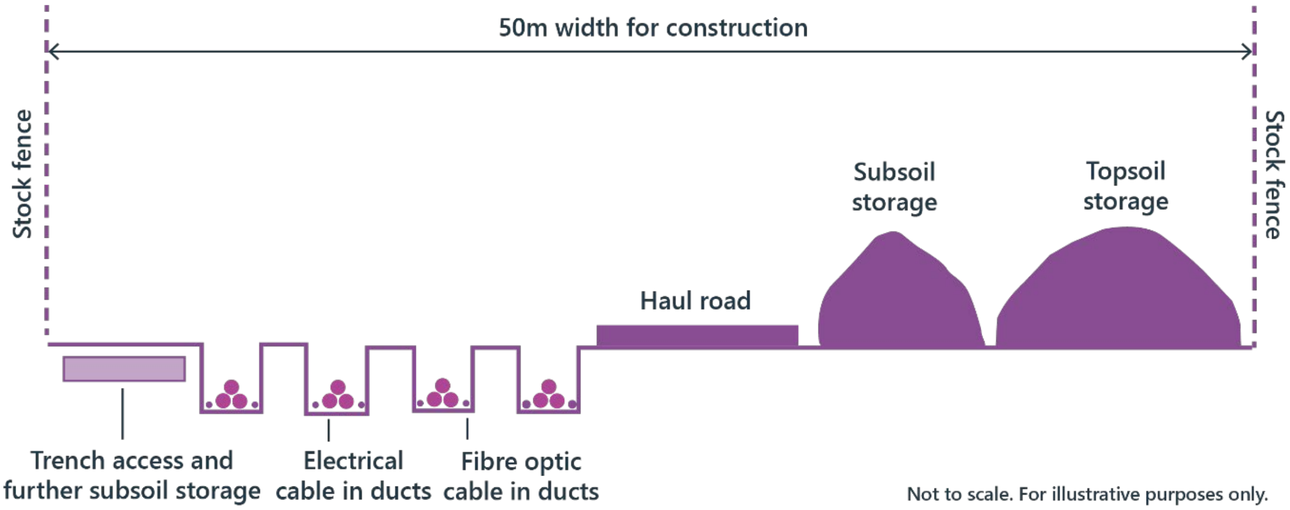
4.4.6 The up to 275kV cable system along the onshore cable route will comprise four cable circuits in separate trenches. Each circuit will contain three Power Cables (HVACs) and two Fibre Optic Cables (FOCs) drawn through pre-installed ducts.

4.4.7 The 400kV cable system between the new substation and the existing National Grid Bolney substation will comprise two cable circuits in separate trenches. Each circuit will contain three Power Cables and two FOCs drawn through pre-installed ducts.

4.4.8 The standard temporary cable construction corridor will be 50m wide and consist of the trenches, excavated material and a haul road. The construction corridor may require widening beyond the standard width in predetermined locations to allow enough space for access / equipment at crossings and avoidance of obstacles. The PEIR Assessment Boundary has been defined considering this enlargement at potential locations. Sufficient space to provide temporary drainage infrastructure has also been included in the onshore part of the PEIR Assessment Boundary.

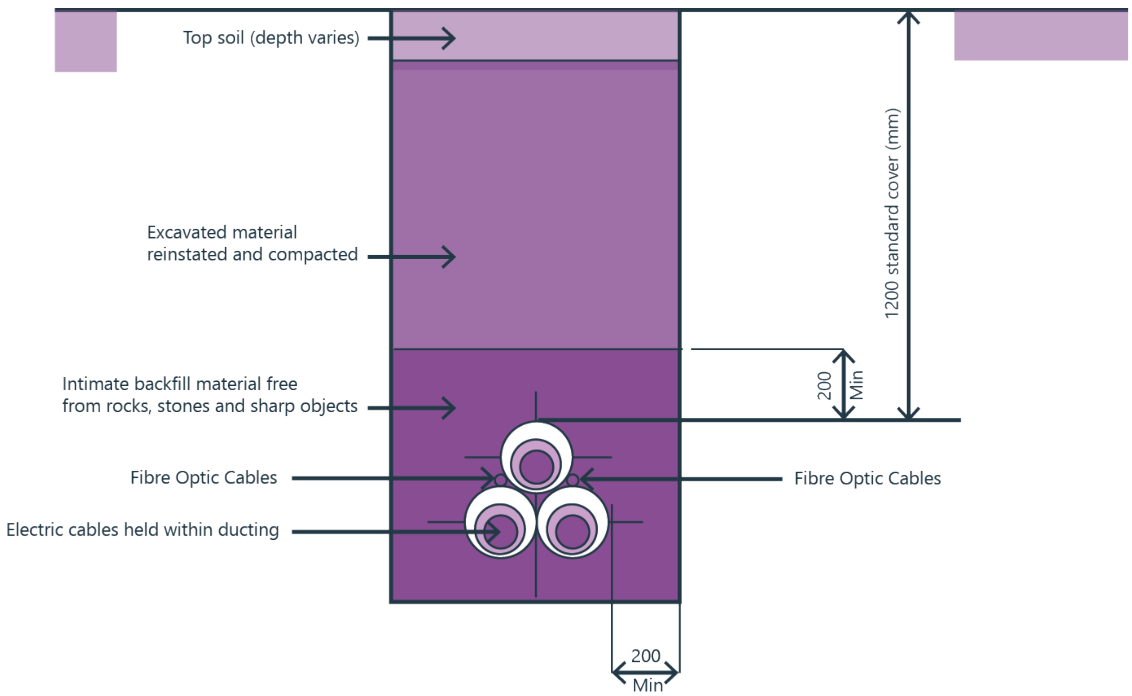
4.4.9 **Graphic 4-19** presents a cross section to illustrate layout of a temporary cable construction corridor. The corridor is routed as straight as possible to reduce overall length and to maximise the distance between TJBs (see **paragraph 4.4.15**) through lower friction between the cable and the ducts during cable pull.

Graphic 4-19 Temporary cable corridor cross section

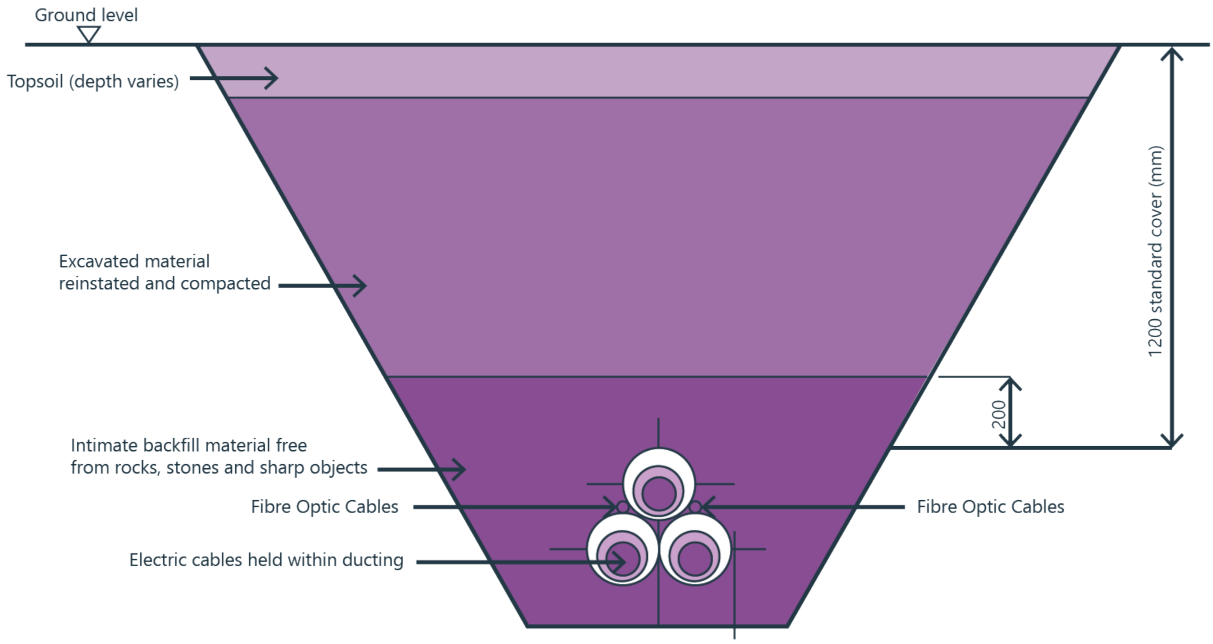


4.4.10 The haul road will enable the transportation of machinery used for topsoil stripping and subsoil excavation. This soil will be stored in bunds within the temporary working cable corridor. It is anticipated that a mechanical excavator will be used for these activities. **Graphic 4-20** and **Graphic 4-21** present the proposed trench profiles for hard solid ground and soil.

Graphic 4-20 Trench profile for hard/solid ground



Graphic 4-21 Trench profile for soil



4.4.11 Where required, a layer of stabilised backfill (likely sandy material) will be deposited for the purposes of protection under the cable ducts. The cable ducts will then be positioned in the trenches.

4.4.12 Trenches will be backfilled with the originally excavated material or cement bound sand (CBS) to the layer of the protective tiles/tape (use of CBS is dependent on soil thermal resistivity). Protective cover tiles/tape will be placed on top of the material to prevent the cable from being damaged. Any surplus material from excavation will be spread across the cable corridor area. The topsoil material will be reinstated, and the land returned to its original use.

4.4.13 FOCs will be installed alongside the transmission cables for communication and monitoring purposes as illustrated in **Graphic 4-20** and **Graphic 4-21**. Each fibre optic and power cable is likely to consist of an oversheath, a metallic sheath, a metallic screen, insulation and a conductor. Power cable cores are likely to be made of copper or aluminium with cXLPE insulation.

4.4.14 The onshore cable corridor assessment assumptions that can be confirmed at this stage are provided in **Table 4-18.**

Table 4-18 Maximum onshore cable corridor assessment assumptions

Assessment assumption	Maximum value
Trench width: at base	0.9m
Trench width: at surface	Between 2m and 4m dependant on soil strength. Maximum angle of trench dependant on soil strength.

