AQUIND Limited

PEIR CHAPTER 3

Description of Proposed Development

CONTENTS

TABLES

PLATES

FIGURES

APPENDICES

3 DESCRIPTION OF THE PROPOSED DEVELOPMENT

3.1 INTRODUCTION

3.1.1.1 This chapter of the Preliminary Environmental Information Report ('PEIR') provides the description of the Proposed Development. The activities and programme proposed for the construction, operation and maintenance and decommissioning of the Proposed Development are also described. Due to the nature of the Proposed Development, the marine and onshore components are described separately.

3.1.1.2 The information provided is preliminary and subject to change as work continues to iteratively refine the proposals and to take into account responses to the consultation. The final proposals for which development consent will be sought will be detailed within the ES and DCO.

3.1.1.3 In broad terms, the Proposed Development will comprise the following components, as illustrated in Plate 1.1 and Table 1.1 in Chapter 1 - Introduction:

- HVDC marine cables;
- HVDC underground cables;
- Converter Station;
- HVAC cables; and
- Fibre optic data transmission cables and associated infrastructure.

3.1.1.4 The use of the term 'Proposed Development' will differ throughout the PEIR depending on whether it is being used in reference to the onshore or marine components of the Proposed Development. The information in Table 1.1 in Chapter 1 details which parts of the 'Proposed Development' are onshore in the UK and those parts that are located in the UK marine area.

3.1.2 MARINE EXTENT

3.1.2.1 The marine components of the Proposed Development are all of that part of the Project within the UK Marine Area (defined by Section 42 of the Marine and Coastal Access Act 2009 (the 'MCAA 2009') as being from the Mean High Water Spring Tide ('MHWS') out to the limit of the UK/France Exclusive Economic Zone ('EEZ') (Figure 3.1).

3.1.3 ONSHORE EXTENT

3.1.3.1 The onshore components of the Proposed Development are all elements of the Proposed Development above the Mean Low Water Spring ('MLWS') level (Figure 3.2).

3.1.4 DEVELOPMENT ENVELOPE

3.1.4.1 Chapter 2 - Consideration of Alternatives explains the alternatives and design options considered when formulating and refining the proposals for the Proposed Development.

3.1.4.2 The Proposed Development envelope shown in this document and the subject of this consultation consists of a maximum parameter envelope and design principles for a number of key project components. The Proposed Development envelope is outlined in red in the Site Boundary drawings. The final design of the Proposed Development (which in some instances will be confirmed post consent in accordance with defined and consented spatial and design parameters) will lie within the area currently identified, but the final Site Boundary is likely to be reduced due to the removal of options currently being presented, when further information is known and as a result of consultation feedback.

3.1.4.3 The information presented within this chapter outlines the development options that are being considered for the Proposed Development and the range of potential spatial and design parameters upon which the subsequent technical assessment chapters are based. Where the spatial and design parameters for the Proposed Development are not yet confirmed, the technical assessments have been undertaken based on the maximum development envelope, so as to take into account a worst-case scenario, ensuring a robust assessment of the likely significant effects associated with the Proposed Development is carried out.

3.1.5 DESIGN FLEXIBILITY

3.1.5.1 PINS Advice Note Nine: 'Using the Rochdale Envelope' (Planning Inspectorate, 2018) provides guidance regarding the degree of flexibility that may be considered appropriate within an application for development consent.

3.1.5.2 In relation to some aspects detailed design work for the Proposed Development will occur post the issuing of the decision on the DCO application and following the appointment of the contractors. This is necessary to ensure there is sufficient flexibility in the proposals to provide the appointed contractors scope for value engineering through innovative design and/or construction techniques. All design and construction techniques employed will be in accordance with the development envelope assessed and for which development consent is sought.

3.1.5.3 Pre-construction surveys and site investigations will be undertaken to further inform the detailed design post any DCO being made. The project components that are likely to require the greatest level of flexibility are listed below:

- Landfall Installation – installation methodology and location of permanent and temporary works;

- Marine Cable Route – whilst a preferred Marine Cable Corridor has been identified, micro-routing within the corridor will be required based on the requirements of the appointed contractors and pre-installation surveys;
- Marine Cable Route Preparation and Clearance – what is required will be dependent upon results of the marine geophysical survey, Cable Burial Risk Assessment (‘CBRA’), contractor requirements and pre-installation surveys. The works may include the need for clearance of mobile bedforms (e.g. sandwaves), boulders, seabed debris, out of services (‘OOS’) cables and the disposal of excavated material. Any unexploded ordnance (‘UXO’) will need to be identified and cleared (or avoided). Permission for undertaking these UXO activities will be sought through a separate marine licence(s) with the Marine Management Organisation (“MMO”) outside the DCO process, following a DCO being made;
- Marine Cable Burial Depth – the recommended burial depth of the marine cable will be outlined in the CBRA. The final burial depth will be dependent upon the pre-installation surveys and the requirements of the contractor, including selected installation/burial techniques;
- Marine Cable Crossings – the final design of cable crossings will be dependent on the geotechnical survey, CBRA, Contractors’ requirements, pre-installation surveys and the Crossing Agreements to be signed with the relevant cable operators;
- Onshore utility crossings – several utility crossings will be required for the Onshore Route;
- Converter Station Design – a preferred site with a footprint of 200 m x 200 m (approximately 4 ha) has been identified to be a suitable for the Converter Station. A maximum parameter envelope will be defined for the Converter Station, allowing flexibility for siting, orientation and massing within this envelope which accords with the consented design and environmental parameters; and
- Converter Station Area – This is the area of land identified to accommodate: the Converter Station and associated equipment; the connection between AQUIND Interconnector AC cables and the National Electricity Transmission System (‘NETS’) at Lovedean Substation; the Cable Corridor to accommodate AC cables (and FOC) between the Converter Station and Lovedean Substation; the DC Cables (including FOC) from Converter Station southwards; the temporary construction compound area(s); access road; and, mitigation measures, for example additional planting and attenuation pond.

3.2 PROPOSED DEVELOPMENT - MARINE

3.2.1 INTRODUCTION

UK Landfall and Marine Cable Corridor Selection

3.2.1.1 Chapter 2 Consideration of Alternatives explains the UK Landfall site and Marine Cable Corridor selection process, including details of the alternative locations that were considered. The UK Landfall location is at Eastney, to the south-east of Portsmouth, Hampshire and is shown in Figure 3.3.

Proposed Marine Cable Corridor

3.2.1.2 The Marine Cable Corridor is identified in Figure 3.1. The total length of the Marine Cable Corridor in UK waters is approximately 109 km from the UK/France EEZ boundary line to the Landfall at Eastney. Kilometre Points ('KP') have been used to denote positions along the centre line of the Marine Cable Corridor. In UK waters, these start at KP 0 at the Eastney Landfall site and finish at KP 109 at the UK/France EEZ boundary line (Table 3.1).

3.2.1.3 The Inshore Marine Cable Corridor refers to the section of the Marine Cable Corridor that runs from the UK Landfall out to the 12 nm limit of UK territorial waters (i.e. KP 0 - KP 45). The Offshore Marine Cable Corridor is the section of the Marine Cable Corridor from the 12 nm limit out to UK/France EEZ boundary line (KP 45 to KP 109).

Definition of Parameters

3.2.1.4 The following parameters are used in defining the Marine Cable Corridor:

- Survey Centreline ('SCL'): the centreline of the Marine Cable Corridor which is also the centreline of the as-surveyed marine geophysical and geotechnical survey corridor;
- Marine Cable Corridor: the corridor encompassing the marine geophysical and geotechnical survey, centred on the SCL. This is 500 m wide from KP 0 to KP 8.6, then 520 m wide from KP 8.6 to the UK/France EEZ boundary line. The Marine Cable Corridor is also extended to include a 1,500 m diameter centred on the Atlantic Crossing cable crossing at KP 72.6; and
- Marine Cable Route: this will be the final route for the cable that lies within the Marine Cable Corridor, comprising two bundled pairs of cables 50 m apart, with a works zone of 15 m either side.

3.2.1.5 Positional references in this PEIR are in relation to KP along the SCL. The start of the Marine Cable Corridor for the purposes of the Proposed Development begins at KP0.027 of the as-surveyed geophysical and geotechnical survey corridor. The final Marine Cable Route will diverge from the SCL but will be within the maximum extent of the Marine Cable Corridor within the UK marine area.

Table 3.1 - KP of key features along the Marine Cable Corridor

KP	Key Feature
0.027	Start of the Marine Cable Corridor at MHWS
0.050	Start of survey data
0.076	MLWS
8.600	10 m water depth
45.116	12 nm
109.107	UK/France EEZ Boundary Line

3.2.2 MARINE CABLE SYSTEM AND DESIGN

3.2.2.1 The Proposed Development will consist of four 320 kV HVDC marine cables which will be installed for the majority of the Marine Cable Route as two bundled pairs. There is the potential that the marine cables will be installed as four individual cables for up to approximately 200 m between the point where the marine cables exit from the Landfall on the seabed and the location where the trenching starts for the two pairs of bundled marine cables. Each pair will be capable of facilitating the transfer of up to 1000 MW, resulting in a total net power transfer capacity of approximately up to 2000 MW. The final design of the marine cables will be determined as part of the final design stage, which will be undertaken by the cable manufacturer following the appointment of the contractors.

Cable System

3.2.2.2 The Proposed Development will use twin symmetrical monopole HVDC links ('poles'), as demonstrated by Plate 3.1. This enables the independent operation of each 1000 MW circuit. Each bundled pair will correspond to one pole.

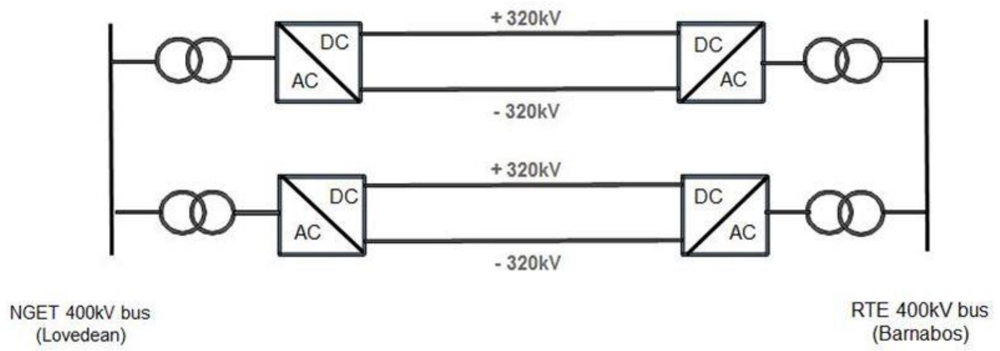

Plate 3.1 - Schematic diagram of a HVDC monopole system

Cable Design

3.2.2.3 The Proposed Development is proposing to use copper or aluminium conductors with Cross Linked Polyethylene ('XLPE') insulation for the marine cables. The cable has an XLPE insulation extruded over the conductor and covered with a water tight lead alloy sheath to protect against water ingress. Over the lead is a polyethylene anti-corrosion layer, bedding layer, galvanised steel armour wires with a polypropylene string layer overall. Each HVDC marine cable will have a diameter of approximately 140 mm and an approximate weight of 50 kg/m (in air) where a copper conductor is used. Aluminium conductor cables will likely have a larger diameter but will weigh less. Plate 3.2 illustrates the cross section of a typical marine XLPE cable.

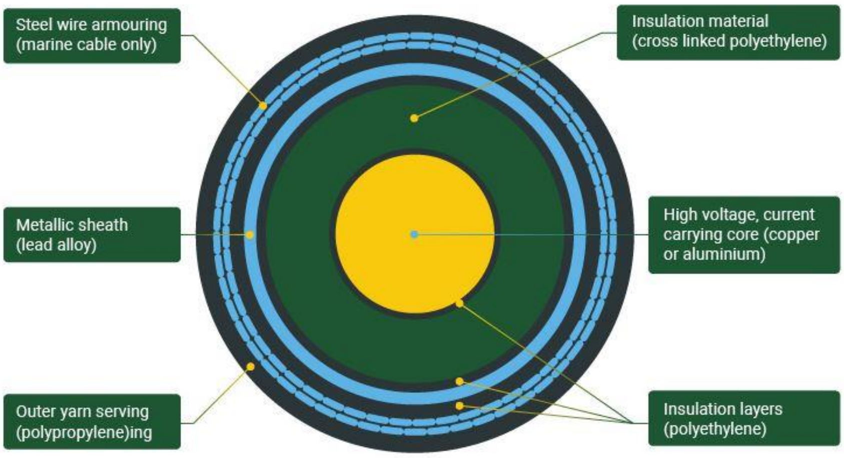

Plate 3.2 - Cross-section of a typical marine XLPE cable

3.2.2.4 Whilst some types of cable contain liquid oil for electrical insulation, XLPE cables contain no oil. Therefore, if a cable is ruptured, no liquids or gases will be released into the marine environment.

3.2.2.5 Due to the weight and length of the cables, they must be installed in multiple sections rather than single lengths between Landfalls. The separate sections will be jointed, generally using in-line joints (where one end is connected to the other and they can be installed in a straight line). However, in certain circumstances during installation, and for any post-installation repairs, it may be necessary to use an omega joint, where the jointed section is laid on the seabed perpendicular to the cable alignment.