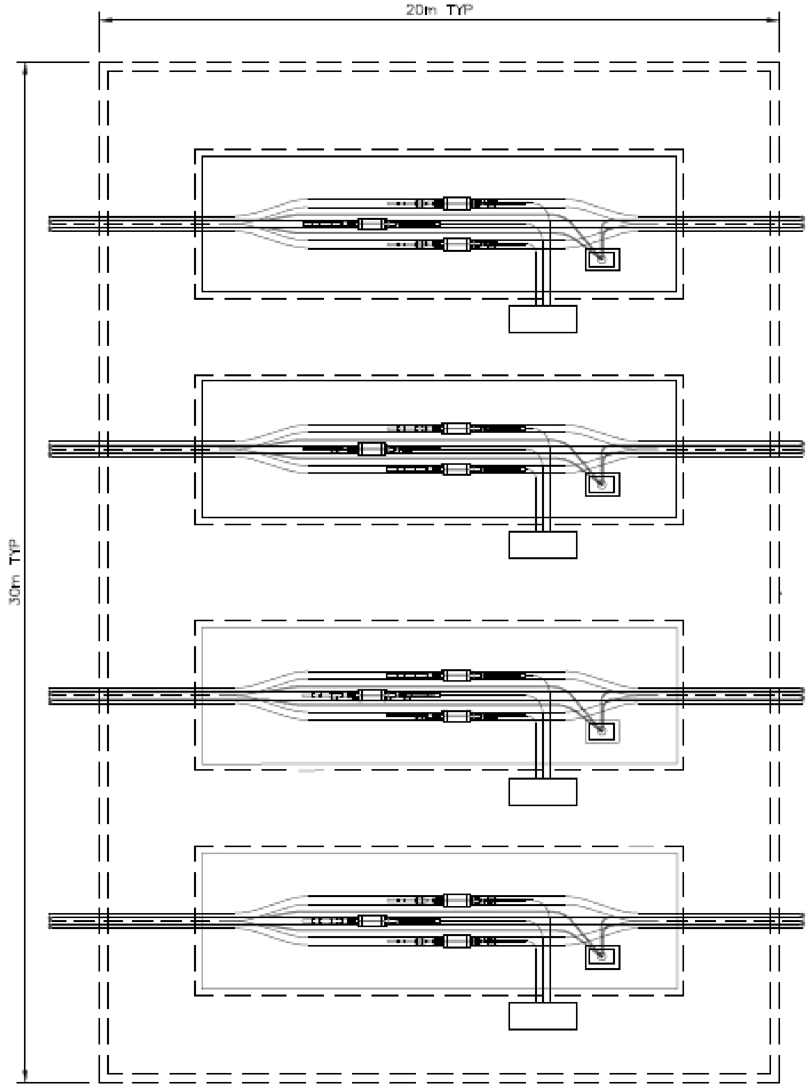
Assessment assumption	Maximum value
	Hard/solid ground: Same as base trench width.
Corridor width: permanent (easement)	15m to 25m (this figure may need to be increased where HDD and cable Joint Bays are located and may be narrowed in areas with particular constraints or to minimise impacts to sensitive sites.)
Corridor width: temporary (easement width including construction)	Up to 50m
Corridor area: permanent (easement)	Route length dependant on the substation location. Corridor width will generally be 15m to 25m wide.
Corridor area: temporary (easement width including construction)	Route length dependant on the substation location. Corridor width will be up to 50m wide.
Burial depth: minimum	1.2m standard cover to top of duct.
Burial depth: maximum (for HDD)	Approximately 25m
Trench: depth of stabilised backfill	Approximately 0.7m
Onshore cable corridor length	Approximately 36km
Onshore cable Area of Search width (not including end points)	Approximately 100m
Number of cables (including fibre optics)	Up to 20
Number of ducts (including fibre optics)	Up to 20
Number of trenches	Up to 4
Depth to top of buried infrastructure (ducts)	Target depth 1m, dependant on cable burial risk assessment
Trenchless (HDD) crossings	A minimum of 11 HDD crossing locations
HVAC: number of cable circuits	Up to 4
HVAC: number of cables	Up to 12

Assessment assumption	Maximum value
Voltage	275kV landfall to substation; 400kV substation to National Grid Bolney substation
Diameter of 275Kv cable	Up to 150mm
Diameter of 400kV cable	147mm
Outside diameter of duct	Up to 250mm
Total installation duration	Up to 3 years
HGV construction traffic movements (two-way) across the onshore temporary cable corridor construction programme	Approximately 51,600

4.4.15 Along the cable route, joint bays will be constructed to enable cable installation and cable jointing. The joint bays are subsurface structures with an associated subsurface link box. These link boxes enable electrical checks and testing to be carried out on the cable system during operation.

4.4.16 The locations of the joint bays will be determined during the detailed design phase. Typically, they are located every 750 to 950m however the location depends on factors such as crossing and bends. **Graphic 4-22** presents a plan view of a typical joint bay configuration.

Graphic 4-22 Illustration of a typical joint bay configuration



4.4.17 **Table 4-19** provides maximum design assessment assumptions for joint bays.

Table 4-19 Joint Bay, Link Box and Fibre Optic Cable Junction Box design assessment assumptions

Assessment assumption	Maximum value
Joint Bays (JB)	
Number of JB locations	Approximately 45 (dependant on substation location, route and length)
Number of JBs per location	4
Max distance between JBs (on one circuit)	1,000m
JB width	4m

Assessment assumption	Maximum value
JB length	14m
JB area	56m^2
JB depth	Approximately 1.5m
JBs - Total area	10,080 m^2
Spoil volume per JB	88.2m^3
JBs - total spoil volume	15,876m^3
JB construction duration per location (does not include cable pulling duration)	6 to 8 weeks
Link Boxes (LB)	
Number of LBs	Approximately 180
Max distance between Link Boxes (LB) (on one circuit)	1,000m
LB & Fibre Optic Cable Junction Box (FOCJB) dimensions (length & width)	2m x 2m
LB area	4m^2
LB depth	1m
LBs: Total area	4m^2
Spoil Volume Per LB	4m^3
LBs: Total Spoil Volume	720m^3
Fibre Optic Cable Joint Boxes (FOCJB)	
Number of FOCJBs	Approximately 180
Maximum distance between FOCJBs (on one circuit)	1,000m
FOCJB dimensions (length & width)	2m x 2m
FOCJB area	4m^2
FOC JB depth	1m
FOCJB total area	4m^2
Spoil volume per FOCJB	4m^3

Assessment assumption	Maximum value
LBs total spoil volume	720m^3

Crossings

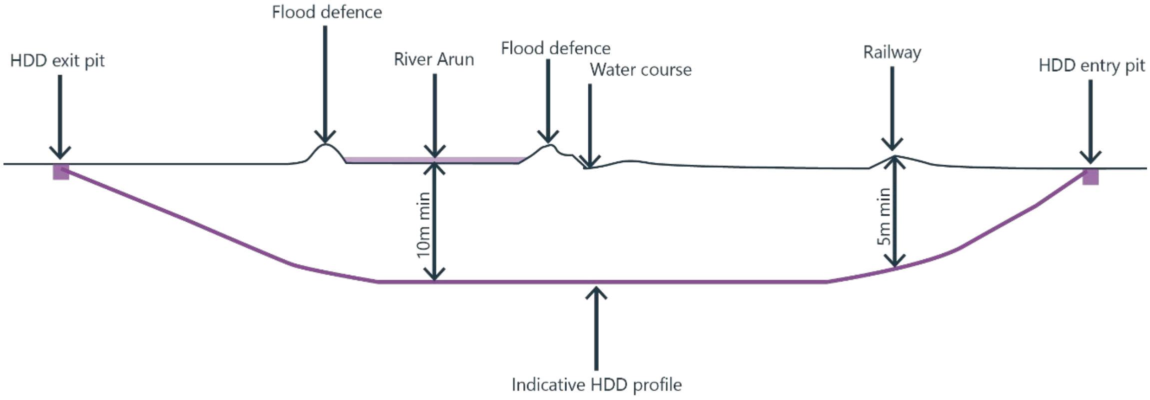
4.4.18 There are road, rail, water, footpaths, third party services, and other crossings along the cable route. Each crossing will be individually reviewed/surveyed during detailed design to confirm the crossing methodology employed. Open cut crossing methodology will predominantly be used. This involves the preparation of the crossing (damming / fluming / pumping in the case of water courses) to allow the trenches to be excavated and ducts installed. The crossing area will be reinstated to the original form. The crossings schedule is provided in **Appendix 4.2, Volume 4.** Traffic control measures and diversions will be implemented for open cut road crossings.

4.4.19 Similarly, open cut footpath crossings such as on the South Downs Way will be temporarily diverted where possible in a safe and controlled manner, with minimal disruption. Whilst there may still be a need for short-term closures, these will be communicated in advance and will be limited to the days where the onshore cable trench is first excavated.

4.4.20 HDD will be used for main watercourses, railways and roads that form part of the Strategic Highways Network, although if necessary other trenchless methodologies will be considered. Other trenchless methodologies to be considered could include auger boring and micro-tunnelling. The Crossings Schedule details the crossings for the onshore cable route and can be found in **Appendix 4.2, Volume 4**. **Figure 4.5, Volume 3** shows the location of all trenchless crossings on the onshore cable corridor. The use of trenchless methodology is less intrusive from a crossing interaction, traffic management and environmental perspective, however the equipment used is louder and as it requires 24 hour working, proximity to noise receptors must be considered. Further details on the trenchless technologies considered are described in **Chapter 3: Alternatives**.

4.4.21 HDD involves drilling a bore from one location to another under the crossing. Following completion of the bore the ducts lengths are strung out and connected in a line of equal length to the crossing and pulled through. Each circuit will have separate HDDs. The configuration and design assumptions of the trenchless crossings will be determined during the detailed design phase and informed by the EIA process. **Graphic 4-23** shows an example of a planned trenchless crossing of the River Arun and the Chichester to Littlehampton railway line using an HDD of approximately 350m.