3.2.2.6 The HVDC marine cables is designed, manufactured and installed for a minimum service life of 40 years.

Fibre Optic Cable

3.2.2.7 In addition to the four HVDC marine cables, two fibre optic data transmission cables, each 35-55 mm in diameter will be laid together with the marine cables within a shared trench (one per pole). Each fibre optic cable (‘FOC’) will include fibres for a Distributed Temperature Sensing (‘DTS’) system as well as protection, control and communications fibres. Plate 3.3 illustrates the configuration of the FOC and the four HVDC cables (installed in two bundled pairs with a 50 m separation distance) within the cable trench.

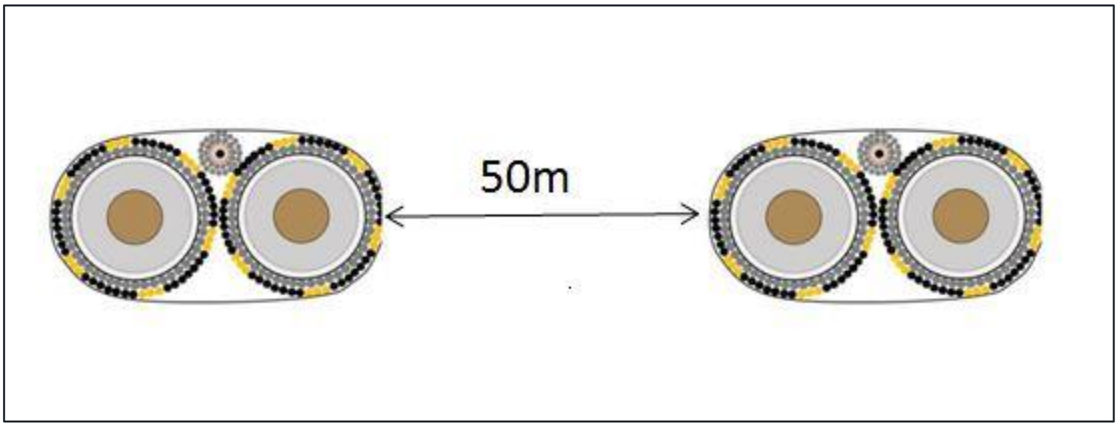

Plate 3.3 - Configuration of the HVDC and fibre optic cables within the cable trench. This Plate illustrates installation of cables as two bundled pairs (not to scale)

3.2.3 PROGRAMME, DURATION AND SEQUENCE OF INSTALLATION WORKS FOR MARINE CABLE

3.2.3.1 Due to the potential for adverse weather conditions between October and March, cable installation operations in European waters are typically limited to a 6-month window between April and September. However, this may extend into the winter season due to developments in technology and operations, dependent on a number of conditions and subject to interactions with activities of other marine users and other limitations.

3.2.3.2 It is anticipated that the marine installation will be capable of taking place during 2021-2023 and Table 3.2 outlines the indicative marine construction programme for the Proposed Development.

Table 3.2 - Anticipated schedule of works for the marine elements of the Proposed Development

Activity	Indicative Programme
Marine Cable Manufacture	2021-2022
Marine Cable Pre-Installation Works	2021
Marine Cable Installation	2022-2023
HDD landfall installation	2022

3.2.3.3 These timescales are subject to cable production, installation campaigns and types of vessels used, environmental considerations and other circumstances which are not within the Applicant's control, such as weather conditions causing vessel down time. In the event of delay due to such circumstances, a second phase of UK marine cable installation would occur, which would take place during 2023. Noting there is potential for the installation period to be extended, the construction programme used for the purpose of the EIA will incorporate this potential delay as the likely worst-case scenario.

3.2.3.4 Accordingly, the worst-case programme, outlined in Table 3.3, will form the basis of assessments for the EIA, and allows for a more flexible campaign approach to cable installation to accommodate disruptions and weather down time. In addition, some seabed preparation and installation activities may occur in the winter.

Table 3.3 – Worst case marine cable installation programme

		2021				2022				2023			
Activity	**Description**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Seabed Clearance/Preparation	PLGR, sandwave clearance, boulder removal, OOS cable recovery, cable crossing preparation												
Landfall Installation	Drilling and ducting												
UK Marine Cable Installation	Shallow and Deepwater												
Cable Crossings	Construction of crossing												

3.2.4 MARINE SURVEYS

3.2.4.1 Marine surveys have been undertaken in order to define the Marine Cable Corridor, target burial depths, cable installation techniques and the requirement for cable and scour protection. These include benthic ecology, geophysical and geotechnical surveys.

3.2.4.2 The surveys listed above enable the identification of the following along the Marine Cable Corridor:

- Sediment types (surface and shallow geology);
- Bathymetry and slopes;
- Seabed features (e.g. mobile sediments (sand waves and large ripples), boulders);
- Seabed debris (e.g. abandoned fishing gear);
- Marine heritage and archaeological features; and
- In-service and OOS cables and pipelines.

3.2.4.3 Prior to the installation of the marine cables, further ground condition surveys will likely be required to be undertaken by the appointed contractors. These surveys would confirm that there have been no physical changes to the seabed, identify any UXO and allow the final Marine Cable Route to be identified.

3.2.4.4 Figure 3.4 illustrates the surface and shallow geology along the Marine Cable Corridor obtained through analysis of the geophysical survey data. Further qualitative description of the characteristics and potential constraints of the Marine Cable Corridor identified by the geophysical survey can be found in Appendix 3.1 Table 1.

3.2.4.5 Prior to the installation of the marine cables, further surveys may be required to be undertaken by the appointed contractors. The final alignment of the Marine Cable Route within the Marine Cable Corridor will be informed by these surveys.

3.2.5 ROUTE PREPARATION FOR MARINE CABLE

3.2.5.1 Analysis of the survey data will identify the location and extent of route preparation along the Marine Cable Corridor. Two types of preparation will be required prior to the installation of the marine cable:

- Clearance of obstacles and/or seabed features:
  - Seabed debris (OOS cables, wires, abandoned fishing gear);
  - Boulders;
  - Sandwaves and large ripples; and
  - Uneven seabed (gulleys, slopes, pits and free spans).
- Construction of crossing structures over in-service cables that are crossed by the marine cables.

3.2.5.2 In addition to the above marine surveys, UXO surveys were undertaken to ensure the geotechnical survey locations were clear of UXO.

3.2.5.3 A further detailed UXO survey for the construction corridor will be undertaken as part of the pre-installation surveys. Where potential UXO are identified, the Marine Cable Route will be refined, where possible, to avoid the potential UXO exclusion zones. If UXO cannot be avoided, they may require removal/detonation.

3.2.5.4 Removal or detonation of UXO will be undertaken by a registered Explosives and Ordnance Survey Disposal ('EODS') specialist contractor and will be subject to a separate marine licence.

3.2.5.5 Analysis of data received to date has identified indicative areas along the Marine Cable Corridor where seabed preparation is required (Figure 3.5 and Appendix 3.1 Table 2).

3.2.5.6 Upon completion of all marine surveys and analysis of the data, further detail will be available to refine the location and extent of seabed preparation. The following sections provide an overview of the typical clearance and preparation activities expected for the features identified.

Seabed Debris

3.2.5.7 A pre-lay grapnel run ('PLGR') will be undertaken to clear seabed debris in advance of the cable lay and burial. A grapnel hook will be towed by a vessel along the centre line of each bundled cable pair to a penetration depth of 1 m. Debris recovered by the grapnel will be collected on board the vessel for later recycling process or disposal at suitable onshore facilities.

Out of Service Cables

3.2.5.8 Where OOS cables are encountered, the cable will be cut at a length appropriate to the Marine Cable Corridor. The cut sections will be disposed of as appropriate at suitable onshore waste handling facilities. The rest of the OOS cable will remain in its existing condition on the seabed, the cut ends will either be re-buried or covered with mattressing. There are approximately ten OOS cables along the UK marine cable corridor. Note that locations may differ from those indicated, some may no longer be present, and some may exist but be unmapped.

Boulder Removal

3.2.5.9 Surface boulders will be removed by ploughing and/or grabs. Towing a plough across the seabed in areas of the Marine Cable Corridor where large boulders have been identified can create a swathe of up to 15 m wide within which any boulders present will be pushed to one side. Multiple swathes will be required to clear the Marine Cable Corridor (up to approximately 80 m wide). Boulders greater than 0.5 m in any one dimension have been identified by the survey. Approximately 6% of the Marine Cable

Corridor includes occasional boulders (10-20/10,000 m^2) and 13% numerous boulders (>20/10,000 m^2).

Sandwaves and Ripples

3.2.5.10 Areas of mobile sediments (i.e. sandwaves and large ripples) are known to be present along the Marine Cable Corridor. Figure 3.6 and Appendix 3.1 Table 3 identify the location of sandwaves and large ripples along the Marine Cable Corridor. Large ripples occupy 3.9 km (3.6% of the Marine Cable Corridor) across eight locations, and sandwaves occupy 4.0 km (3.7% of the Marine Cable Corridor) across nine locations.

3.2.5.11 Where possible, the marine cables will be routed within the Marine Cable Corridor to avoid mobile bedforms and therefore minimise the requirement for clearance. This will initially be undertaken at the preliminary route engineering stage, before the procurement process. However, since mobile sediments are, by definition, mobile, there may be a requirement for additional re-routing after the pre-installation survey and prior to construction.

3.2.5.12 In areas where sandwaves and ripples are present and where re-routing of the marine cable to avoid such features is not possible, two clearance options are being considered to enable the cables to be buried to the required depth; Mass Flow Excavation ('MFE') and dredging.

3.2.5.13 Clearance of areas of sandwaves and large ripples will reduce excessive inclines, creating a flatter alignment for the installation equipment and enable burial in the more stable sediment below the bedforms, thereby reducing the risk of future exposure of the marine cables.

3.2.5.14 It is anticipated that approximately 600,000 to 1,700,000 m^3 of sediment along the Marine Cable Corridor will need to be cleared by MFE and/or dredging. This volume also includes dredging/MFE required for other activities such as installation of the HDD exit pits and omega cable joints.

Mass Flow Excavation

3.2.5.15 MFE is performed by a form of jetting machine, which uses high flow water jets to temporarily displace and suspend seabed sediments to create a trench into which the marine cable will be installed. Once suspended, the seabed sediment is typically removed via tidal currents and re-deposited locally.

3.2.5.16 The excavator is suspended above the seabed from a vessel crane, drawing in seawater to produce a jet of water to disturb the seabed (Plate 3.4 – Mass Flow Excavator at the seabed). The power of the jets and the height of the excavator above the seabed can be adjusted depending on the seabed conditions.

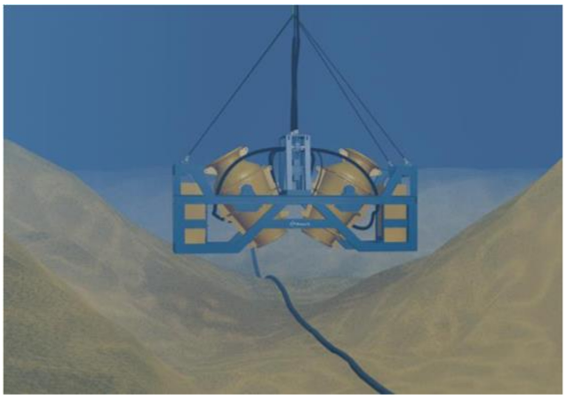

Plate 3.4 – Mass Flow Excavator at the seabed

3.2.5.17 MFE is most effective in areas of sand and gravel but can be used for harder materials such as soft clay, but only up to shear strengths of approximately 5-20 kPa depending on project specific requirements.

3.2.5.18 In shallow water the excavator can be deployed from a small workboat vessel, but in deeper water, a larger vessel would be required. It is also possible to mobilise an excavator onto a vessel that may already be on site.

Dredging

3.2.5.19 Dredging is an alternative clearance technique that may be used to remove/reduce the height of seabed features along the marine cable corridor.

3.2.5.20 Localised dredging will likely be undertaken using a trailing suction hopper dredger (‘TSHD’) vessel. At the location where dredging is required, the TSHD will reduce its sailing speed and lower its suction pipe and draghead to the seabed. Depending on the vessel, the draghead is typically 4 – 5 m wide and able to penetrate 30 – 50 cm into the seabed. Once the draghead reaches the seabed, it is trailed along the seabed and suction pumps are used to suck up the dredged material, typically a mixture of sand and seawater. The dredged material is vertically loaded into the ‘hopper’ or hold of the vessel. Once fully loaded, there are several options for the discharge of the material from the vessel. These include, deposit of the material onto the seabed via bottom opening doors or release of the material using a fall pipe below the sea surface.

3.2.5.21 At locations where material will be excavated and used as backfill (e.g. at cable joints), the TSHD vessel will discharge the dredged material directly back to the seabed, either via bottom opening doors, side discharge or, preferably, fall-pipe approximately 5 m above the seabed and approximately 30 – 40 m from the dredged area, in a stockpile. Once operations are complete, the stockpiled material will be dredged back into the TSHD vessel and deposited into the cable joint pit.

Deposit of Dredged Material

3.2.5.22 Opportunities for beneficial re-use of the dredge material will be considered for the Proposed Development. However, the worst-case scenario is considered to be the deposit of dredged material within the Marine Cable Corridor. The locations for depositing material within the Marine Cable Corridor will be informed by hydrodynamic and sediment plume modelling assessments. It is likely that the sediment will be re-deposited naturally through local wave and tidal driven process. The option to re-use material as in-fill during cable burial operations will also be considered.