Graphic 4-23 Cross section of River Arun and the Chichester to Littlehampton railway line HDD



Temporary access and haul road

4.4.22 Temporary access points are required along the onshore cable corridor to allow the transportation of materials, equipment and personnel to and from the construction sites. These access points will allow access to the construction corridor where there will be a temporary haul road running along the length of the cable route, except for locations where there are trenchless or road crossings. **Figure 4.6 a-c, Volume 3** presents the locations of all the proposed access points along the onshore cable corridor. Key assessment assumptions of the access and haul roads are presented in **Table 4-20**.

4.4.23 The use of temporary culverts, flume pipes or bridges may be required where obstacles are encountered along the haul road.

4.4.24 The haul road will comprise crushed aggregates and a geotextile membrane where the existing ground is not considered stable enough. It will be used during installation works and construction activities and be removed prior to final reinstatement.

4.4.25 Potential access points are proposed along the onshore temporary cable corridor based on suitability for the Proposed Development requirements, likely environmental and social impacts, highway safety and connection to key road infrastructure. Existing access points and tracks have been utilised where possible. The selected number and location of these access points will be confirmed at a later stage and agreed with the relevant local authorities and landowners.

4.4.26 The likely access points identified have been assessed for the effect on the road network, along with associated traffic management arrangements, in **Chapter 24: Transport**. Further details on access will be documented in the Outline Construction Traffic Management Plan in **Appendix 24.1, Volume 4**.

Table 4-20 Maximum access and haul road assessment assumptions

Assessment assumption	Maximum value
Temporary roadway width	5m to 10m
Aggregate depth	0.3m

Construction compounds

4.4.27 Construction compounds are required for:

- landfall works (see **paragraph 4.3.73**);
- trenchless crossings; and
- logistics; storage of materials and equipment, also includes welfare facilities and office space as appropriate.

4.4.28 All construction compounds are located within the PEIR Assessment Boundary and are shown on **Figure 4.7 a-c, Volume 3.** Construction compounds for trenchless crossings (HDD compounds) should fit within the standard 50m wide construction corridor, typically being 50m x 75m. However, additional areas are included within the PEIR Assessment Boundary to allow for any small changes to the HDD location.

4.4.29 Along the cable route seven sites have been identified as potential construction or logistic compounds. It is anticipated that approximately four compound will be required, but the location and number of these compounds will be selected at a later stage in agreement with the principal construction contractor.

4.4.30 Following completion of constructions works, the compound facilities will be removed, and each compound site will be returned to its original state. Construction compound details are provided in **Table 4-21.**

Table 4-21 Construction compounds maximum assessment assumptions

Assessment assumption	Maximum value
Number of onshore cable corridor main compound areas	Approximately 4 compounds required: West of River Arun – 57,000m^2 Crossbush – 23,000m^2 Washington, West Sussex – 45,000m^2 Oakendene – 53,000m^2
Onshore cable corridor main compound area	Approximately 4ha per compound.
Construction compound dimensions (length and width)	Vary depending on the compound

Assessment assumption	Maximum value
Construction compound use duration per compound	Up to 3 years and 6 months
HDD compounds (length and width)	50m x 75m
HDD compound construction duration per compound (does not include cable pulling duration)	3 to 4 months

Pre-construction

4.4.31 Pre-construction activities are to secure and prepare all sites and access for the construction activities. These include:

- ecological surveys and works;
- archaeological surveys and works;
- utilities search;
- drainage surveys and works;
- geotechnical surveys;
- site investigations;
- fencing;
- access route preparation;
- topsoil removal and storage; and
- haul road construction along the cable route.

4.4.32 Fencing will be used to mark out the cable corridor area. Vegetation will be cleared, where appropriate, from the working width of the cable corridor at the appropriate time of year.

Construction

4.4.33 Construction along the cable corridor will be performed with the commitment to a safe work site and to minimise potential impacts as much as practicable. Generally, where possible construction will take place during daylight hours with a requirement only for local task lighting. The high-level construction sequence is as follows:

- excavate trenches;
- connect ducts and place the ducts in the trenches;
- backfill the trenches with an initial layer of fine protective material and then excavated material; and
- reinstatement of the topsoil.

4.4.34 In parallel to the above sequence the JBs and link boxes will be installed which involves:

- excavation of the transition joint pit; and
- civil works.

4.4.35 The JBs and link boxes will remain open; ready for cable installation. Following cable installation and testing, they will be backfilled, and the working area reinstated. Further details on reinstatement measures are provided where appropriate in the land-based aspect chapters such as **Chapter 19: Landscape and visual impact, Chapter 21: Soils and agriculture, Chapter 23: Terrestrial ecology and nature conservation,** and **Chapter 25: Ground conditions.**

4.4.36 Access to all construction sites will be managed throughout the construction period with suitable supervision provided at access points to the cable route, and construction compounds. Access to all construction sites will be managed by the construction contractor. Where open cut methodology is used for road crossings traffic management will be controlled.

Cable installation and testing

4.4.37 Following construction of the cable route, with installation of the ducts and JBs, the cables will be installed. Each cable is pulled from one JB to the next (approximately 750 to 950m distance). Testing will be performed to confirm the section of installed cable. This sequence repeats for all cables (HVAC and FOC) and for each circuit along the entire length of the cable route. Once the onshore and offshore cable installation is complete final testing / commissioning will be undertaken.

Construction lighting regime for the onshore cable and substation

4.4.38 External lighting of the construction site for both the onshore cable and the new substation will be directional. The work will usually be scheduled during daylight hours. If night or 24-hour working is required, such as during HDD operations, then portable directional task lighting will be deployed.

4.4.39 External lighting of the construction site will be designed and positioned to:

- provide the necessary levels for safe working;
- minimise light spillage and / or light pollution; and
- avoid disturbance to adjoining residents / occupiers of buildings and to wildlife.

4.4.40 At construction compounds and specific locations where night working is required or in poor light conditions during normal working hours, portable lighting units will be used where necessary to ensure safe working and / or site security.

4.4.41 Site or welfare cabins, equipment and lighting will be sited to minimise visual intrusion as far as is consistent with the safe and efficient operation of the work site. Site lighting will be positioned and directed to minimise glare and nuisance to residents, walkers and to minimise distractions or confusion to passing drivers on railways or adjoining public highways. Implementation will comply with the requirements set out in the following standards and guides as far as it is reasonably practicable and applicable to construction works:

- BS EN 12464-2:2014 Light and lighting. Lighting of work places. Outdoor work places;
- Institute of Lighting Professionals Guidance Note 1 for the Reduction of Obtrusive Light (2020);
- Chartered Institute of Building Services Engineers (CIBSE) Society of Light and Lighting Guide 1: The Industrial Environment (2018); and
- CIBSE Society of Light and Lighting Guide 6: The Exterior Environment (2016).

4.4.42 When lighting is necessary, appropriate lighting units will be designed to minimise spillage of illumination outside the construction works area into surrounding habitats, e.g. lighting will be directional, task orientated and where possible, fully shielded. This is to minimise the impact of lighting on ecological resources, including nocturnal species. Further details regarding lighting during the construction phase will be developed with the principal construction contractor.

Onshore substation

Introduction

4.4.43 The purpose of the new substation is to increase the cable route voltage from 275kV to the 400kV required to connect to the existing National Grid Bolney substation.

4.4.44 Design refinement of the onshore substation location has been undertaken since the Scoping stage and is described in further detail in **Chapter 3: Alternatives**. Following assessment of a number of options, two substation search areas are under consideration. These two substation search areas lie within the PEIR Assessment Boundary and are as follows:

- Bolney Road/Kent Street; and
- Wineham Lane North.

4.4.45 **Figure 4.8, Volume 3** illustrates the locations of the two substation search areas and their corresponding cable corridor options. Of the two areas under consideration, only one will be included in the ES and associated DCO Application. Two areas are being assessed at PEIR to ensure that consideration is given to the likely significant effects and relevant consultation feedback before a final location is selected.

4.4.46 The overall built site footprint for the proposed onshore substation is anticipated to be up to 5.9 hectares (ha) within a larger PEIR Assessment Boundary. The additional land could be used to provide associated necessary development, such as permanent drainage infrastructure and landscaping, if such features cannot be delivered within the 5.9 ha footprint anticipated for the permanent onshore substation itself. The onshore substation will comprise electrical components and equipment necessary to connect the electricity generated by the Proposed Development to the existing network. These include:

- transformers;
- reactors;
- capacitor banks;
- open busbars;
- fire walls;
- reactive compensation equipment;
- harmonic filters;
- HV/MV equipment;
- switch room;
- control building; and
- welfare facilities.

4.4.47 Some equipment will be placed outdoors and other equipment will be housed in buildings or enclosures.

4.4.48 An indicative layout for an onshore substation is illustrated in **Graphic 4-24**. The final layout may not entirely align with the indicative layout, but subject to the maximum design assumptions presented in **Table 4-22** which are assumed for both substation search area options.