3.2.5.23 The options for depositing dredged material will be confirmed as the design of the Proposed Development evolves. The preference is for re-use and deposit of material within the Marine Cable Corridor.

Uneven Seabed

3.2.5.24 Uneven seabed due to the presence of gulleys, slopes and pits along the Marine Cable Corridor may require the placement of rock and/or the installation of mattresses, prior to cable installation, to create stable seabed surface to enable the safe installation of the marine cables. In addition, the combination of uneven seabed, tidal currents and associated scouring effects has the potential to create free spans under the cable (an area where seabed sediment has been eroded and is therefore no longer supporting the cable) and may therefore require the placement of rock and installation of mattresses. The placement of rock and/or mattresses may also be required at cable crossings and at the HDD exit/entry point on the seabed. An analysis of survey data has identified the potential requirement for rock and/or mattresses at KP 72.6 (location of the Atlantic Crossing cable) and KP 41 – 50 where hollows, slopes and ridges have been identified. Table 3.4 - summarises the location of slopes over 10° and uneven ground identified along the Marine Cable Corridor.

Table 3.4 - Location of slopes over 10º and uneven ground along the UK marine cable corridor

KP (from – to)	Description
25.5 – 25.7	Slope over 10°, uneven hard ground
42.1 – 42.3	Slope over 10°, uneven hard ground
42.7 – 44.2	Slope over 10°, uneven hard ground
45.1 – 45.8	Slope over 10°, sandwaves

KP (from – to)	Description
47.0 – 47.1	Slope 10°, sand and gravel ridge
47.7 – 49.9	Large ripples and sandwaves

3.2.6 MARINE CABLE INSTALLATION

3.2.6.1 It is anticipated that the marine cables will be installed as two bundled pairs. Options for cable installation are dependent upon the characteristics of the seabed and the presence of seabed features.

3.2.6.2 As illustrated in Figure 3.4, seabed sediments throughout the Marine Cable Corridor are highly variable; gravel, sand, silt and clay have been recorded.

3.2.6.3 The marine cables will be carried on a cable lay vessel ('CLV') either on carousels or in cable tanks. The cables will be pulled via tensioners, overboard the vessel and on to the seabed. Depending on the burial technique adopted, burial can be simultaneous to cable lay, pre-lay burial or post-lay burial:

- Simultaneous Cable Lay and Burial - buries the cable at the same time as it is laid on the seabed. This is typical of a ploughed system, where the cable feeds through the plough to its burial point. This can apply to ploughs, trenchers (wheel or chain), and jetting (including vertical injectors).
- Pre-lay Trenching - a trench is created into which the cable is subsequently laid. This can be undertaken by V-shaped (displacement) ploughs and dredging techniques. Time between cable lay and backfill should be minimised and is anticipated not to exceed 1-2 months.
- Post-lay Burial - burial that occurs after the cable has been laid on the seabed. This can apply to ploughs, trenchers and jet tools (most commonly the latter); this is also known as free-lay. Time between cable lay and burial should be minimised and is anticipated not to exceed 1-2 months.

3.2.6.4 Cable installation and protection methods will be undertaken in deep water (i.e. >10 – 15 m depth) and shallow water (i.e. < 10 – 15 m depth).

Deep water cable installation

3.2.6.5 Deep water installation refers to the installation of the marine cables in water depths of 10 – 15 m or greater. Approximately 100 km of the Marine Cable Corridor is within deep water.

3.2.6.6 Two types of CLV can be used for cable installation in deeper waters; Dynamically Positioned ('DP') vessels and Cable Lay Barges ('CLB') (Plate 3.5 - Example of CLV: Cable Lay Barge – Ulisse (left) and DP Vessel – Responder (right)).


Plate 3.5 - Example of CLV: Cable Lay Barge – Ulisse (left) and DP Vessel – Responder (right)

3.2.6.7 The primary difference between the two types of CLV is that DP vessels maintain their position using thrusters, whereas a CLB relies on an anchored mooring arrangement which is maintained using anchor handling vessels.

3.2.6.8 Based on the above, it is likely that both types of CLV will be required for cable installation in deeper water.

Shallow water installation

3.2.6.9 Shallow water installation refers to the installation of marine cables in water depths less than 10 – 15 m. Approximately 9 – 21 km of the Marine Cable Corridor is in shallow water.

3.2.6.10 Specialised CLV, typically CLBs which have a shallower draft, are used for cable installation in shallow waters. Any ploughing and trenching equipment can be deployed from the barge to bury the marine cables.

3.2.6.11 There are several CLVs and CLBs with flat bottomed hulls that are designed to maximise the benefits of both barges and DP vessels. Under the right conditions, these vessels can ground on the seabed at low tide. However, the seabed at the approach to the Landfall contains rocks and boulders, therefore this approach is unlikely. Further seabed surveys will confirm whether this is the case or not.

3.2.6.12 Similarly, some projects have adopted the use of dredged 'flotation pits' to enable CLVs/ CLBs to approach closer to the shore. These would typically be excavated by a backhoe dredger. The parameters of the flotation pits will be determined prior to production of the ES.

Cable Burial

3.2.6.13 Cable burial can be achieved using ploughs, jet trenchers or mechanical trenchers. It is likely that a combination will be used for the Proposed Development, to take into account different water depths and seabed conditions. TSHD may also be used for pre-lay trenching instead of a displacement plough. Trials of equipment, to demonstrate suitability, may be undertaken within the Marine Cable Corridor during the seabed preparation phase, or at the start of the Construction Stage.

Plough

3.2.6.14 Ploughs are towed machines generally used for simultaneous cable lay and burial operations where the cable lay vessel controls the cable laying speed to match the plough performance and residual tension targets. Whilst they are essentially passive, ploughs can be steered and plough penetration depth is controlled remotely from the surface via an umbilical cable.

3.2.6.15 There are two principal types of cable plough: displacement and non-displacement ploughs.

- Displacement ploughs create an open v-shaped trench into which the cable is laid. Displacement ploughs are commonly used for pre-cut trenching for cable installation and are suitable for use with most types of sediment. The trench that is created may be backfilled using backfill blades at the rear of the machine, through a second pass by a separate backfill plough or left to backfill naturally. Displacement ploughs can only be used in water depths greater than 10 m; they are therefore not suitable for shallow water installation activities. Due to the nature of the activity, the use of a displacement plough will cause disturbance to the seabed, the extent of disturbance will be dependent on the characteristics of the surface and shallow seabed sediments. The seabed and sea surface footprint of a displacement plough is greater than that of other burial installation methods.
- Non-displacement ploughs (Plate 3.6) are designed to slice through the seabed using a thin-bladed shear so as not to create an open trench and therefore causing minimal disturbance to the seabed. Non-displacement ploughs are suitable for use with most types of sediments.

Plate 3.6 - Non-displacement Cable Plough (image courtesy of DeepOcean)

3.2.6.16 In addition to the seabed characteristics, other considerations for the selection of ploughs as a burial technique include manoeuvrability requirements, depth of water, cable bending requirement and the requirement for pre-lay trenching.

Jet Trenching

3.2.6.17 Jet trenching machines (Plate 3.7) are typically used post-cable lay, to bury marine cables. Within non-cohesive material (e.g. sands and gravels) high flow and low-pressure water jets are used to enable the sediments to be fluidised and displaced. Conversely, to trench a cable through cohesive sediments (e.g. clay), low flow and high-pressure water jets are utilised to mobilise clays. Use of water jets to fluidise the seabed sediments underneath the cables allows the formation of a trench into which the cable can sink under its own weight, or by a depressor, to the required depth. The trench created may be partially or completely filled by the settling of the fluidised material. The previous seabed level typically recovers over time through natural sedimentation.

Plate 3.7 - Jet Trencher (image courtesy of DeepOcean)

3.2.6.18 In addition to seabed characteristics, other considerations for the use of jet trenching as a burial technique include local water currents, water depth, organic content in seabed sediment, cohesiveness of sediment (increased clay content reduces the performance of jetting) and sediment size (larger sediments i.e. gravels reduce the performance of jetting).

Mechanical Trenching

3.2.6.19 Mechanical trenchers are typically mounted on tracked vessels and use a cutting wheel or a chain to cut a defined trench through the seabed (see Plate 3.8 - Mechanical Trencher – Chain Cutter with additional Jet Trenching capability (image courtesy of DeepOcean). Mechanical trenchers can operate in the majority of sediments, including hard bedrock but do not work as effectively in mobile sands, unless scoop-like teeth are attached to the chains.

3.2.6.20 Mechanical trenchers are fitted with cutting teeth which cut the trench and mechanical scoops which transport the cut material away from the trench. The cable is then guided into the trench base by a depressor arm, in some instances divers are used to assist in the laying of the cable.

Plate 3.8 - Mechanical Trencher – Chain Cutter with additional Jet Trenching capability (image courtesy of DeepOcean)

3.2.6.21 The trench created during mechanical trenching can be back filled or left to refill through natural sedimentation.

3.2.6.22 Mechanical trenchers can be used for pre-lay burial, post-lay burial and simultaneous lay and burial.

3.2.6.23 Seabed characteristics need to be considered prior to the use of mechanical trenching as a burial methodology. In areas of softer sediments, there is a risk of trench collapse due to instabilities, as well as clogging of the cutters. Harder sediments, such as boulders, can also jam the cutters, resulting in the requirement for recovery and maintenance and therefore possible delays during installation. Mechanical trenchers have relatively low installation speeds and are therefore impracticable to use for long distances of cable.

TSHD Pre-lay Trenching

3.2.6.24 TSHD techniques for pre-lay installation create the trench approximately 3 months before cable installation. The material removed to form the trench would be placed in spoil heaps adjacent to the trench. The cable would then be laid into the pre-formed trench. The TSHD would then be used again to return the spoil heap material back to the trench to backfill above the cable.

3.2.6.25 The use of a TSHD as a method for pre-lay trenching is currently under review for inclusion in the final project design. It is the intention to assess the suitability of this method further as part of the EIA.

Cable Burial Depth and Width

3.2.6.26 The depth to which the marine cables will be buried through employing the methods listed above is dependent on local seabed characteristics, hydromorphological conditions and the risk and probability of likely hazards (i.e. snagging by fishing gear/anchors).

3.2.6.27 Burial depth will be informed by the results of the marine geotechnical survey and preliminary information from the CBRA.

3.2.6.28 The CBRA will identify the Recommended Minimum Depth of Lowering ('RMDL') (i.e. the minimum depth recommended for protection of the cable from external threats) and the Target Depth of Lowering ('TDL') (TDL = RMDL multiplied by a safety factor), as illustrated in Table 3.9 – Definition of trench parameters. The RMDL is largely driven by shipping (frequency and vessel size, hence probability of anchor threat, and potential depth of anchor penetration) and fishing (frequency and type). Due to the proximity of the Channel Traffic Separation Zones, containing major vessels transiting to and from the UK and northern Europe, and the vessel movements associated with the major ports of Portsmouth and Southampton, shipping (and hence anchoring) is considered the prime risk to the marine cables in UK waters.

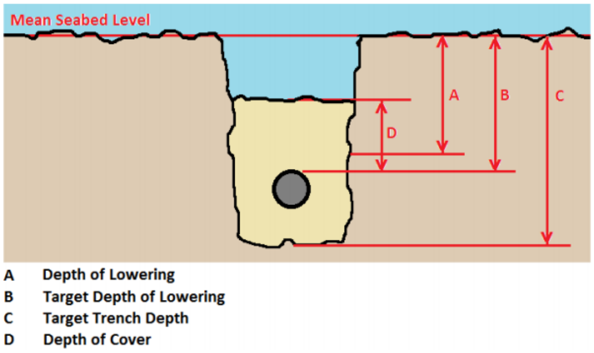

Plate 3.9 - Definition of trench parameters (Carbon Trust, 2015)

3.2.6.29 Preliminary estimates suggest that the TDL to achieve burial protection against external hazards in UK waters varies from 0.6 m to 5.1 m. Where the TDL is not achieved during burial, remedial action (e.g. further attempts at burial, or use of alternative protection such as rock placement or mattresses) would not be required as long as the RMDL is achieved.

3.2.6.30 Trench widths themselves would likely range from 0.5 – 3 m, depending on the type of burial equipment and whether the trench was made pre- or post- cable lay on the seabed. As outlined in the previous sections, the trench will be backfilled, either naturally or through backfill techniques (including separate backfill plough or TSHD operations), or will be protected with alternative protection.

3.2.6.31 The cables can be over-buried, in that too much overburden above the cable can increase the temperature of the cable. This may occur because of overly conservative design or increased (or reduced) burial due to sediment movement (sandwaves, etc). If this increased burial is anticipated, it can be designed for, with added cable weight and thickness. Unexpected over-burial can lead to hotspots and cable failures, which may result in recovery and repair of the cables and needs to be avoided wherever possible.

Cable Spacing

3.2.6.32 The Proposed Development is proposing installation of the four HVDC cables as two bundled pairs.

3.2.6.33 Spacing between two bundled pairs is driven by the operational spacing requirements of the installation equipment and will be approximately 50 m between each bundled pair. The final Marine Cable Route will be located within the Marine Cable Corridor.