Graphic 4-24 Indicative layout of the onshore substation

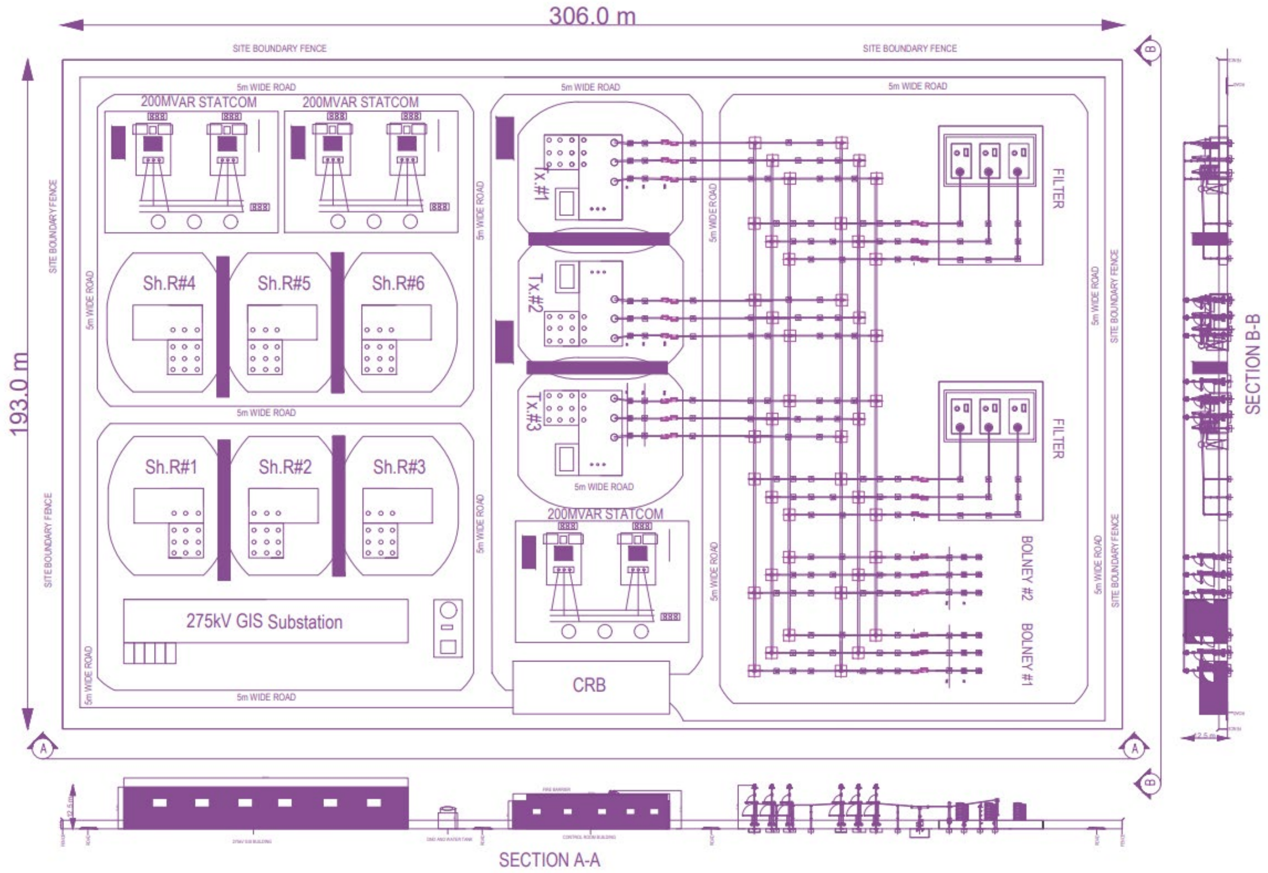


Table 4-22 Maximum assessment assumptions for the onshore substation

Assessment assumption	Maximum value
Permanent area of site for all infrastructure	Up to 5.9ha
Temporary works area	Up to 2.5ha
Maximum building height	12m
Maximum height of fire walls	10m
Lightning protection mast height	12m
Maximum number of buildings	12
Maximum length building	70m
Maximum width of building	20m
Duration of construction	Up to 3 years

Installation

4.4.49 Access to the substation will be required during construction as well as operation. The construction access route will be used for the duration of the substation construction works. Site access works will involve stripping topsoil. The topsoil will be protected and stored nearby for the duration of the onshore substation construction works.

4.4.50 Construction activities for the onshore substation will include enabling works and construction works. Enabling works will prepare the site ahead of construction and include vegetation clearance, access road construction, installation of drainage systems, installation of a construction compound, delivery of materials, plant, machinery and fuel, and any earthworks necessary for the installation of the substation foundations.

4.4.51 Generally, substation construction will take place during daylight hours with a requirement only for local task lighting. Construction works will involve:

- landscaping;
- installation of perimeter fencing;
- installation of underground services and substation foundations;
- construction of the control and switchgear buildings and plant buildings;
- construction of cable trenches;
- construction of ducts and pits;
- construction of the oil containment bund; and
- provision of utility supplies.

4.4.52 Once all construction activities have been carried out, the electrical equipment will be installed, commissioned and tested for the performance of the connection between the new substation and the National Grid Bolney substation. Finally, the site will be secured, and the temporary area returned to its original use and condition.

4.4.53 It is anticipated that Heavy Goods Vehicles (HGVs) will be required during the enabling and construction phases of the development. Abnormal Load movements are expected to be required during the construction phase to transport permanent plant and equipment to the site. The expected movements are detailed in **Table 4-23**. Further details on the delivery of abnormal loads will be detailed in the Abnormal Loads Assessment in **Appendix 24.3: Abnormal indivisible loads assessment, Volume 4**.

Table 4-23 Maximum HGV and abnormal loads assessment assumptions for the substation

Assessment assumption	Maximum movements
HGV construction traffic movements (two-way)	Approximately 8,050

Assessment assumption	Maximum movements
Abnormal Indivisible Loads	9

4.4.54 Abnormal Indivisible Loads (AILs) will be comprised of:

- 3 transformers; and
- 6 shunt reactors.

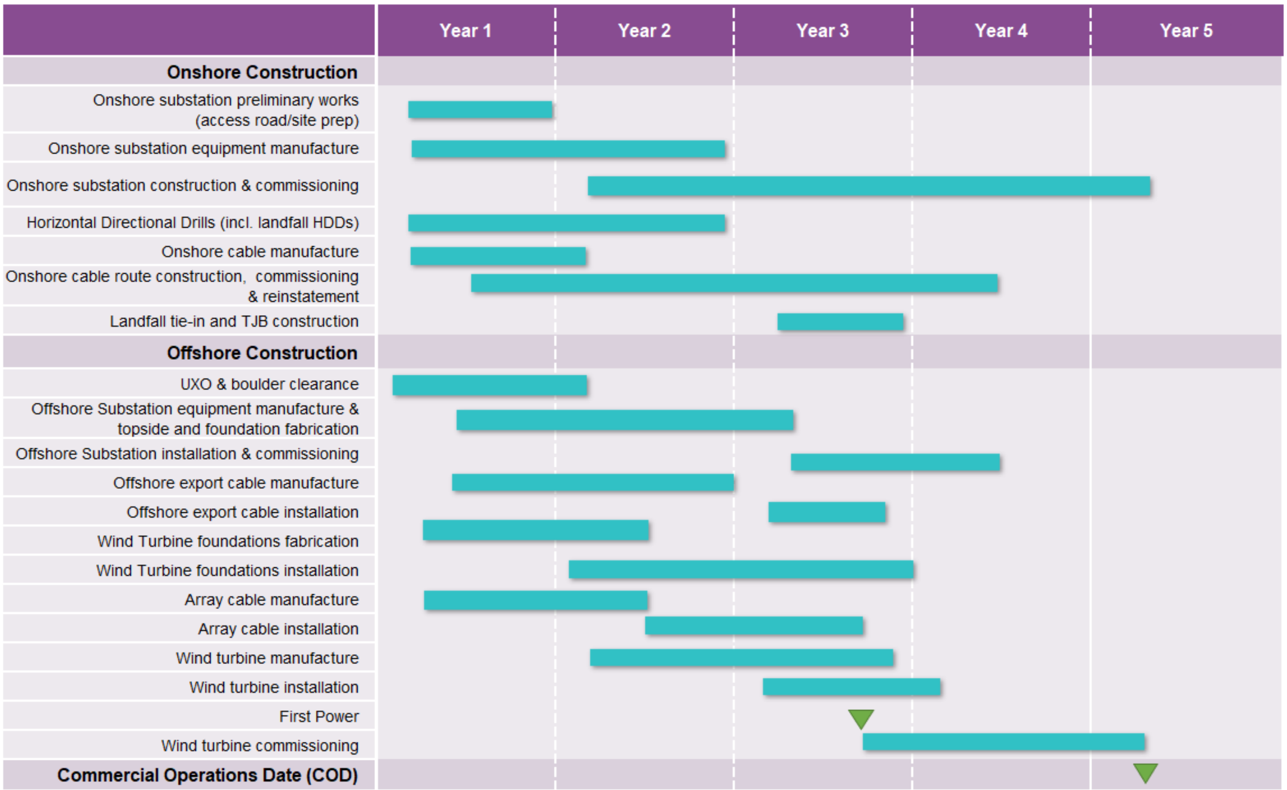
Grid connection export cable

4.4.55 A buried cable connection is required from the proposed onshore substation to the existing National Grid Bolney substation. This connection will comprise a maximum corridor of two circuits with a total of six single core 400kV and four Fibre Optic Cables, all placed within a 50m wide corridor. The construction methodology for this grid connection will be the same as the methodology outlined for the cable route in **Section 4.4.33** from the landfall to the substation.

4.5 Construction programme

4.5.1 An indicative construction programme for the Proposed Development is presented in **Graphic 4-25**. The programme illustrates the anticipated duration of the major construction / installation elements. The anticipated maximum total construction duration is approximately four years.

Graphic 4-25 Indicative construction programme



Construction timing

4.5.2 Indicative hours for the construction work and any construction-related traffic movements to or from any site of the Proposed Development are as follows:

- 07:00 to 19:00 hours Monday to Friday;
- 08:00 to 13:00 hours on Saturday.

4.5.3 No activity outside of these indicative hours, including Sundays, public holidays or bank holidays will take place apart from under the following circumstances:

- where continuous periods of construction work are required, such as concrete pouring or directional drilling[2], and West Sussex County Council and the South Downs National Park Authority (for any works within the South Downs National Park) has been notified prior to such works 72 hours in advance;
- for the delivery of abnormal loads to the connection works, which may cause congestion on the local road network, where the relevant highway authority has been notified prior to such works 72 hours in advance;
- where works are being carried out on the foreshore; and
- as otherwise agreed in writing with West Sussex County Council and the South Downs National Park Authority within the South Downs National Park.

4.6 Operation and maintenance

Introduction

4.6.1 The operational lifetime of the Proposed Development is expected to be around 30 years. Taking place after commissioning of the Proposed Development, operation and maintenance activities can be divided into three main categories:

- scheduled maintenance;
- unscheduled maintenance; and
- special maintenance in the event of major equipment breakdown and repairs.

4.6.2 For the Proposed Development, RED will draw on experience gained in operating and maintaining Rampion 1. This includes identifying potential synergies when developing the operation and maintenance strategy for the Proposed Development.