3.2.6.34 Whilst the proposed cable spacing is to not exceed 50 m between bundles, there is the potential, particularly between approximately KP 41 – 50, that the Contractor may propose locally increased separation to minimise impacts within a section of particularly uneven bathymetry. This cannot be fully determined at this stage and the final cable spacing requirements will be confirmed in the final design of the Proposed Development.

Non-Burial Protection Measures

3.2.6.35 Where it is not possible to bury the cable under the seabed to the target depth, non-burial protection will be required to protect the cables from anthropogenic (i.e. fishing and vessel anchoring) and natural hazards (i.e. currents and mobile sediments). Areas where the marine cables cannot be buried and where protection will be required include:

- In-service cable crossings;
- Across boulder or gravel fields where seabed clearance has not been possible;
- Areas of mobile sediment which are underlain by material in which minimum depth of lowering could not be achieved;
- Where burial installation activities have been unsuccessful (i.e. cable was surface laid or minimum depth of lowering could not be achieved, or where the trenching system has had to be recovered, either to change technique, for repairs or due to poor weather);
- At a cable repair/joint location; and
- At the transition between the Landfall HDD exit and the buried cable.

3.2.6.36 Table 3.5 summarises the non-burial protection methods that are being considered for the Proposed Development.

Table 3.5 - Non-burial cable protection methods

Non-Burial Protection	Description
Tubular Protection	Protective sleeves made of polyurethane or ductile iron within which the marine cable is placed. Potential risk of hydrodynamic loading and/or entanglement with vessel anchors and/or fishing gear. Commonly used in combination with mattresses or rock placement.
Mattresses (Frond and Concrete)	Pre-fabricated, flexible concrete coverings connected by polypropylene ropes which are laid on top of the cable to stabilise and protect it. The placement of mattresses is slow and as such is only used for short sections of cable.

Non-Burial Protection	Description
	Typical dimensions are 6 m x 3 m and either 150 mm or 300 mm thick. There are variations dependent upon manufacturer. In areas of potential scour, frond mattresses could be used. Frond mattresses are designed to mimic natural seaweed to stimulate settlement of sediment over the cable. The mattresses comprise continuous lines of overlapping buoyant polypropylene fronds that, when activated, create a viscous drag barrier that significantly reduce current velocity. The frond lines are secured to a polyester webbing mesh base which is secured to the seabed.
Rock Placement	Placement of rocks of varying size to form a protective barrier over the marine cable. This method is typically used for scour protection, crossing of seabed infrastructure or where burial depth has not been reached.
Grout/Rock Bags	Bags filled with grout, sand or rock and placed over the marine cable. Generally applied to smaller areas.

Cable Crossings

3.2.6.37 The Marine Cable Corridor crosses one in-service cable; the Atlantic Crossing at KP 72.6 (Figure 3.7) a subsea telecommunications cable which links the USA with three European countries. A cable crossing agreement will be put in place with the relevant parties, in line with the relevant guidance. This agreement will detail the design and methodology for the cable crossing. It is anticipated that non-burial protection methods will be employed at the cable crossing. Figure 3.8 illustrates the typical cable crossing methods. The footprint of cable crossings will be a maximum, for each of the two bundled pairs of cables, of 30 m x 10 m for the pre-lay berms and 600 m x 6 m for the post lay berms.

Cable Sections and Joints

3.2.6.38 CLVs are limited to the maximum quantity of cable they can carry on board (typically 40 km to 74 km of bundled cable pair), it will therefore be necessary to install the marine cables in sections which are joined via cable joints (either in-line or omega).

3.2.6.39 The final number and location of the cable joints will be determined once the contractors have been appointed and is dependent on a number of factors including final cable weight, type of CLV used and the final marine cable installation methodology, particularly at the Landfall and in shallow waters.

3.2.6.40 There are likely to be between 8-12 in-line joints required within the UK marine cable corridor. This does not include the joints that will be required between the onshore and marine cable at the transition joint bays (‘TJB’) at Landfall which will be located above the MHWS mark. There may also be a requirement for a larger omega joint to be installed.

3.2.6.41 It is anticipated that the joints will be manufactured on board the CLV and will take approximately 5-6 days to complete and 1-2 days to deploy onto the seabed, during which time the vessel will be anchored or positioned by DP.

3.2.6.42 Once installed on the seabed, the joints will be placed onto a pre-dredged trench and/or placement of rock protection/mattress will be required. Seabed preparation work for an in-line joint is likely to be less than for an omega joint.

3.2.7 LANDFALL INSTALLATION

3.2.7.1 Landfall installation includes elements relevant to both the marine and onshore extent of the Proposed Development. Details of the Landfall installation works in relation to the onshore extent of the Proposed Development are provided in section 3.3.7.

3.2.8 MARINE CABLE INSTALLATION VESSELS

3.2.8.1 The number and specification of vessels required during installation activities will be determined by the appointed contractor. It is anticipated that several types of vessels will be required during installation of the marine cables.

3.2.8.2 Table 3.6 summarises the likely type and number of vessels that will be utilised during the installation activities.

3.2.8.3 The location of the port facilities required to support installation activities has not yet been determined, local options include Southampton and Portsmouth. Smaller ports may be utilised for crew changes. Cable load may happen at the manufacturer's facility which will be confirmed once the contracts are awarded or at local ports where cables will be shipped to by a manufacturer.

3.2.8.4 It is anticipated that installation vessels will have a rolling 500 m exclusion zone for navigational safety purposes. Where barges are used for cable installation the exclusion zone may increase to 700 m to accommodate the anchor spread. These works will be detailed through a Notice to Mariners ('NtM') prior to the commencement of works.

3.2.8.5 The information provided in

3.2.8.6 Table 3.6 is based on one marine cable installation phase. Should two campaigns be required, it is anticipated that this will require the same number of vessels. The table presents vessel information for route preparation activities as well as for the three burial techniques for cable laying. The worst case will be pre-lay or post-lay burial and two parallel campaigns may occur at the same time which would require double the number of cable lay and support vessels to complete the works more quickly. The indicative number of movements shown in

3.2.8.7 Table 3.6 has factored in multiple campaigns but does not account for weather down time.

Table 3.6 - Indicative parameters for vessels required for seabed preparation, cable installation and HDD works

Activity	Indicative no. of vessels	Indicative no. of movements
Seabed Preparation		
PLGR, boulder removal, uneven seabed and cable crossings	7	100
Dredging/MFE	4	200
Cable Burial Method: (Simultaneous lay and burial)		
Main cable lay vessels (includes a barge)	3	50
Support vessels (e.g. anchor handler, survey vessels)	5	600
Cable Burial Method: (Pre-lay)		
Main cable lay vessels (includes a barge), MFE, trench support vessels	5	200
Support vessels (e.g. anchor handler, survey, guard vessels)	17	1300
Cable Burial Method: (Post-lay)		
Main cable lay vessels (includes a barge) and MFE vessels	5	250
Support vessels (e.g. anchor handler, survey, guard vessels)	17	1400
HDD Installation		
Jack up vessel/barge	2	10
Support vessels (e.g. anchor handler, crew transfers, tug)	5	2200

Post-lay Marine Surveys

3.2.8.8 Post installation, a survey will be undertaken along the Marine Cable Route to ensure the marine cables are adequately buried and the risk to navigation reduced as low as reasonably practical and that the crossings have been constructed as designed.

3.2.8.9 The specification of this is site-specific, driven by factors such as burial depth achieved, seabed conditions, risk to cable and seabed mobility. However, at this stage it is assumed that a multibeam echo sounder and cable tracker survey would be undertaken on completion of cable installation. If remedial works are required, further post-works surveys may be required

3.2.8.10 If a post-lay burial methodology is adopted, and whilst burial should occur within two months of cable lay, a survey may be undertaken after cable installation, prior to cable burial (depending on the time between lay and burial) and also following the burial operations.

3.2.8.11 For simultaneous cable installation operations using a cable plough the "as-built" status is not always established with a post survey. The depth of lowering can be derived from the plough sensors and the seabed disturbance is considered negligible.

3.2.9 MARINE CABLE OPERATION AND MAINTENANCE

Survey

3.2.9.1 The Marine Cable Route and burial depths and/or non-burial protection will be designed to minimise the requirement for regular inspection surveys. However, further surveys may be required throughout the operational lifetime of the Proposed Development. The results of these surveys will be compared against the post-lay survey results. Cable inspection surveys will likely involve the use of a survey vessel with a ROV and geophysical survey equipment, including multibeam echosounder, side scan echo sounder, sidescan sonar and magnetometer.

3.2.9.2 It is anticipated that inspection surveys would be undertaken every 6-12 months for the first 2-5 years, then reducing in frequency to once every 1-5 years for the operational lifetime of the project. There may be other survey requirements relating to cable crossing agreements and any requirements of relevant Port Authorities.

Maintenance and repair

3.2.9.3 The Proposed Development has been designed so that routine maintenance to the marine cables is not required during their operational lifetime. However, there may be the requirement to undertake unplanned repair works, due to the following events:

- Mechanical/electrical failure of components within the cables;
- Exposure of, or damage to, the cables as a result of fishing activities and/or vessel anchoring; and

- Exposure of cables due to changes in seabed morphology (e.g. areas of free spanning) or changes in hydrodynamics (e.g. increase in bed erosion due to dredging works in the vicinity of the marine cables).

3.2.9.4 It is assumed that an indicative worst-case failure rate of the marine cables (including internal and external failures) would be one repair every 10-12 years. If repair works are required, it is likely that the repairs would be undertaken by a single vessel, likely to be an anchored barge in shallow water (<10 - 15 m) or a DP vessel in deeper water (>10 -15 m). Typically, repair works would require exposure of the cable at the point where the fault is identified, cutting the cable where damaged, recovery to the surface, repair and re-deployment and re-burial to the seabed as an omega joint using methods similar to those employed during installation.

3.2.9.5 Depending on the extent of cable damage, cable repair operations typically have a duration of several weeks to months.

3.2.9.6 In addition, the FOC will monitor the operational performance of the marine cables. Temperature and vibration monitoring will be undertaken to monitor the performance of the cable, particularly in areas known to be at risk from interference i.e. areas of known mobile sediment, shipping grounds, anchoring ground and commercial fishing areas. In the event that anomalies are recorded, further investigation and, if necessary, corrective action will be undertaken.

Emissions from Operational Marine Cable

3.2.9.7 During operation of the Proposed Development, emissions to the environment are anticipated to be negligible.

Electric and Magnetic Fields

3.2.9.8 The DC marine cables will be installed as two bundled pairs. Within each bundle, one cable will have positive polarity and one negative. The magnetic field produced by each cable within the bundle would be equal and opposite, producing a very low magnetic field i.e. far below the limit stated by the International Commission on Non-Ionising Radiation ('ICNIRP') guidelines for DC magnetic fields which is 40T, micro Tesla). Furthermore, the marine cables will be buried throughout approximately 90% of the Marine Cable Corridor which will further reduce the magnetic field on the surface of the seabed. Table 3.7 provides estimates of resultant magnetic fields that would occur at maximum load (directly above each bundled pair) at distances from the cables (e.g burial depth from the sea bed). Cable burial depth is anticipated to range from 0.6 m – 5.1 m along the Marine Cable Route.

3.2.9.9 The magnetic field values will be confirmed at the final design stage once the cable supplier has been appointed.

Table 3.7 - Estimated magnetic field emissions at various cable depths

Cable Depth (m)	Magnetic Field from marine cables (μT)	Total Static Field including Geostatic field (μT)
0.5	165	211
0.6	116	161
1	42	89
2	11	58
3	5	53
4	3	51
5	2	50
6	1	50

3.2.9.10 Installation of the marine cables as bundled pairs will also minimise the impact of compass deviation as a result of magnetic field emissions. At 5 m distance compass deviation is anticipated to be less than 3 degrees. At 10 m distance, this is anticipated to be less than 1 degree.

Heat

3.2.9.11 Heat is lost during the transport of electricity as a result of the resistance of the conductor material within the HVDC cable. A study undertaken to inform the Nemo Link Interconnector project calculated that localised temperature increases in the seabed above the cables would be 1.2°C at 30 cm depth and 0.7°C at 10 cm depth.

3.2.9.12 Emissions of heat to the surrounding marine environment are anticipated to be minimal as the cable will be buried for much of the marine cable corridor up to depths of between 0.6 - 5.1 m. In addition, the natural movement of tides and currents will dissipate any heat that reaches the surface of the seabed.

3.2.10 DECOMMISSIONING OF MARINE CABLES

3.2.10.1 The marine cables will be designed, manufactured and installed for a minimum service life of 40 years.

3.2.10.2 The importance of considering the decommissioning process as part of the early stages of the consenting process is acknowledged. Decommissioning activities would be determined by the relevant legislation and guidance available at the time of decommissioning. In addition, a decommissioning plan will be developed and agreed with The Crown Estate. It is anticipated that a separate Marine Licence application for decommissioning works may be required closer to the time of decommissioning. The decommissioning plan would support this application and provide the level of detail that cannot be provided years in advance.

3.2.10.3 At the time of decommissioning, the options for decommissioning the cable will be evaluated and will likely include consideration of leaving the marine cable in situ, removal of the entire marine cable or removal of sections of the marine cable. These options will be evaluated against the environmental implications, safe navigability of the area for other sea users and liability risks. Current best practice is to leave the inert and environmentally benign cable in situ so to avoid unnecessary disturbance of the seabed. A similar process will be undertaken for other infrastructure installed as part of the Proposed Development i.e. non-burial cable protection.