4.6.3 A key principle is that the wind farm will be designed to operate under minimum supervisory input. The chosen operation and maintenance concept will depend upon:

- the required operation and maintenance tasks determined by the operator and/or agreed with the main equipment suppliers to maintain operability and availability of the wind farm;

[2] Horizontal directional drilling (HDD) is a continuous activity and cannot be paused once started, so works may need to continue outside the indicative construction hours.

- health, safety, security and environmental (HSSE) legislation and best practice;
- requirements or constraints imposed by public authorities or other authorities;
- site specific weather and metocean conditions;
- industry best practice; and
- optimum economic viability.

Offshore operation and maintenance

4.6.4 The overall operation and maintenance strategy will be finalised once the operation and maintenance base location and technical specification of the Proposed Development are confirmed. It will require a harbour-based operation and maintenance base plus a combination of Crew Transport Vessels (CTVs), Special Operation Vessels (SOVs), Jack-Up Vessels (JUVs), heavy lift vessels, cable laying vessels and helicopters.

4.6.5 There will be scheduled services on each WTG and the offshore substations. These scheduled services will include:

- inspections;
- system performance assessments;
- oil and filter change outs;
- bolt tensioning, and
- statutory inspections, e.g. lifting and fire equipment inspections.

4.6.6 Scheduled and unscheduled maintenance activities will require access to the WTGs 365 days per year.

4.6.7 In addition to scheduled maintenance activities, experience shows that each WTG will need to be accessed by an operation and maintenance crew approximately (but not limited to) once a month. These visits are for activities such as fault-finding, manual hardware resets, minor repair jobs, and inspections of WTGs after lightning storms.

4.6.8 In addition to the maintenance of the WTGs it may be that remediation work will be required on the other wind farm components, for example survey and repair work to cables, foundations, WTG structures above and below the water, and the offshore substation platform(s).

4.6.9 Cable surveys and foundation inspections will initially be undertaken approximately every two years. The interval may increase if assets are proven to be stable, however more frequent and detailed surveys may be required if cables become exposed or due to the mobility of the seabed. The more detailed surveys could require dedicated surveying vessels. **Table 4-24** details the maximum design assumptions for operational and maintenance activities and **Table 4-25** presents the maximum operation and maintenance vessel assessment assumptions for operation and maintenance.

4.6.10 Although expected to be very infrequent through the life of the Proposed Development, it may be necessary to replace some of the larger components of the WTGs in the event of failure or breakdown. The possible replacements can be systematic change of bearings, transformer, blades, generator or gearbox. As the size of some of these components is too large to be handled by the service vessels, jack up barges with mobile crane or larger special ships will need to be used.

4.6.11 Maintenance and remedial work on WTGs, foundations and cables will involve the following:

- painting and application of coatings of WTGs and transition pieces will be required for corrosion protection, which will be carried out by technicians using hand-tools. Surface preparation is required to break down existing surface coatings and any existing corrosion. There will be one full paint job per WTG every 10 years, and one touch-up paint job per WTG every three years;
- marine growth and bird waste will be physically brushed off WTGs and substation structures by hand, using a brush, and if required, a high-pressure jet wash (using sea water only). There will be up to five cleaning events per WTG and substation per year;
- access ladders may require replacing due to damage or corrosion. One ladder replacement is anticipated every five years;
- sacrificial foundation anodes will be installed on the foundation below the water level for corrosion protection. These will require replacement by divers from a support vessel every five years;
- the J-Tube (a tube that surrounds the cable for protection) will occasionally require repair or modification after being cut for cable repairs;
- cable remedial burial on array, interconnector and export cables may be required if they have become exposed during natural sediment transport processes;
- where rock protection has been applied to cables during the construction phase, this may require replenishing due to natural processes. Up to 25% of original protection will be replenished over its lifetime; and
- the cable route will be designed and installed to require no reburial through life. However, array, interconnector and export cables infrequently develop faults in service which are detected by the wind farm protection systems, and reburial has been required on other projects and should be considered possible. Indicatively, it is estimated that a total of 5km will require remedial work, over the life of the Proposed Development, dependent on survey results. This could be achieved through jetting, or the placement or replacement of rock armour.

4.6.12 **Table 4-24** provides the maximum assessment assumptions for operational and maintenance activities for the Proposed Development.

Table 4-24 Maximum assessment assumptions for operational and maintenance activities

Assessment assumptions	Maximum value
WTG maintenance	
Maximum number of full painting events - lifetime quantity	300 (1 full event every 10 years)
Maximum number of cleaning events (bird waste and marine growth removal) - lifetime quantity	15,000 (up to 5 cleaning events per WTG per year)
Major WTG component replacement	
Maximum number of exchange events – lifetime quantity	350 (assumes 3 to 4 events per WTG over the lifetime including margin)
Footprint of seabed disturbance via jacking-up activities per exchange event	1,100m^2 (assumes 1,000m^2 from construction vessel plus 10%)
WTG access ladder replacement	
Maximum number of ladder replacement events - lifetime quantity	600 (assumes replacement every 5 years)
Maximum footprint of seabed disturbance if jack-up vessel required	1,100m^2 (assumes 1,000m^2 from construction vessel plus 10%)
WTG anode replacement	
Maximum number of anode replacement events - lifetime quantity	600 (assumes replacement every 5 years)
Maximum footprint of seabed disturbance if jack-up vessel required	1,100m^2 (assumes 1,000m^2 from construction vessel plus 10%)
WTG J-tube replacement or modification	
Maximum number of J-tube replacement events - lifetime quantity	200 (assumes 2 per WTG over lifetime)
Maximum footprint of seabed disturbance if jack-up vessel required	1,100m^2 (assumes 1,000m^2 from construction vessel plus 10%)
Offshore platform major component replacement	

Assessment assumptions	Maximum value
Maximum number of full painting events - lifetime quantity	6 (1 full event every 10 years per platform)
Touch-up painting in addition to full painting events	21 (1 touch-up event every 3 years)
Maximum number of cleaning events (bird waste / and marine growth removal) - lifetime quantity	450 (up to 5 cleaning events per platform per year)
Maximum number of exchange events - lifetime quantity	27 (assumes 9 events per platform)
Maximum footprint of seabed disturbance if jack-up vessel required	1,100m^2 (assumes 1,000m^2 from construction vessel plus 10%)
Offshore platform access ladder replacement	
Maximum number of ladder replacement events - lifetime quantity	36 (assumes 3 platforms, 2 ladders per platform, replacement every 5 years)
Maximum footprint of seabed disturbance if jack-up vessel required	1,100m^2 (assumes 1,000m^2 from construction vessel plus 10%)
Offshore platform anode replacement	
Maximum number of anode replacement events - lifetime quantity	72 (assumes 4 legs on each of 3 platforms with replacement every 5 years)
Offshore platform J-Tube replacement	
Maximum number of J-Tube replacement events - lifetime quantity	60 (assumes 2 per J-Tube over lifetime)
Array cable remedial burial	
Maximum number of remedial burial events for array cable – lifetime quantity	18 (assumes 0.07 reburial events per 1km installed over lifetime, and maximum of 250km of array cables)
Maximum length of cable subject to jetting remediation re-burial per remedial burial event	2,000m (rock dumping will also be considered)
Maximum width of disturbed seabed per individual jetting event	The higher of 10m or 2x water depth

Assessment assumptions	Maximum value
Maximum footprint of (temporary) seabed disturbance per individual jetting exercise (for cable remediation)	200,000m^2
Array cable repairs	
Maximum number of cable repairs - lifetime quantity	6
Maximum cable trench width	10m
Maximum length of cable pulled from trench repair event	600m
Maximum footprint of seabed disturbance per event	6,000m^2 (assumes 600m of cable pulled from trench)
Predicted duration of each cable repair event	3 months
Footprint of seabed disturbance via jacking-up activities for single cable repair event	1,100m^2
Array cable protection replacement	
Percentage of original cable protection requiring replacement	25%
Export cable remedial burial	
Maximum number of remedial burial events for export cables - lifetime quantity	3 events per cable (assumes 0.07 reburial events per 1km installed over lifetime)
Maximum length of cable subject to jetting remediation re-burial) per remedial burial event	2,000m
Maximum width of disturbed seabed per individual jetting event	10m
Maximum footprint of (temporary) seabed disturbance per individual jetting exercise (for cable remediation)	20,000m^2
Export cable repairs	

Assessment assumptions	Maximum value
Maximum number of cable repairs - lifetime quantity	4
Maximum cable trench width	10m
Maximum length of cable pulled from trench per repair event	600m
Maximum footprint of seabed disturbance per event	6,000m^2 (assumes 600m of cable pulled from trench)
Predicted duration of each cable repair event	3 months
Footprint of seabed disturbance via jacking-up activities for single cable repair event	1,100m^2
Export cable protection replacement	
Percentage of original cable protection requiring replacement	25%

4.6.13 The scheduled maintenance of the WTGs and offshore substation assets will be carried out within the structures themselves on mechanical, electrical, control and instrumentation and structural components. All other maintenance with possible environmental considerations is outlined in **Table 4-24**. Routine maintenance may occur 365 days per year.

Operation and maintenance vessel numbers and typical type

4.6.14 **Graphic 4-26** shows a typical service vessel that will be used to transport operation and maintenance personnel to the offshore site.

Graphic 4-26 Typical crew transfer vessel which can carry 12 to 16 passengers and equipment (from Brighton Boat)

4.6.15 **Table 4-25** provides the maximum assessment assumptions for the operation and maintenance vessels.

Table 4-25 Maximum offshore vessels and logistics assessment assumptions for operation and maintenance

Assessment assumptions	Maximum value
Offshore operation and maintenance activities	
Operation and maintenance vessels - CTVs	6
Operation and maintenance vessels - SOVs	2
JUVs	4
Onshore facilities area - offices	2,500m^2
Onshore facilities area - workshop and warehouse	2,500m^2
Harbour facilities - quayside length	125m
Operational hours	24 hours, 7 days a week

Assessment assumptions	Maximum value
Offshore operation and maintenance activities[3]	
Helicopter maintenance visits	For unplanned maintenance tasks when CTV access not possible - access by winching directly onto WTGs
Offshore helipads	None required
Operating base	Brighton City Airport (Shoreham Airport)
Number of helicopter return trips required during operation and maintenance phase per year	60
Refuelling	Onshore base only
Jack-up WTG visits (per year)	12
Jack-up platform visits (per year)	6
Jack-up total trips (per year)	18
Crew vessels WTG visits (per year)	1,095
Operation and maintenance vessel peak quantities	
Large operation and maintenance vessels	3
Small operation and maintenance vessels e.g. CTV	6
Lift vessels	2
Cable maintenance vessels	2
Auxiliary vessels	8

Maintenance port and facilities

4.6.16 The maintenance port and facilities will be located in Sussex and it is assumed that all direct labour will be resident within the area. It is likely that the existing facilities at Newhaven Port will be utilised (and expanded where necessary) as the base for operations management of Rampion 2, as this will yield synergies and enable effective coordination with the existing operations team on Rampion 1.

4.6.17 At this stage the possibility of a supplementary satellite or alternative facility (in addition to Newhaven) further west in Sussex has not been discounted. The decision on whether to use an additional facility will depend on factors such as the

[3] A single visit comprises a return trip to and from Rampion 2 array area

eventual westward extent of the offshore wind farm and whether it is beneficial to have crew boat(s) stationed here to service the most westward WTGs, with vessels from Newhaven servicing the central/eastern parts of the turbine array.

Onshore operation and maintenance

4.6.18 Maintenance of the onshore cable is expected to be minimal. During operation, periodic testing of the cable is likely to be required (every two to five years). This will require access to the link boxes at defined inspection points along the cable route. This will involve attendance by up to three light vehicles, such as vans, in a day at any one location. The vehicles will gain access using existing field accesses and side accesses as agreed with landowners to reach the relevant sections of the cable.

4.6.19 Monitoring of the onshore substation will be done remotely using CCTV technology and other remote monitoring equipment. The security fencing installed during construction will remain in place. Certain areas of the substation will have permanent light fittings, however, these lights will only be used when required for unscheduled maintenance or emergency repair purposes.

4.6.20 Unscheduled maintenance or emergency repair visits will typically involve a very small number of vehicles, typically light vans. Infrequently, equipment may be required to be replaced, then the use of an occasional HGV may be utilised, depending on the nature of the repair.

4.6.21 Inspection and minor servicing may be required for the electrical plant, but it is anticipated that the substation will require minimal scheduled maintenance and operation activities.

4.6.22 Lighting during onshore operation and maintenance activities is expected to be minimal. External lighting will be directional and limited to essential security and safety requirements. External works will usually be scheduled during daylight hours. If night working is required then portable directional task lighting will be deployed.

4.7 Decommissioning

Offshore decommissioning

4.7.1 At the end of the operational lifetime of the Proposed Development, it is anticipated that all structures above the seabed or ground level will be completely removed. The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. The decommissioning duration of the offshore infrastructure may take the same amount of time as construction of the Proposed Development, up to four years, although this indicative timing may reduce.

4.7.2 The Energy Act (2004) requires that a decommissioning plan must be submitted to and approved by the Secretary of State for Business, Energy and Industrial Strategy, a draft of which will be submitted prior to the construction of the Proposed Development. The decommissioning plan and programme will be updated during the Proposed Development's lifespan.

4.7.3 To take account of changing best practice and new technologies, the approach and methodologies employed at decommissioning will be compliant with the legislation and policy requirements at the time of decommissioning.

WTGs, offshore substations and accommodation platform

4.7.4 WTGs will be removed by reversing the methods used to install them. Piled foundations will likely be cut approximately 1m below the seabed, with due consideration made of likely changes in seabed level and removed. This could be achieved by inserting a pile cutting device. Once the piles are cut, the foundations could be lifted and removed from the site. At this point in time, it is not thought to be reasonably practicable to remove entire piles from the seabed, but endeavours will be made to ensure that the sections of pile that remain in the seabed are fully buried.

4.7.5 The offshore substations will most likely be a reverse installation where the decommissioning most likely will be in two phases, in the first phase the topside will be lifted from the foundation to a transport vessel/barge and sailed to a suitable harbour for decommissioning. In the second phase the foundation will be decommissioned; if piled foundation they will be decommissioned as described in **paragraphs 4.3.35** to **4.3.37** . Any scour protection will be left in situ.

Offshore cables

4.7.6 Although it is expected that most array and export cables will be left in situ in line with current Government approved practice, for the purposes of the Environmental Impact Assessment it has been assumed that all cables will be removed during decommissioning. Exposed cables are more likely to be removed to ensure they don’t become hazards to other users of the seabed. At this point in time, it cannot be accurately determined whether and which cables will be exposed at the time of decommissioning

4.7.7 In the event that cables are removed, it is likely that equipment similar to that which is used to install the cables could be used to reverse the burial process and expose them. Therefore, the area of seabed impacted during the removal of the cables could be the same as the area impacted during the installation of the cables. Divers and/or ROVs may be used to support the cable removal vessels.

4.7.8 Once the cables are exposed, a grapnel will be used to pull the cables onto the decks of cable removal vessels. The cables will be cut into manageable lengths and returned to shore. Once onshore, it is likely that the cables will be deconstructed to recover and recycle the copper and/or aluminium and steel within them.

Intertidal area

4.7.9 To minimise the environmental disturbance during wind farm decommissioning the preferred option is to leave cables buried in place in the ground with the cable ends cut, sealed and securely buried as a precautionary measure. Alternatively, partial removal of the cable may be achieved by pulling the cables back out of the ducts. This may be preferred to recover and recycle the copper and/or aluminium and steel within them.

Vessel activities

4.7.10 Decommissioning is currently based on reverse installation and the assumptions about maximum number of vessels and helicopters and their movements is therefore the same as described for construction of the wind farm in **Table 4-5**.

Onshore decommissioning

Onshore cable

4.7.11 It is anticipated that the onshore electrical cables will be left in-situ with ends cut, sealed and buried to minimise environmental effects associated with removal.

Onshore substation

4.7.12 The onshore substation may be used as a substation site after decommissioning of the Proposed Development or it may be upgraded for use by another offshore wind projects. This will be subject to a separate planning application.

4.7.13 Should the onshore substation need to be decommissioned fully, however, the decommissioning works are likely to be undertaken in reverse to the sequence of construction works and involve similar levels of equipment. All relevant sites will be restored to their original states or made suitable for an alternative use. Further detail will be provided in the decommissioning plan.

4.7.14 The decommissioning duration of the onshore infrastructure may take the same amount of time as construction of the Proposed Development, up to four years, although this indicative timing may reduce.

4.8 PINS Scoping Opinion responses

4.8.1 **Table 4-26** sets out the comments received in Section 2.3 of the PINS Scoping Opinion relevant to the Proposed Development and how these have been addressed in this PEIR. Full details of the PINS Scoping Opinion comments and responses is provided in **Appendix 5.1: Response to the Scoping Opinion, Volume 4**. Regard has also been given to other stakeholder comments that were received in relation to the Scoping Report (RED, 2020). The information provided in the PEIR is preliminary and therefore not all the Scoping Opinion comments have been able to be addressed at this stage.

Table 4-26 PINS Scoping Opinion responses relevant to the description of the Proposed Development

Reference	Scoping Opinion comment	How this is addressed in this PEIR
Para 2.3.1	**Description of the Proposed Development** The ES should include the following: - A description of the Proposed Development comprising at least the	A clear explanation of the Proposed Development presented in the PEIR is provided throughout this chapter (**Chapter 4: The Proposed**

Reference	Scoping Opinion comment	How this is addressed in this PEIR
	information on the site, design, size and other relevant features of the development; and - A description of the location of the development and description of the physical characteristics of the whole development, including any requisite demolition works and the land-use requirements during construction and operation phases.	**Development**). The PEIR is a stage in a process of ongoing refinements to the design, which will continue into the ES. Final land-use requirements and any requisite non-residential demolition works will be refined and presented in the ES.
Para 2.3.2	Paragraphs 2.3.50 – 2.3.56 of the Scoping Report provides some detail on operation and maintenance activities. The ES should provide a full description of the nature and scope of these activities, including the types of activity, their frequency, and how works will be carried out for both the onshore and offshore elements of the Proposed Development. This should include consideration for the potential overlapping of activities with those required for the continuing operation of Rampion 1.	This PEIR chapter (**Section 4.6**) provides a description of the nature and scope of operation and maintenance activities, including the types of activity, their frequency, and how works will be carried out for both the onshore and offshore elements of the Proposed Development. Further details will be provided in the ES.
Para 2.3.3	Paragraph 2.3.56 and subsequent aspect sections of the Scoping Report address decommissioning in respect of the Proposed Development. The ES should include the rationale in support of the assessment of potential significant effects during the decommissioning phase, including a description of anticipated decommissioning activities (e.g. where the magnitude of impact is similar to that during construction). Where there is uncertainty of impacts during decommissioning this should be clearly explained along with the implications for the assessment of significant effects (including assumptions and mitigation on which reliance is placed). For example, there is reference to a “decommissioning plan” but production of such a document does not appear in	This PEIR chapter (**Section 4.7**) provides a description of anticipated decommissioning activities. The effects arising during the decommissioning phase are assessed in aspect **Chapters 6** to **28**.