Retrieval of Buried Cables

3.2.10.4 Prior to any removal of buried cables, the cable will need to be located, which may require the seabed to be excavated through dredging and/or MFE.

3.2.10.5 Should it be decided to remove the marine cables from the seabed, removal would typically be undertaken by using jetting techniques to expose a section of the cable or a specialised grapnel to raise the cable to the surface. Removal could either be by attaching a grapnel to the cable to lift it back onto the cable recovery vessel or through using a roller along the full length of the cable to raise to seabed level and using the grapnel to lift it, in sections, to the cable recovery vessel. Removal of buried cables has the potential to cause seabed disturbance.

3.2.10.6 Whilst large cables can be pulled directly from the seabed without the requirement for de-burial works due to their high tensile capacity, the cable properties are likely to be compromised, therefore any cables recovered using this method will be deemed as scrap cable. Any sub-sea trenches left after cable removal will be filled by the natural action of tides and currents. A post-recovery survey would be undertaken and provided to regulators to confirm the successful removal of the cable.

3.2.10.7 It is anticipated that the size, type and number of vessels used in the retrieval of cable would be similar to that used during installation.

Disposal/Re-use of Marine Cable

3.2.10.8 Following retrieval of the buried cable, it will be transported back to shore where it will be disposed of in accordance with the relevant waste management legislation and best practice. The principals of the waste hierarchy will be applied which states a preference of avoiding the production of waste altogether and re-use or recycling of materials preferable to disposal.

Worst Case Approach

3.2.10.9 There are several development options and construction methodologies being considered for the Proposed Development and the final design will be confirmed upon appointment of the contractors. It is therefore necessary to use the worst-case scenario for the assessment to ensure a robust assessment of the likely impacts from the Proposed Development has been considered. Appendix 3.2 summarises the worst-case scenario for the marine components of the Proposed Development which has been used to inform the technical assessments which information is provided in relation to in this PEIR.

3.3 PROPOSED DEVELOPMENT - ONSHORE

3.3.1 SITE LOCATION AND CONTEXT

3.3.1.1 The Onshore elements of the Proposed Development comprise the Converter Station, the Onshore Cable Corridor and the Landfall.

3.3.1.2 The Site Boundary for the Landfall, Onshore Cable Corridor and Converter Station Area is identified in Figure 3.2. This shows the current Site Boundary within which the Onshore Components of the Project could be located. The Site Boundary has been split into 10 sections for ease of reference for description and assessment. These sections are described below and shown on Figure 3.9.

3.3.1.3 The Onshore Cable Corridor includes a number of route options. These options represent potential routes currently being considered. Further technical work and investigation is underway to assess the feasibility of these options and therefore they remain options at this time. The Site Boundary shown in the drawings has been designed to accommodate all the potential options identified. At this consultation stage, the Site Boundary therefore may be considered to be 'generous' because it will include land at this stage, which may not be required in the final design of the development, once the outcome of further investigations and assessments and consultation responses are available. It is expected that the Site Boundary will significantly reduce, due to route choices having been made from the options currently being considered.

3.3.1.4 The UK Converter Station is proposed to be located adjacent to the existing National Grid Electricity Transmission ('NGET') substation, west of the village of Lovedean within the administrative boundary of WCC. The Onshore Cable Route will travel through the administrative boundaries of EHDC, WCC, HBC and PCC, reaching the proposed Landfall location at Eastney, a district in the south-east of Portsmouth.

The Existing Substation

3.3.1.5 The Applicant has a Connection Agreement in place with NGET to connect to the existing 400 kV Lovedean substation in Hampshire which was confirmed via the CION process as explained in Chapter 2 - Consideration of Alternatives.

3.3.1.6 The NGET substation is located to the north-west of the village of Lovedean. The substation straddles the administrative boundaries between WCC (western side) and EHDC (eastern side). Lovedean solar farm is located to the south-east of Lovedean Substation within EHDC. The town of Waterlooville is located approximately 2.5 km to the south with Denmead located 2 km to the south west.

3.3.1.7 Crabdens Copse Site of Importance for Nature Conservation ('SINC'), Stoneacre Copse and Crabdens Row SINC are three areas of Ancient Woodland that surround the NGET substation to the north-east and south-west.

The AC Cable Corridor

3.3.1.8 The AC Cable Corridor is proposed within the area of land between Lovedean Substation and the proposed Converter Station. The AC Cable Route, providing the link between the Converter Station and the NETS via Lovedean Substation, will be located here and will be up to 400 m in length. The AC Cables are proposed to exit the Converter Station on its eastern side. The precise location of the AC Cable Route within this area has yet to be determined, because the design of the two connection points for the AC Cables within Lovedean Substation are not yet known.

The Converter Station

3.3.1.9 The site under consideration for the proposed Converter Station is shown in Figure 3.10, and lies within WCC's administrative boundary. The proposed Converter Station will be located in the north-west corner of the Site Boundary, (i.e. west of Lovedean Substation and north of Stoneacre Copse as indicated in Figure 3.10). The location of the Converter Station within this site has yet to be determined.

3.3.1.10 Scattered residential properties are located on Old Mill Lane, the closest of which is approximately 0.2 km north of the proposed Converter Station. In addition, a small cluster of residential properties are located within the vicinity of the proposed Converter Station approximately 0.3 km to the east on Broadway Lane, with Lovedean village approximately 1.3 km to the south-east.

3.3.1.11 The Converter Station is surrounded by a patchwork of agricultural fields and woodland. Areas of woodland surrounding the Lovedean Substation and adjacent to the proposed Converter Station include ancient woodland, deciduous woodland (Priority Habitat Inventory) and broadleaved woodland (National Forest Inventory). SDNP is located approximately 180 – 200 m from the nearest parts of the Site Boundary. The Converter Station Site, although outside the SDNP administrative area, is located within the South Downs Landscape Character Area.

3.3.1.12 Catherington Down Local Nature Reserve ('LNR'), a designated SSSI is located approximately 1.5 km to the east and Yeoll's Copse LNR is approximately 1 km to the east of the indicative Converter Station location.

3.3.1.13 Listed buildings within the vicinity of the Converter Station options include Grade II Listed 'The Old Thatched Cottage', approximately 840 m east of the Converter Station; and Grade II Listed Denmead Farmhouse with associated Granary, approximately 800 m west of the indicative Converter Station location.

3.3.1.14 The surrounding land is classified by the Environment Agency ('EA') as Flood Zone 1, land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (0.1%). Lovedean Substation, AC Cables, DC Cables and Fibre Optic Cables and Converter Station Site are within Bedhampton and Havant Springs Groundwater Source Protection Zone ('SPZ').

3.3.1.15 There are no Air Quality Management Areas ('AQMA') or Noise Action Planning Important Areas ('NIA') within the Converter Station Area.

3.3.1.16 The SDNP has been given the status of an International Dark Skies Reserve.

The DC Onshore Cable Corridor

3.3.1.17 From the Converter Station southwards to Eastney and onwards into the Marine Cable Corridor on its route to France, the Cable Corridor will be used to accommodate DC Cables (and the FOC described below). The proposed Cable Corridor (from Converter Station to Landfall) passes through the urban areas of Waterlooville, Purbrook, Drayton and Portsmouth. The Cable Corridor passes through four administrative areas, WCC, EHDC, HBC, and PCC, with the Landfall located within PCC's administrative boundary at Eastney.

3.3.1.18 There are Listed Buildings located along the Onshore Cable Route and in the surrounding areas. In addition, residential areas are situated along the route, predominately where the route runs along highways and through built-up areas.

3.3.1.19 There are 10 European and Ramsar designated sites within 10 km of the Proposed Development. The proposed Cable Corridor crosses, and for a short section, in the Portsmouth area, runs adjacent to, Langstone Harbour which is designated as a Ramsar Site, SSSI, SAC and SPA. Other ecologically sensitive areas include Ancient Woodland, within 500 m of the Onshore Cable Route.

3.3.1.20 The Onshore Cable Corridor passes through areas that are designated as Flood Zone 1, Flood Zone 2 and Flood Zone 3.

The Landfall

3.3.1.21 The proposed Landfall is located within the triangular Car Park south of Fort Cumberland Road, and west of Fort Cumberland Open Space SINC, within PCC's administrative boundary.

3.3.1.22 There are existing residential properties directly to the north and south, including Southsea Leisure Park and residential accommodation on Fort Cumberland Road.

3.3.1.23 Langstone Harbour, approximately 0.8 km to the north-east of the Landfall, is designated as a Ramsar Site, SSSI, SAC (Solent Maritime) and a SPA (Chichester and Langstone Harbours). The Kench, Hayling Island LNR is located approximately 1.4 km to the east.

3.3.1.24 The Landfall is situated within the South Coast Plain Landscape Character Area. There are three Scheduled Monuments in the vicinity of the Landfall: Fort Cumberland directly to the east, Eastney Forts and Perimeter Defences of Barracks to the west and Eastney Sewage Pumping Station approximately 0.3 km to the north. There are a number of Listed Buildings surrounding the Landfall, including two within the Site Boundary (the Grade II Listed World War II Anti-Tank Defences at Eastney Beach and World War II Pillbox at Eastney Beach).

3.3.1.25 The Portsmouth to South Hayling Coastal Path runs along the southern coast, starting from the west of the Landfall. Eastney Beach is identified as a SINC, located at the seafront and stretches from Langstone Harbour westwards. Fort Cumberland SINC is located east of the Landfall.

3.3.1.26 Land alongside the south coast of Eastney is classified as Flood Zone 3 (annual probability of flooding 1 in 100 or greater where fluvial flooding dominates and 1 in 200 or greater annual where flooding from the sea dominates). However, this classification does not take into account the presence of flood defences, which are located along the eastern frontage of Portsea Island and defend against tidal and coastal flooding, with a standard of protection ranging up to a maximum of 1 in 500 years, confirmed via consultation with the East Solent Coastal Partnership. Consequently, considering the existing flood defences, land elevation, the Site's ground levels and that the location of the main flood risk is likely to be tidal, the area is considered to have a low risk of flooding.

3.3.2 SUBSTATION CONNECTION WORKS

3.3.2.1 To facilitate the connection of the Converter Station, there will be a requirement to provide additional outdoor electrical infrastructure at Lovedean substation.

3.3.2.2 NGET is currently evaluating the extent and location of infrastructure works required at the Lovedean Substation to facilitate the connection of the Project to the GB National Electricity Transmission System ('NETS'). Any works that are necessary for the connection of the Proposed Development will be assessed as part of the EIA, irrespective of whether consent is sought for them as part of the DCO application.

3.3.2.3 Lovedean Substation currently uses Air Insulated Switchgear ('AIS'). If the bays for the Proposed Development also utilise AIS, the new equipment at the NGET substation will be similar to the equipment already installed within the NGET substation with a typical height of around 6-7 m.

3.3.2.4 An alternative approach to AIS is Gas Insulated Switchgear ('GIS') which is more compact. This is a common technology within NGET substations and uses sulphur hexafluoride ('SF6') as an insulation medium. SF6 would be tightly controlled and monitored, due to it being a greenhouse gas.

3.3.2.5 To facilitate the Applicant's connection capacity of 2000 MW, two bays are required at Lovedean substation to comply with the limit on the "Infrequent Infeed Loss Risk" of 1800 MW requirement set by NETS SQSS. This has been agreed in the Connection Agreement with National Grid.

3.3.2.6 Regardless of the technology type, each bay would require a Portable Relay Room ('PRR'), to store associated protection cubicles and batteries. Although specific details are still to be confirmed, a PRR would typically be a steel container with dimensions of approximately 8 m (L) x 3.2 m (W) x 4 m (H).

3.3.3 CONVERTER STATION

3.3.3.1 A Converter Station is required to convert electricity between HVDC, used to transmit electricity between the UK and France, and HVAC, used to transmit electricity within the UK electricity transmission network. Plate 3.10 below, shows an indicative converter station layout illustrating the equipment and structures required at a converter station site.

Location

3.3.3.2 The Converter Station is proposed to be located within the Converter Station Area, adjacent to the NGET substation in Lovedean, Hampshire. The proposed Converter Station would be located approximately 100 m to the west of the NGET substation and will be connected by two 400 kV underground AC Cable circuits, each consisting of three cables and associated FOC and Earth Continuity Conductors. The proposed Converter Station will be located in the north-west corner of the Site Boundary, (i.e. west of Lovedean Substation and north of Stoneacre Copse as indicated in Figure 3.10). The precise location of the Converter Station within this location has yet to be determined. The detail of where this is to be located will be confirmed in the final proposals for the Proposed Development and assessed as part of the EIA.

3.3.3.3 Accompanying the proposed Converter Station, although anticipated to be located outside the Converter Station footprint (but within the Converter Station Area), up to two separate Telecommunication buildings (potentially one for each circuit) are proposed. Further details of FOC-related infrastructure are set out in 3.3.6, below. The development within the Converter Station Area will also include temporary works to facilitate construction, including construction lay down areas. It will also include permanent works including the provision of the access road to the Converter Station from Broadway Lane, landscaping and an attenuation pond.