Reference	Scoping Opinion comment	How this is addressed in this PEIR
	the Applicant's scoping commitments register (Scoping Report appendix 2).	
Para 2.3.4	*Offshore* Inter-array cabling and offshore export cables are described as having a "Target depth" for burial of 1m (dependant on cable burial risk assessment). The cable burial risk assessment is recorded as commitment C-45 in appendix A of the Scoping Report, although it is not immediately clear whether this would take place prior to or post any DCO consent. The ES should be clear on the range of burial depths that have been considered as part of the assessment(s). Where reliance is placed on a subsequent risk assessment as mitigation, the ES should also explain the effectiveness and degree of confidence that can be placed on this measure.	This PEIR chapter (**Chapter 4**) describes the target burial depth, which will be dependent on cable burial risk assessment to be carried out when the cable route is finalised. This will be undertaken post-consent and will be secured through deemed marine licence conditions.
Para 2.3.5	The Scoping Report does not explain whether HVAC or Direct Current (HVDC) technologies are proposed, and the ES should describe the technology proposed or options sought in this regard. The Scoping Report also explains that array cables will be 33kV or 66kV but not the circumstances in which either 33kV or 66kV options would be chosen, or whether it might be a combination of both. The ES should describe these options, any differences in the physical infrastructure requirements and provide an assessment of environmental effects that may result between one or the other (or combined) option	This PEIR chapter (**Chapter 4**) describes the technology proposed and states that the 33kV or 66kV option will be chosen based on the WTG model selected. **Chapter 3: Alternatives (Section 3.5)** describes the selection process between HVAC and HVDC
Para 2.3.6	The Inspectorate understands that preliminary engineering investigations indicate "several" design options for the WTG foundations could be	This PEIR chapter (**Section 4.3**) describes all options under consideration for the WTG

Reference	Scoping Opinion comment	How this is addressed in this PEIR
	considered including monopiles and jackets, and that “other solutions such as suction buckets may be used”. The ES should include a full and detailed description of all the foundation options for which development consent is being sought, including maximum diameter of piles should they be used. The Inspectorate makes further comments on flexibility in design in the following paragraphs.	foundations and their maximum assessment assumptions.
Para 2.3.7	The Scoping Report identifies the potential need for seabed preparation for foundations and inter array cabling, which may include boulder and/or sandwave clearance. Any requisite seabed preparation for the export cable route should also be described and any resultant likely significant effects assessed within the ES. Should seabed preparation involve dredging, the ES should identify the quantities of dredged material and identify the likely location for disposal. The Applicant’s attention is drawn to the scoping consultation response of the MMO relating information required as part of the ES in supporting characterisation of new or existing disposal sites if they are to be included as part of the Proposed Development.	This PEIR chapter (**Chapter 4**) describes the seabed preparation activities for foundations and inter-array cabling. Site characterisation of new or existing disposal sites will undertaken in support of the DCO Application, and will identify any requirements for a disposal site, in line with the MMO scoping consultation response.
Para 2.3.8	The ES should identify the worst-case footprint of seabed disturbance that would arise from all offshore construction activities, for example seabed clearance/preparation, and vessel jack up and anchoring. The maximum footprints of all permanent components should also be identified.	This PEIR chapter (**Section 4.3**) identifies the worst-case footprint of seabed disturbance that will arise from all offshore construction activities.
Para 2.3.9	The Scoping Report states that the construction of the landfall is “anticipated” to be via a trenchless technique “such as” HDD. The Inspectorate notes that commitment C-	This PEIR chapter (**Chapter 4**) describes the construction of the landfall and techniques to be adopted.

Reference	Scoping Opinion comment	How this is addressed in this PEIR
	4 of Scoping Report Appendix A states that a HDD technique "will" be used at the landfall location. No other trenchless or trenched techniques are presented. The ES should describe and assess the options considered in this regard and the assessment of alternatives should explain the reasons for the selected option(s).	**Chapter 3: Alternatives** provides a description and assessment of the techniques considered for landfall.
Para 2.3.10	*Onshore* Paragraph 2.3.38 of the Scoping Report explains that, in addition to buried cabling, onshore cable installation methods such as HDD will be also be used as required to avoid or minimise potential effects where constraints are identified, including environmentally sensitive water course crossings, major roadways and railways. The ES should identify the locations and type of all such crossings. Where reliance is placed in the ES on the use of a specific method as mitigation, the Applicant should ensure that such commitments are appropriately defined and secured. The Inspectorate notes that commitment C – 18 of the Scoping Report Appendix A refers to a "Crossing Schedule" being produced, and this should be cross-referenced throughout the aspect chapters where special crossing types are relevant.	**Appendix 4.2: Crossings schedule, Volume 4** identifies the locations and types of all such crossings, and is cross-referenced in the PEIR where appropriate. This PEIR chapter (**Chapter 4**) identifies the locations and types of all trenchless crossings. Where reliance is placed in the PEIR on the use of a specific method as mitigation, the PEIR and subsequently the ES will ensure that such commitments are appropriately defined and secured.
Para 2.3.11	Paragraph 2.3.45 of the Scoping Report explains that onshore cable construction may be phased and there is a possibility that the installation of all onshore cables may not occur in a single operation. It is also explained that haul roads, and any construction compounds will be removed, and reinstatement will take place on completion of the installation. The construction programme should be defined in the ES on the basis of a	The construction programme defined in this PEIR chapter (**Chapter 4**) is based on a worst case in respect of phasing periods. This PEIR chapter (**Chapter 4**) identifies where new access routes, either temporary or permanent, are required to access the onshore cable corridor and compounds, as well as the duration for which they will be required in light of

Reference	Scoping Opinion comment	How this is addressed in this PEIR
	worst case in respect of phasing periods. The ES should identify where new access routes, either temporary or permanent, are required to access the onshore cable corridor and compounds, as well as the duration for which they will be required in light of phasing (eg how long they will need to be retained for in light of cable installation in multiple operations).	phasing (e.g. how long they will need to be retained for in light of cable installation in multiple operations).
Para 2.3.12	The Scoping Report identifies the need for joint bays and link boxes "at regular intervals along the route" to enable the cable installation and connection process. Regular intervals are defined as 600 – 1,000m in C-19, Appendix A of the Scoping Report, although it does define whether their locations will be determined by the time the application is made. The Inspectorate anticipates this may not be the case. If uncertainty persists, the ES should identify a worst-case scenario for the number of jointing pits and link boxes that may be required, and their impact during both construction and operation. Where commitments are made at specific locations to mitigate any potential effects, these should be secured through the Code of Construction Practice (CoCP) (or equivalent) as referred to at paragraph 4.4.27 of the Scoping Report.	Joint bays and link boxes are required at regular intervals along the route; this is dependent on substation location, cable route and length, as described in this PEIR chapter (**Chapter 4**), and will be finalised at the detailed design stage post-consent. Any impacts associated with joint bays and link boxes during construction and operation are identified and assessed in aspect **Chapters 6** to **28**. Where commitments are made at specific locations these will be detailed through the Outline COCP.
Para 2.3.13	For the avoidance of doubt, the Inspectorate understands that the connection of the new substation to the existing National Grid Bolney substation would be via underground cabling (as is implied but not expressly stated at paragraphs 2.3.34 - 2.3.48 of the Scoping Report). The Inspectorate expects the ES to provide greater clarity as to the necessary connection works between the new substation and the Bolney substation (up to 5km	This PEIR chapter (**Chapter 4**) outlines how the Proposed Development will connect into the existing National Grid Bolney substation. This will be via underground cabling. This PEIR chapter (**Chapter 4**) provides greater clarity as to the necessary connection works between the new substation and the existing Bolney substation.

Reference	Scoping Opinion comment	How this is addressed in this PEIR
	away). This is particularly important if / where construction and operation of the connection may be of a different form or type (e.g. overhead line) to the connection of the new substation to the landfall. In addition, paragraph 2.3.35 states that the existing National Grid Bolney substation would require "underground cables and minor upgrades", and it is unclear whether these works would be part of the Proposed Development (as associated development) or subject to separate consent by National Grid or another party. These matters should be clearly set out in the ES and likely significant effects should be assessed.	
Para 2.3.17	**Flexibility** The Inspectorate notes the Applicant's desire to incorporate flexibility into their draft DCO (dDCO) and its intention to apply a 'Rochdale Envelope' approach for this purpose. Where the details of the Proposed Development cannot be defined precisely, the Applicant will apply a worst-case scenario, as set out in section 2.2 of the Scoping Report. The Inspectorate welcomes the reference to Planning Inspectorate (PINS)Advice Note nine 'Using the 'Rochdale Envelope' in this regard	The Rochdale Envelope approach will be applied where appropriate. Where applied, a maximum design scenario will be adopted. PINS Advice Note Nine 'Using the Rochdale Envelope' will be adhered to.
Para 2.3.18	The Applicant should make every attempt to narrow the range of options and explain clearly in the ES which elements of the Proposed Development have yet to be finalised and provide the reasons. At the time of application, any Proposed Development parameters should not be so wide-ranging as to represent effectively different developments. The development parameters will need to be clearly defined in the DCO and in the accompanying ES. It is a matter for the Applicant, in preparing an ES, to	This chapter (**Chapter 4**) and **Chapter 3: Alternatives** provide narrative on the narrowing of the range of options and provide clear explanation of the Proposed Development presented in the PEIR. The PEIR is a stage in a process of ongoing refinements to the design, which will continue into the ES.

Reference	Scoping Opinion comment	How this is addressed in this PEIR
	consider whether it is possible to robustly assess a range of impacts resulting from a large number of undecided parameters. The description of the Proposed Development in the ES must not be so wide that it is insufficiently certain to comply with the requirements of Regulation 14 of the EIA Regulations. In this regard, the Inspectorate expects that the component parameters presented in tables 2.2 and 2.3 of the Scoping Report will be refined and further detailed as part of the ES	
Para 3.3.11	The Inspectorate understands that the maximum height to blade tip of the Proposed Development's WTGs is 325m, whereas those installed as part of Rampion 1 are 140m to blade tip. This is likely to be a key consideration across the aspect chapters of the ES (particularly landscape and visual, cultural heritage and socio-economics), and the ES should be clear as how the magnitudes of effects of the Proposed Development (within the design envelope) account for the relationship with the Rampion 1 project	Details of the assessment assumptions are set out in this chapter (**Chapter 4**). The preliminary assessment of effects of the WTGs in relation to landscape and visual impact, cultural heritage and socio-economics, are set out in **Chapter 19: Landscape and visual impact, Chapter 26: Historic environment** and **Chapter 18: Socio-economics**.
Para 3.3.13	As set out in paragraph 2.3.11 of this Scoping Opinion, the ES should be clear as to the potential construction programme options where the installation of all onshore cables may not occur in a single operation. Paragraph 4.4.26 and Figure 2.7 of the Scoping Report states that the construction of the Proposed Development will have a duration of approximately 5 years although it does not clearly state how this accounts for flexibility in the onshore construction programme and whether this accounts one or more cable installation operations.	An outline construction programme is presented and described in this chapter (**Section 4.5**).

Reference	Scoping Opinion comment	How this is addressed in this PEIR
Para 3.3.14	**Residues and Emissions** The EIA Regulations require an estimate, by type and quantity, of expected residues and emissions. Specific reference should be made to water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation and quantities and types of waste produced during the construction and operation phases, where relevant. This information should be provided in a clear and consistent fashion and may be integrated into the relevant aspect assessments.	Information on anticipated emissions from the Proposed Development is provided in this chapter (**Chapter 4**) and relevant aspect chapters (**Chapters 6** to **28**). An outline Site Waste Management Plan will be prepared and submitted as part of the DCO Application.
Para 4.4.5	It is not yet confirmed which method of cable protection will be adopted for the proposed development, though it is noted that cable burial is the preferred option. The ES should explain the types of cable protection which could be used, and the associated impacts upon benthic subtidal and intertidal ecology.	The exact form of cable protection to be used will depend upon local ground conditions, hydrodynamic regime/processes, and the selected cable protection contractor. However, the final choice will include one or more of the following: 1. concrete 'mattresses'; 2. rock placement; 3. geotextile bags filled with stone, rock or gravel; 4. polyethylene or steel pipe half shells, or sheathes; and 5. bags of grout, concrete, or another substance that cures hard over time. This is described in this chapter (**Section 4.3**). The impacts of introduced artificial substrates have been addressed in **Chapter 9: Benthic subtidal and intertidal ecology, Section 9.10** using available literature and a worst-

Reference	Scoping Opinion comment	How this is addressed in this PEIR
		case scenario to undertake a precautionary assessment.
5.1.11	The Scoping Report states that up to 4 trenches will be required for the installation of the onshore corridor. The ES should report the number of trenches to be used and also dimensions of each and how long they would remain open for. The intention is to use trenchless techniques where possible; the ES should assess the landscape effects which may be created by open trenches.	**Chapter 19: Landscape and visual impact, Table 19-19** provides a summary of the assessment assumptions of the onshore elements of the Proposed Development with a full description provided in this chapter (**Section 4.4**). Effects on landscape character/ elements as a result of the installation of the onshore cable corridor are assessed in **Appendix 19.3, Volume 4** and summarised in **Section 19.9** of **Chapter 19: Landscape and visual impact**.
5.6.3	The Scoping Report has scoped out potential impact on local roads, PRoW and the users of these routes during decommissioning works on the basis that the effects of decommissioning will be lower than construction. The Inspectorate is unable to agree that this can be scoped out at this stage as the effects and subsequent mitigation have not been quantified for the construction phase. Although the transport impacts during decommissioning works would be similar or potentially lower than during construction, the ES should assess these matters where significant effects are likely to occur.	Acknowledged. It is proposed that all onshore and offshore subsurface cable infrastructure will be left in situ as part of the decommissioning phase (outlined in this chapter **Section 4.7**). Decommissioning effects will relate only to the removal of the onshore substation and traffic generation will therefore be lower than during construction. An assessment of the decommissioning effects of the onshore substation is included in **Chapter 24: Transport, Section 24.12**.

4.9 Glossary of terms and abbreviations

Table 4-27 Glossary of terms and abbreviations

Term	Description
Areas of temporary land use	Land required for construction but not permanent land requirement for the Proposed Development.
Array cables	Cables connecting the WTGs to each other and to the offshore substation(s).
Aspect	Used to refer to the individual environmental topics.
Associated development	Associated Development is defined by the Planning Act 2008 as having a direct relationship with the principal development, either supporting the construction or operation or helping to address its impact It is for the Secretary of State to decide on a case by case basis whether or not development should be treated as associated development.
Cable circuit	A collection of conductors necessary to transmit electric power between two points. For HVAC this consists of three conductors (or a multiple of three).
CBS	Cement Bound Sand
CIBSE	Chartered Institute of Building Service Engineers
CTV	Crew Transfer Vessel
DCO Application	An application for consent under the Planning Act 2008 to undertake a Nationally Significant Infrastructure Project made to the Planning Inspectorate who will consider the application and make a recommendation to the Secretary of State, who will decide on whether development consent should be granted for the Proposed Development.
Decommissioning	The period during which a development and its associated processes are removed from active operation.
Development Consent Order (DCO)	This is the means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects, under the Planning Act 2008.
Embedded environmental measures	Equate to 'primary environmental measures' as defined by Institute of Environmental Management and Assessment (2016). They are measures to avoid or reduce potential impacts and

Term	Description
	subsequent effects that are directly incorporated into the design of the Proposed Development.
Environmental Impact Assessment (EIA)	The process of evaluating the likely significant environmental effects of a proposed project or development over and above the existing circumstances (or 'baseline').
Environmental Statement (ES)	The written output presenting the full findings of the Environmental Impact Assessment.
FOC	Fibre Optic Cables
FOCJB	Fibre Optic Cable Joint Boxes
Geophysical	Relating to the physics of the earth.
HAT	Highest Astronomical Tide
HDPE	High Density Polyethylene
HGV	Heavy Goods Vehicles
High Density Polyethylene (HDPE) duct	A duct used to house copper and fibre optic cables installed using traditional pulling techniques.
Horizontal Directional Drill (HDD)	An engineering technique avoiding open trenches.
HSSE	Health, Safety, Security and Environment
HV	High Voltage
HVDC	High Voltage Direct Current
Impact	The changes resulting from an action.
Inshore	The sea up to two miles from the coast.
Intertidal	The area of the shoreline which is covered at high tide and uncovered at low tide.
Iterative design	A process by which the design is repeated to make improvements, solve problems, respond to environmental measures and engage local communities and statutory stakeholders.
JB	Joint Bays

Term	Description
Land cover	The surface cover of the land usually expressed in terms of vegetation cover or lack of it. Related to but not the same as land use.
Landfall	The area between the transition pit and the mean low water springs tide line (MLWS).
LAT	Lowest Astronomical Tide
Likely significant effects	It is a requirement of Environmental Impact Assessment Regulations to determine the likely significant effects of the Proposed Development on the environment which should relate to the level of an effect and the type of effect.
Link boxes (LB)	Underground chambers or above ground cabinets adjacent to the cable trench containing low voltage electrical earthing links.
Marine aggregate	Marine dredged sand and/or gravel.
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
National Grid Substation	Infrastructure where overhead power lines or underground cables are connected and electricity is transformed for distribution to the local area via the National Grid.
Nationally Significant Infrastructure Project (NSIP)	Nationally Significant Infrastructure Projects are major infrastructure developments in England and Wales that bypass normal local planning requirements. These include proposals for renewable energy projects.
Noise sensitive receptors	Locations or receptors that may potentially be adversely affected by the addition of a new source of noise. These can include residential properties, people and sensitive species.
Offshore	The sea further than two miles from the coast.
Offshore export cable	Cables that transfer power from the offshore substation(s) to shore.
Offshore part of the PEIR Assessment Boundary	An area that encompasses all planned offshore infrastructure and relevant buffer areas.

Term	Description
Offshore substation	Housing for the electrical components needed to transform power supplied by the WTGs. An export cable connects the offshore substation and the transition join bay at landfall.
Offshore Wind Farm	A group of WTGs located offshore.
Onshore export cable	Cables that transfer power from the offshore export cables to the onshore substation(s).
Onshore part of the PEIR Assessment Boundary	An area that encompasses all planned onshore infrastructure.
Onshore substation	A compound housing electrical equipment enabling connection to the National Grid. The substation also contains equipment to help maintain stable grid voltage.
Planning Act 2008	The legislative framework for the process of approving major new infrastructure projects.
Planning Inspectorate (PINS)	The Planning Inspectorate deals with planning appeals, national infrastructure planning applications, examinations of local plans and other planning-related and specialist casework in England and Wales.
Pre-lay plough	Offshore cable laying construction equipment.
Preliminary Environmental Information Report (PEIR)	The written output of the Environmental Impact Assessment undertaken to date for the Proposed Development. It is developed to support public consultation and presents the preliminary findings of the assessment to allow an informed view to be developed of the Proposed Development, the assessment approach that has been undertaken, draw preliminary conclusions on the likely significant effects of the Proposed Development and environmental measures proposed.
Proposed Development	The development that is subject to the application for development consent.
Receptor	These are as defined in Regulation 5(2) of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 and include population and human health, biodiversity, land, soil, water, air, climate, material assets, cultural heritage and landscape that may be at risk from exposure to pollutants which could potentially arise as a result of the Proposed Development.
RED	Rampion Extension Development

Term	Description
Rochdale Envelope	The Rochdale Envelope is a parameter-based approach to environmental assessment which aims to take account of the need for flexibility in the evolution of detailed design.
ROV	Remotely Operated Vehicle
RPM	Revolutions Per Minute
SCADA	Supervisory Control and Data Acquisition
Scour	A localised sediment erosion feature caused by local enhancement of flow speed and turbulence due to interaction with an obstacle.
Secretary of State (SoS)	The body who makes the decision to grant development consent.
Stakeholder	Person or organisation with a specific interest (commercial, professional or personal) in a particular issue.
Subsea grab	General term for all subtidal benthic grab sampling equipment used for sediment and faunal sampling such as a Day Grab.
Subtidal	The region of shallow waters which are below the level of low tide.
The Applicant	Rampion Extension Development Limited
Transition Joint Bay (TJB)	A buried chamber where sections of cables are jointed together.
Transpooling	The process of spooling flexible cables or pipes from one storage system to another.
Unexploded Ordnance (UXO)	Unexploded ordnance are explosive weapons (bombs, shells, grenades, land mines, naval mines, etc.) that did not explode when they were employed and still pose a risk of detonation, potentially many decades after they were used or discarded.
Wind Turbine Generators (WTGs)	The components of a wind turbine, including the tower, nacelle, and rotor.
WTGs	Wind Turbine Generators
XLPE	Cross Linked Polyethylene

4.10 References

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