Baseline Principles and Parameters for Converter Station Design

3.3.3.4 The proposed Converter Station footprint of 200 m x 200 m (approximately 4 ha) would be within a securely fenced compound. Other works within the Converter Station Area (as described in 3.3.3.3 above) will be located outside the footprint of the Converter Station.

3.3.3.5 The equipment for both circuits will be contained within the same compound.

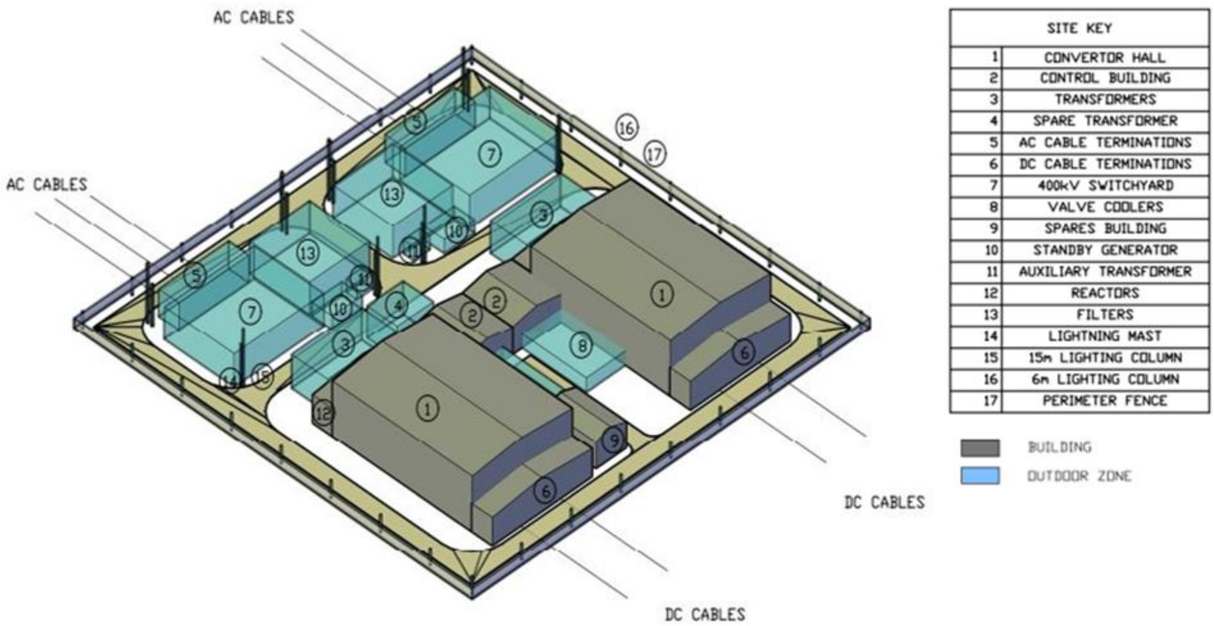

Plate 3.10 - Indicative Converter Station layout

3.3.3.6 The outdoor equipment which forms part of the proposed Converter Station will be similar to the equipment that is found within typical electrical substations, such as the adjacent Lovedean Substation. The 400 kV switchyard (item 7 in Plate 3.10), transformers (item 3 in Plate 3.10) and AC/DC filters (item 13 in Plate 3.10) will be located outdoors.

3.3.3.7 Power electronics are required to convert the power between AC and DC or vice versa. This equipment is housed indoors, within the two converter hall buildings (item 1 in Plate 3.10), each of which will measure approximately 90 m in length, 50 m in width and 22 m in height. The maximum height of the building may be increased to up to 26 m, dependent on the preferred architectural and roof design solution.

3.3.3.8 A control building (item 2 in Plate 3.10) is also required. This would be at a reduced height compared to the converter hall buildings and is likely to be a two-storey arrangement. The spares building (item 9 in Plate 3.10) would be a similar height.

3.3.3.9 The lightning masts, which could be up to 4 m taller than the tallest building, are tall, narrow structures, with catenary wiring potentially strung between them to shield the outdoor equipment from direct lightning strikes.

3.3.3.10 Lighting columns, approximately 6 m and 15 m high (see items 15 and 16 in Plate 3.10) are proposed to illuminate the outdoor areas of the Converter Station during emergency situations, such as an intruder or unplanned maintenance work. The lights will not be used during normal operation.

3.3.3.11 Auxiliary power supplies will be provided in the event of a power failure at the Converter Station to ensure continuity of operation. Back-up sources such as stand-by diesel generators will be only used if other sources of auxiliary supply are unavailable during construction and operational timescales.

3.3.3.12 Cooling systems will be required to remove heat generated within the Converter Station building. These systems will be located outside the Converter Station building.

Telecommunication Buildings

3.3.3.13 Up to two Telecommunication buildings associated with the FOC (potentially one for each circuit) are anticipated to be located outside the main Converter Station security fence, so that they can be accessed by third parties. Further details regarding this infrastructure are set out in section 3.3.6, below. This infrastructure is anticipated to be located outside the 4 ha area indicated for the Converter Station footprint, although is likely to be immediately adjoining it.

Access to Converter Station

3.3.3.14 The proposed access to the Converter Station for Construction and Operational Stages will be taken from Broadway Lane in the vicinity of Day Lane.

3.3.3.15 The access road to the Converter Station will be approximately 1.2 km in length, and is expected to be a standard width of 7.3 m.

3.3.3.16 The Access Road will carry the Converter Station related construction traffic, including Heavy Goods Vehicles ('HGVs') and Abnormal Indivisible Loads ('AIL'), during the construction period.

3.3.3.17 This road will also continue to be used for site access following the completion of construction. During general maintenance and operational outages, access by maintenance staff is typically light vehicles (e.g. cars, vans) and use of HGVs or AILs will only be required in the rare event of a major equipment failure. AIL vehicles would be required on the rare occasion that a transformer, or other similarly large plant, is required to be replaced at the Converter Station).

3.3.3.18 An attenuation pond is proposed to capture surface water run-off from the Converter Station and access road. This is a pond that would be planted with reeds or similar vegetation. The size of this pond will be subject to agreement regarding run-off rate assumptions, but could hold up to 2,500 m^3. This would be situated at a low point of the site, with swales running alongside the access road.

3.3.3.19 A Fire Prevention Plan will be confirmed. However, sufficient space has been left for the installation of a deluge system. Although a common approach is to provide suitable containment and allow a fire to extinguish itself within a suitably contained area.

3.3.3.20 The technical specifications will require that the Converter Station is designed to keep EMFs below public and occupational exposure policy limits. EMFs are produced by voltage and current flow within the electric power system; though are also naturally present such as due to the magnetic field of the Earth (to which a compass responds) and natural electrical electric fields in the atmosphere. For public exposure, compliance is required with 1998 ICNIRP guidelines for AC fields and with 1994 guidelines for DC static fields. For occupational exposure, limits defined in the Control of Electric Fields at Work Regulations 2016 which implement ICNIRP 2010 guidelines will be required to be complied with.

Converter Station Construction Works

3.3.3.21 The construction of the proposed Converter Station is expected to be undertaken between 2020 – 2023. The start of the works will depend on several factors, including, among others, the progress of the planning and permitting process in the UK and France. Work associated with landscaping and land reinstatement of area used for car parking, laydown and site cabins is anticipated to be carried out in 2024.

3.3.3.22 Given the topography of the Converter Station site, bulk earthworks would be required to create a level platform of between 83.8 m AOD and 84.8 m AOD.

3.3.3.23 Preliminary foundation assessment has concluded that the foundations are likely to be conventional ground bearing for areas where cut is required to achieve a level platform and piles where fill is required. This is subject to final design requirements and level of the Converter Station platform.

3.3.3.24 Where piles are required, it is envisaged that driven piled options (e.g. H-steel or precast) would be utilised, with a depth of up to 15 m. Bored piled techniques are assumed to pose an unacceptable risk to the SPZ1-protected aquifer that lies beneath the site. Materials excavated on higher parts of the site would be used to fill lower levels, to minimise material movement off-site. It is anticipated that surplus excavated material from the creation of the platform may be capable of reuse to create bunds in appropriate locations to provide visual screening mitigation, where such measures are identified as appropriate.

3.3.3.25 The engineering works associated with the construction of building platforms, the development of the site drainage system and the construction of permanent access, internal roads within the proposed Converter Station and car parking arrangements would be completed prior to the construction of the Converter Station. The buildings will likely be constructed of steel frame and cladding.

3.3.3.26 Landscaping (including bunding if/where appropriate and associated planting) is proposed around the perimeter of the Converter Station site and other necessary/appropriate locations as identified via the Landscape and Visual Impact Assessment ('LVIA'), the preliminary results of which are discussed in Chapter 15 of this PEIR, to help integrate the proposed Converter Station into the surrounding environment.

3.3.3.27 Where necessary, haul roads to facilitate the construction of landscaping bunds will be provided during construction. Construction traffic associated with the construction of bunds would use these haul roads, from the main site compound, which is accessed via the proposed access road.

3.3.3.28 When the appointed contractor mobilises, the Site Boundary will be secured within a perimeter fence, with access controlled through a security gate. Temporary laydown areas which will include welfare facilities, vehicle parking, site offices, equipment storage, local power and water supplies and spoil/waste containment will be set up at this stage. These temporary laydown areas are likely to have a total footprint of approximately 4-5 ha. All vegetation will be removed in these areas and some earthworks may be required to create a level platform, which will be covered with up to 400 mm of crushed stone. This area will be in use for the duration of the construction and commissioning stages, and restored thereafter.

3.3.3.29 There will be a requirement for Abnormal Indivisible Loads ('AIL') to be delivered to the Converter Station site e.g. transformers (7), large earthworks plant and cable drums (10).

3.3.3.30 At the peak of construction, up to 60 HGV movements per day are envisaged, with up to 10 telescopic cranes and approximately 150 personnel on site.

3.3.3.31 An existing distribution voltage overhead line emanates from the south-eastern corner of the NGET substation. This will need to be undergrounded, to facilitate the delivery of large loads.

3.3.3.32 The access road may join the existing PRoW (Footpath 28) for a portion, which would require hedgerow removal and temporary closure of the PRoW during Converter Station construction activities. The access road could be used as a part of the PRoW, following completion of construction activity. Alternatively, the access road could be located in the fields, to the north of the PRoW.

3.3.4 AC CABLE ROUTE CONNECTING THE CONVERTER STATION TO LOVEDEAN SUBSTATION

3.3.4.1 The Converter Station requires an AC Cable Route of up to 400 m to connect to Lovedean substation. It is expected to be orientated such that the DC cables enter the Converter Station compound through its western boundary and the AC cables from the east.

Location

3.3.4.2 There will be two 400 kV AC cable circuits that will connect the proposed Converter Station to the existing NGET substation at Lovedean. Each circuit will sit in a single trench (i.e. there will be two trenches).

Baseline Principles

3.3.4.3 Each AC circuit will require three cables, resulting in a total of six AC cables required for the connection.

3.3.4.4 Installed alongside the AC cables will be an Earth Continuity Conductor, which is an insulated metallic conductor to provide a path to earth for any fault currents. The Earth Continuity Conductor will be installed between the centre cable and one outer cable; this would cross to the other side of the centre cable at the mid-point of the AC Cable Route for technical reasons.

3.3.4.5 There is also a requirement for a Fibre Optic Cable ('FOC') to be installed alongside the AC cable in each trench for control and protection and cable monitoring purposes. An indicative cross-section is shown in Figure 3.11.

3.3.4.6 Electric fields from the AC Cables are proposed to be contained by the cable's protective metal sheath.

3.3.4.7 The calculated prospective maximum magnetic field strength due to the proposed AC cable is well below the public exposure basic restriction level (360µT).

AC Cable Construction Works

3.3.4.8 The design and configuration of the AC Cables will be subject to detailed design and may be impacted upon by elements such as soil conditions, length of the AC Cable Route, impact from the environment and existing infrastructure. The cable circuits will be installed in flat formation (3 cables are required for each of the two circuits).

3.3.4.9 The AC cables will be delivered to site on cable drums. Each cable drum will typically hold around 700 m to 1,000 m of cable.

3.3.4.10 It is anticipated that the AC Cable Route will also utilise a ducted installation method, with ducts installed underground between the Converter Station and the NGET substation, prior to the AC cables being pulled through.

3.3.4.11 The normal burial depth across agricultural land and open countryside is typically 900 mm to the top of the protection covers. Where possible, a minimum buffer of 2 m on either side of the cable trench to major tree roots will be employed, see Figure 3.11. Where possible, a nominal separation distance between AC cable circuits will be maintained.

3.3.4.12 During construction works, an additional land area will be required close to the AC Cable Route for construction and laydown purposes. The length of the AC Cable Route is anticipated to be up to 400 m and for this short length it is not anticipated that a temporary Haul Road is required. Space will be required at the excavation point for excavated material and this will generally be placed to the side of the Onshore Cable Route.

3.3.4.13 Figure 3.11 illustrates a section through a typical construction corridor for the AC cables. The overall width between the temporary fences will be approximately 23 m depending on the local environment and selection of cable design. It would be possible to reduce the width in places however this would require extra handling and a separate storage area for the excavated material. If the Onshore Cable Route length is increased then the haul road will be required and the construction corridor will be increased accordingly. The Onshore Cable Route construction corridor is subject to change to take into account local conditions and will be confirmed during the detailed design stage.

3.3.5 ONSHORE DC CABLE CORRIDOR

3.3.5.1 An HVDC cable is proposed to be installed onshore between the Converter Station and the Landfall, to transmit electricity between the two.

Location

3.3.5.2 The Onshore Cable Corridor is described in paragraphs 3.3.5.6 - 3.3.5.39. The Onshore Cable Corridor, within which the onshore HVDC cable will be laid, passes through the urban areas of Waterlooville, Purbrook, Drayton and Portsmouth, with the Landfall located at Eastney.

3.3.5.3 The intention is to locate the cables within existing highways or road verges (see Figure 3.12), where practicable, to utilise previously developed land. However, in certain locations where there are constraints (see Figure 3.13) to using the highway or verges it may be necessary to utilise land outside the highway. Cables will be installed in ducts, mostly in trenches or in certain specific locations via trenchless installation methods such as HDD.

3.3.5.4 The majority of the route is expected to be navigated in the vicinity of the existing buried services. It is expected that the following services will be encountered throughout the Onshore Cable Route:

- Water main and distribution pipes;

- Drainage pipes;
- Sewage pipes;
- Gas main and distribution pipes;
- Electricity cables;
- Telecommunication cables;
- Street light power cables; and
- Traffic light power cables.

3.3.5.5 The baseline principles for the Onshore Cable Route including assumptions, parameters and details of the proposed construction methodology and associated works, are provided in paragraphs 3.3.5.40 to 3.3.5.73.

DC Cable Corridor Sections

3.3.5.6 The DC Cable Corridor is described in sections, with some sections providing an element of optionality for this stage of the development which is to be consulted on as part of the current consultation exercise. Those sections are broken down further to provide a description of different options under consideration. The sections are shown on the Site Boundary drawings in Figure 3.9.

Section 1 – Lovedean (Converter Station Area)

3.3.5.7 Section 1 encompasses the Converter Station Area which includes: the existing NGET Lovedean Substation (including works at Lovedean Substation to connect AQUIND Interconnector to the National Electricity Transmission System); the land required for the Converter Station and associated equipment; temporary construction compound(s); access road; and mitigation measures, for example additional planting and attenuation pond; the northern most end of the Cable Corridor; and telecommunications equipment associated with the FOC. The Converter Station will be located adjacent to, and immediately to the west of, the existing Lovedean Substation. Between Lovedean Substation and the proposed Converter Station, AC Cables will be installed within a Cable Corridor. The precise location of the AC Cable Route will be subject to detailed design following further investigations and feedback from the consultation process.

3.3.5.8 From the Converter Station southwards to Eastney and onwards into the Marine Cable Corridor on its route to France, the Cable Corridor will be used to accommodate DC Cables (and the FOC described below). The Cable Corridor, within which the Cable Route will be situated, will run southwards from the Converter Station through land belonging to Winchester College and the field that lies to the east of Old Mill Lane. The Cable Route will be installed via two trenches in this section. There are no alternative options presented for this part of the route.

Section 2 – Anmore

3.3.5.9 The Cable Corridor will continue south, through agricultural land to a point to the north of the properties located along the northern side of Anmore Road. The Cable Route would be installed in two trenches in this section. There are no alternative options presented for this part of the route.

Section 3 – Denmead/Kings Pond Meadow

3.3.5.10 The Cable Corridor contains options for the Cable Route being considered between land to the north of properties located on the northern side of Anmore Road at Kings Pond, and Hambledon Road (at its junction with Soake Road). Options for the Cable Route and appropriate installation methods are being explored whilst further technical investigations are undertaken to refine the route, and feedback is obtained via the consultation process.

3.3.5.11 The use of HDD for Cable installation is being explored to cross this area and assessment of the feasibility of this method is still ongoing. This area is known to be the meeting point of two geological formations, with separate water tables, one of which is a SPZ1 – protected aquifer. This is likely to mean that two shorter HDDs are required in this area (with the entry/exit point located in one of the fields south of Anmore Road) rather than one long HDD from north to south.

3.3.5.12 The southern end of the HDD section would be in the field to the north of Hambledon Road. The intention would be for the northern HDD to reach fields to the north of Shafter's Farm. Trenching may be used to install cables through these fields if the HDD is not possible, or if subsequent work identifies it to be a better solution. Alternatively, a solution which uses a combination of HDD and trenching techniques for installation may be utilised.

3.3.5.13 Three options are currently being considered between land north of Anmore Road at Kings Pond and Hambledon Road. Options 3a) and 3b) consider a mix of HDD and trenching installation techniques. Option 3c) utilises trenching. These options are described below.

Option 3a) Kings Pond Meadow

3.3.5.14 This option would run from land north of Anmore Road, crossing Anmore Road near Kings Pond, to Hambledon Road through the fields known as Kings Pond Meadow, via ducts installed by HDD. The field immediately to the south of Anmore Road is designated as a SINC. The field that intersects the south-east corner of the SINC is not, and it is this field where it is anticipated that the HDD will resurface if two HDDs are to be used. Alternatively, some or all sections of this route could utilise trenches for duct installation.

Option 3b) Anmore Road

3.3.5.15 This option would run east, to the north of the properties located to the immediate north of Anmore Road, then south in the field opposite Clifton Crescent, west along Anmore Road and south into Kings Pond Meadow, with all ducts installed in trenches. From this point southwards, to the field north of Hambledon Road, is it anticipated that the cables would be installed via HDD.

Option 3c) Highways Route

3.3.5.16 This option would run east, to the north of the properties located to the immediate north of Anmore Road, then south in the field opposite Clifton Crescent, west along Anmore Road. The two DC Cable circuits would then diverge, with one circuit running southwards down Mill Road and the other would continue further west along Anmore Road before running southwards along Martin Avenue, before they converge and both continue south-eastwards along Hambledon Road. This option is being considered as a potential option whilst further technical feasibility and stakeholder engagement is ongoing to assess the practicability of Options 3a) and 3b).

Section 4 – Hambledon Road to Burnham Road

3.3.5.17 The proposed Cable Corridor runs within the highway boundary, along the B2150 Hambledon Road (from Soake Road Junction), the A3 London Road, B2177 Portsdown Hill Road and Farlington Avenue (at its junction with Burnham Road).

3.3.5.18 The proposed Cable Route will be constructed within the highways boundary and traffic impacts and temporary traffic management measures (for which preliminary information is provided in Chapter 21 Traffic and Transport of this PEIR) are being considered as the design evolves. Assessment in this regard is ongoing. At a number of locations, the potential to move the Cable Route construction away from the main carriageways to minimise traffic disruption, in particular the duration of potential road closures, are still being considered, for example:

- Use of bus lanes and laybys;
- Use of fields adjacent to Hambledon Road;
- Exit via Hambledon Road (B2150) along the parallel (to the southbound carriageway) Southdown View and Hambledon Parade between Auger Row to the north of Charlesworth Drive;
- Use agricultural land immediately west of London Road between London Road (small spur road of the same name) and Milk Lane. In this location the route will either stay on the highway or move into adjacent in the field;
- Use of slip roads and side roads (e.g. just to the north of Bushy Mead and Landsdowne Avenue); and
- Use of a car park on the southern boundary to the B2177 between the A3 and Hilltop Crescent; and

* The continuation of the Cable Route further east along Portsdown Hill Road, up to the field immediately north of the covered reservoirs south of Portsdown Hill Road, and east of Burnham Road and Ainsdale Road (see Option 5c) at 3.3.4., below).

Section 5 – Farlington

3.3.5.19 The proposed Cable Corridor between Farlington Avenue and the Eastern Road includes a few options. These are being considered to allow parts (or all) of Farlington Avenue to be avoided. In this section, all cables are proposed to be installed in trenches.

Option 5a) Farlington Avenue

3.3.5.20 This option includes a Cable Corridor within the highway boundary along the length of Farlington Avenue, before turning east along a short section of Havant Road and then heading south along the A2030 Eastern Road. However, there are constraints along this route and potential options are under consideration as detailed below.

Option 5b) Pump Station Route (i) to (iv)

3.3.5.21 To minimise disruption, other options are being considered, which allow parts of Farlington Avenue to be avoided, by using a grassed strip of land between Farlington Water Works and Havant Road (i.e. Pump Station Route), to the east of Farlington Avenue. This grassed strip of land is an easement strip which contains below-ground infrastructure associated with the Farlington Water Works. The preference is to use this corridor as far as possible, by adopting an engineering solution that will allow the cables to co-exist with the existing below-ground utilities in the area. The sub-options are:

i. From Farlington Avenue, via Ainsdale Road/Burnham Road to the grassed strip, then via Havant Road to Eastern Road;

ii. From Farlington Avenue, via Blake Road to the grassed strip then via Havant Road to Eastern Road;

iii. From Farlington Avenue, via the pedestrian access to the recreation ground to the grassed strip and then via Havant Road to Eastern Road; or

iv. From Farlington Avenue, via Evelegh Road to the grassed strip and then via Havant Road to Eastern Road.

Option 5c) Portsdown Hill Road

3.3.5.22 This option is considered as a means of avoiding Farlington Avenue. The Cable Corridor would remain in Portsdown Hill Road heading east, until running southwards through the field between Portsdown Hill Road and the covered reservoirs, the edge of the recreation ground, the grassed strip and then via Havant Road to Eastern Road.

Section 6 – Zetland Field and Sainsbury's Car Park

3.3.5.23 The proposed Onshore Cable Route would proceed southwards along the A2030 Eastern Road and then either utilise Zetland Field or land within the existing highway boundary along the A2030 Eastern Road, until it diverts off into the Sainsbury's car park. Two options for entering the car park are described below.

Option 6a) A2030 and Fitzherbert Road

3.3.5.24 This option would come off the A2030, into Fitzherbert Road, east of the Sainsbury's petrol station, then down the western side of Sainsbury's car park.

Option 6b) Zetland Field and Fitzherbert Road

3.3.5.25 This option would pass through the south of Zetland Field, onto Fitzherbert Road, via the footpath entrance, then to the east of the petrol station and through the western side of the car park.

Section 7 – Farlington Junction to Airport Service Road

3.3.5.26 South of the Sainsbury's supermarket, the proposed Onshore Cable Route would pass under the railway line, using a trenchless installation technique. The Cable Corridor would then continue southwards through Farlington Playing Fields with the Cable Route installed in two trenches towards the southern end of the Playing Fields. HDD is proposed to be used to enable the Cable Route to continue broadly southwards, passing under the A27 and Langstone Harbour, and emerge on Portsea Island at a car park at Kendall's Wharf, to the east of the A2030 Eastern Road. Two options are being considered for the Cable Corridor southwards from Kendall's Wharf, for the installation of the cables in two trenches.

3.3.5.27 From the car park at Kendall's Wharf on the eastern side of the A2030 Eastern Road, the Onshore Cable Route would potentially either:

i. Exit onto the A2030 Eastern Road, via the access road to Kendall's Wharf or through a break in the trees to the west of the car park (although some vegetation may need to be removed) to the south of the access road to Kendall's Wharf, to run south on Eastern Road; or

ii. Run southwards through the western edge of Baffins Rovers FC football ground, and Langstone Harbour Sports Ground, onto Eastern Road at the southern end of the sports pitches, where there would be no need to remove vegetation to get back onto Eastern Road.

3.3.5.28 Where the Onshore Cable Corridor runs southwards down Eastern Road, the Cable Route may utilise footpaths and/or verges.

Section 8 – Great Salterns Golf Course to Velder Avenue/Moorings Way

3.3.5.29 For this section, the proposed Onshore Cable Corridor would run southwards along Eastern Road to the northern end of Milton Common. The Cable Route may utilise footpaths and/or verges in this section. From the northern end of Milton Common, options have been considered for the remaining part of this section to Velder Avenue/Moorings Way. These options are still being assessed for feasibility and practicability, and therefore the Cable Route previously presented in the January 2018 consultation events is still being considered. Three potential options are described below.

Option 8a) Eastern Road

3.3.5.30 For this option, the Onshore Cable Corridor would run along Eastern Road A2030 (utilising the verge wherever possible), all the way to the junction with Milton Road (A288).

Option 8b) Minor Roads and Moorings Way

3.3.5.31 For this option, the Onshore Cable Corridor would run along Eastern Road (utilising the verge wherever possible), before finding a route through a combination of some or all of the following roads: Eastern Avenue, Salterns Avenue, Shore Avenue. There is potential that each circuit would take a different route in this area, before they both continue eastwards along Moorings Way, or in the southern edge of Milton Common which runs parallel to Moorings Way.

Option 8c) Milton Common

3.3.5.32 Milton Common is known to be an historic landfill site. The options under consideration utilise the edges of Milton Common, to minimise the risk associated with ground conditions. The two potential options being considered are:

i. installing ducts within the path that forms part of the sea defences on the eastern side of Milton Common, and which consist of imported, compacted, material, which is stable and thermally suitable. Following installation, the flood defences would be restored to their original condition. The Cable Corridor would then cross the eastern extent of Moorings Way.

ii. Utilising the western edge of Milton Common, which ground investigations have indicated might suffer less from the issues associated with Milton Common being a historic landfill e.g. settlement and contaminated land. From Eastern Road, the Onshore Cable Corridor would run south along the western edge and then follow Moorings Way eastwards, either in the highway or in the southern edge of Milton Common.

Section 9 – Velder Avenue/Moorings Way to Bransbury Road

3.3.5.33 The proposed Onshore Cable Corridor in this section contains options being considered between the junction of Velder Avenue/Moorings Way and Bransbury Road. Some of these options are subject to further assessment to identify their feasibility and practicability. For this section, it is anticipated that the Cable Route may be installed via trenching, or via a combination of trenching and HDD techniques. There are three options described below.

Option 9a) Highways Route

3.3.5.34 Option 9a) continues from Option 8a) and would run southwards along Milton Road and eastwards along Bransbury Road up to the junction with Henderson Road. There is potential for the Onshore Cable Corridor to enter into the southern side of Bransbury Park and run parallel to the road to reduce the impact on Bransbury Road. The Cable Route could be installed in either of these locations.

Option 9b) Allotments

3.3.5.35 Starting from the southern end of Options 8b) or 8c), the Onshore Cable Corridor would head southwards, either through the University of Portsmouth Langstone Campus grounds or via the dedicated bus lane and Furze Lane. The cables would then join Longshore Way and/or Locksway Road. From here, there are various options for accessing the allotments south of Locksway Road. Some options include utilising different paths for each cable circuit.

i. The option for the Onshore Cable Corridor would travel along Locksway Road and then into the southern-most car park of the Thatched House public house. From here, the proposed cables would be installed under the allotments using HDD, with the exit point located in the open space between the allotments and Kingsley Road.

ii. The option for the Onshore Cable Corridor would utilise Waterlock Gardens/Seaway Crescent and/or Meryl Road to enter the allotments. This option uses a trenching technique within the allotment pathways. The cable circuits may take divergent paths in this area.

3.3.5.36 Upon exiting the open space adjacent to the allotments, the Onshore Cable Corridor would be installed using trenching techniques, via Yeo Court or Kingsley Road to enter Bransbury Park. The Cable Corridor would be routed west of the footpath/cycleway through the Park avoiding the recreational space/treeline where practicable. The Onshore Cable Route would exit Bransbury Park and head eastwards along Bransbury Road to the junction with Henderson Road.

Option 9c) Ironbridge Lane

3.3.5.37 This option is similar to Option 9a) however upon exiting the University of Portsmouth grounds/Furze Lane, the Onshore Cable Corridor continues westwards on Locksway Road until the junction with Ironbridge Lane, where the Cable Corridor turns southwards. There is the option of using Redlands Grove/Tideway Gardens in conjunction with Ironbridge Lane before entering Bransbury Park via the entrance opposite the southern end of Ironbridge Lane and/or accessing Bransbury Park via Kingsley Road/Yeo Court. Once within Bransbury Park, the Onshore Cable Corridor would be routed west of the footpath/cycleway through the Park avoiding the recreational space/treeline where practicable. The Onshore Cable Route would exit Bransbury Park and head eastwards along Bransbury Road to the junction with Henderson Road. This option would provide cable installation via the trenching technique.

Section 10 – Eastney (Landfall)

3.3.5.38 From the junction of Bransbury Road and Henderson Road the proposed Onshore Cable Route would head in an easterly direction along Henderson Road and Fort Cumberland Road to reach the car park south of Fort Cumberland Road and north of Fraser Range.

3.3.5.39 The triangular car park south of Fort Cumberland Road is the proposed Landfall, where the Onshore Cables will be joined to the Marine Cables at the Transition Joint Bays. (Further details are provided in Sections 3.2.7 and 3.3.7).

Baseline Principles for Onshore Cable Route

3.3.5.40 A typical cross-section of the cable trench arrangement in the highway is shown in Plate 2.5 showing each pair of DC cables in its own trench, along with a separate duct for the FOC. The cross-section is based on a standard design and is subject to detailed design and may change to take into account local conditions e.g. navigation around or across existing utilities that are encountered.

3.3.5.41 Where possible, a typical spacing of approximately 5 m is maintained between the trenches. This spacing means the cable pairs are usually installed in opposite sides of the carriageway. Where there is insufficient space in the highway for two pairs, the cable pairs may take divergent routes or be routed outside the highway itself.

3.3.5.42 Each excavated trench would be approximately 0.7 m in width, but could increase to 1 m in order to facilitate the cables being installed deeper, when navigating existing utility services.

3.3.5.43 To minimise disruption, cable ducts will be used for installation. This allows short sections to be worked on at any one time and each length of cable pulled through, rather than needing to fully excavate each 600 m - 2,000 m length. This range matches the typical cable drum lengths that will be delivered to site. The exact lengths depend on the size of drum that can be delivered to each location and on the characteristics of the Onshore Cable Route. In areas where there are more (or sharper) bends the length of cable that can be safely pulled without compromising the cable's integrity is reduced.

3.3.5.44 There may be occurrences where the cables will have to be laid/pulled in open trenches to be able to more precisely navigate around existing utility services or obstacles.

3.3.5.45 Following laying of the duct/cable, the trench will be backfilled with a material with suitable thermal resistivity, such as cement bound sand. The trench will also include a protection slab above the ducts and buried warning tape.

3.3.5.46 Link boxes (or pillars) are required approximately every 6 km along the Onshore Cable Route. Link boxes are typically located alongside a joint bay and are accessed via a man-hole cover, installed at the same level of the surrounding ground. The dimensions of a link box are approximately 0.8 m x 0.8 m x 0.6 m. Link pillars are frequently used on arable land (instead of link boxes) and they are normally located adjacent to hedgerows. They are accessed via doors at the front of the link pillar and the dimensions are approximately 1.0 m x 1.0 m x 0.6 m. The link boxes (or pillars) are connected to the metal casing of the joint via underground bonding leads.

3.3.5.47 To correspond with the lengths of cable that can fit on a drum and pulling tension limits, joint bays will need to be positioned at approximately 600 m to 2,000 m intervals along the route. Permanent easements along the entire Onshore Cable Route will be required to allow future access for maintenance or cable repair works.

3.3.5.48 The public would not be exposed to electric fields from the DC Cables because the field is contained by the cable's protective metal sheath.

3.3.5.49 The calculated prospective maximum electromagnetic field strength due to the DC Cables is well below the limit for public exposure to static magnetic fields (approximately 1000 times lower than the limit of 40,000 µT).

Onshore Cable Route Construction Works

3.3.5.50 During the Construction Stage, there will be a variety of construction zones depending on the phase of work. The construction zone activities will cover the following:

- Excavation of the trench, installation of the cable ducts and reinstatement of the final grade;
- Excavation of joint bays
- Provision for cable pulling, requiring space for cable drums and winches;

- Cable jointing work; and
- Filling of ducts, if necessary to maintain thermal performance e.g. at locations of unexpected service congestion.

3.3.5.51 Temporary laydown compounds will be required for cable drum and accessory deliveries and temporary storage of cable laying plant. Assuming that the cable and accessories are delivered to site as required, a laydown area of approximately 100 m x 50 m is considered sufficient.

While construction site compound locations are yet to be confirmed, at this stage it is expected that there will be three sites located along the Onshore Cable Route as follows:

- At the Converter Station, near Lovedean;
- West of Eastern Road, on the Anchorage Park industrial estate; and
- At the transition joint bay/HDD compound/car park at Eastney.

Excavation of Trenches

3.3.5.52 The cables will be routed to run in parallel or to cross over or under existing utility services. If the services are at 1 m depth, or shallower, it is expected that the cables will cross underneath the service. If it is possible for the cable to cross above the services the utility owner's agreement would be required.

3.3.5.53 Where the Onshore Cable Route is in or immediately adjacent to roads, the installation will require traffic management measures. To minimise disruption, a single lane closure would be used, where practicable, rather than a full road closure.

Installation of Cable Ducts

3.3.5.54 There will be two ducts per trench to accommodate the DC cables, and one duct for the FOC. The installation of ducts minimises the duration of trenching operations, and allows highways to be reinstated more quickly. The cables are pulled through the ducts in sections.

3.3.5.55 In some locations the Onshore Cable Route may cross fields or open land. The width of the temporary construction corridor within these locations will include land necessary for access and construction works. Typically, the width of the temporary construction corridor required through fields/open land is approximately 23 m (this includes a 5 m haul road and safety clearance distance of 1 m either side of this haul road). In such locations, the Onshore Cable Route would be located along field boundaries, where possible.

3.3.5.56 The installation rate for cable ducts is approximately 18 m – 30 m per 10-hour day shift, on average, within urban areas and approximately 50 m per day in open country. These typical installation rates are per gang per shift and are highly dependent upon the level of obstacles and utility services encountered within the road or constraints that need to be observed to minimise the impacts during the Construction Stage.

3.3.5.57 The locations of the ducts within the road will be dictated by, amongst other factors, existing services. Where it is necessary to increase installation depth to clear existing services it may be necessary to increase the distance between ducts to avoid de-rating the circuits (i.e. when the cables operate at the maximum temperature and do not achieve the maximum required current carrying capacity).

Joint Bay Construction and Cable Pulling

3.3.5.58 Joint bays will be positioned in highway verges, fields or car parks, where possible, to limit the need for road closures. It is preferable to avoid the need for the DC cables to cross the highway to access a joint bay location. The excavation for the joint bay (for each circuit) will be approximately 15 m x 3 m with the permanent joint bays themselves being approximately 6 m x 3 m. The excavation would typically be up to 1.7 m deep in roads, footpaths and verges and 1.85 m deep in fields.

3.3.5.59 Cable drums will hold the cable required to be pulled from one joint bay to the next, varying in length depending on the requirements of the route. The drum dimensions will depend on the cable contractor’s cable design, traffic management considerations and cost optimisation.

3.3.5.60 Cable winches will pull the cable through the duct system. The area around the winch will be fenced off and designated as a construction zone.

3.3.5.61 Each joint bay will be open during the cable pulling operation and the expected timescale associated with pulling is four days per joint bay (i.e. that associated with one DC circuit). This assumption has presumed a working day of 10 hours.

3.3.5.62 Once cables are installed in all ducts, the joint bays will be partially backfilled and covered with steel plates for protection whilst awaiting further jointing operation.

3.3.5.63 Once completed, backfilled and reinstated, the joint bays, like the rest of the route, will not be visible. The only evidence of the presence of a cable route will be link boxes or link pillars at joint bays along the route.

3.3.5.64 The installation of the FOC will be undertaken concurrently with the installation of the power cables.

Jointing

3.3.5.65 Jointing of the cables will require the area of each joint bay to be fenced. Typically, in addition to the excavated bay (one per pole), there would be:

- One container for storage and a workshop;
- Welfare facilities;
- Generator, quiet where appropriate, and fuel;
- Temporary shelter installed over the joint bay, to provide a suitable environment for assembling the joints;
- Space at one or both ends of the joint bay for cable installation; and
- Space for parking operatives’ vehicles.

3.3.5.66 Typically, it takes 20 working days to complete one joint bay location. This timescale includes the excavation, set-up, cable pulling, jointing, bonding connections, testing and reinstatement (i.e. site cleared and reinstated to its original state).

3.3.5.67 The jointing operation is performed in joint bays which are located underground in line, or off to one side of the Onshore Cable Route. Each excavation will be approximately 15 m x 3 m, with additional space required at ground level for construction, cable installation, jointing and reinstatement, including a 20 m x 6 m 'compound' during jointing (for approximately one week).

HDD Installation

3.3.5.68 There are 4 locations along the Onshore Cable Route where the ducts may be installed by HDD. These locations are:

- the Eastney Landfall;
- the allotments north-east of Bransbury Park;
- the Portsea Island crossing under Langstone Harbour;
- Kings Pond near Anmore, which may consist of multiple HDDs, see 3.3.5.10 to 3.3.5.15.

3.3.5.69 A trenchless technique more suited than HDD to short crossings may be employed for the installation of the Cable Route under the railway north of Farlington Playing Fields. This alternative method of trenchless installation enables cables to be installed within ducts or pipes under a feature with minimal impact on that feature. The method of trenchless installation anticipated in this location is not yet confirmed and is subject to ongoing investigations.

3.3.5.70 HDD will be used to allow cables to cross under certain constraints along the route namely water ways, railways and environmentally sensitive areas (see Figure 3.13). HDD methodology will also be used to install the marine cables in the intertidal area. The HDD method limits disturbance to the environment when compared with open trenching techniques.

3.3.5.71 The HDD operations drill holes through the ground that will house ducts through which the cables will be pulled at a later date. The HDD methodology begins with the drilling of the pilot bore, which may be performed by a specialist sub-contractor, using wire-guiding techniques to set the profile of the crossing. The maximum depth will typically be between 5m and 15m, depending upon the length of the crossing and the local ground conditions. The bore is then reamed (widened) to the required diameter. The ducts, high-density polyethylene ('HDPE'), are welded together and laid in a single length at one end of the crossing, to be pulled through the bore in a continuous process.

3.3.5.72 The HDD operations require a suitable space for the temporary construction area, which can typically be up to approximately 50 m x 50 m depending on the length and size of the HDD works. The HDD operations require a working area to locate the drilling rig, water bowser/pump, generator, layout of ducts/pipes and other construction equipment. Adjacent land within the Site Boundary (e.g. car parks, fields etc.) is proposed to be utilised to facilitate HDD construction works.

3.3.5.73 The HDD drills that are required for each of the four DC cables would have to be suitably spaced to achieve the required cable rating. Typically, this spacing is around 4 x 5 m at the entrance and exit of the HDD and may increase to around 4 x 10 m depending on burial depth. The maximum width of cable reserve (area required for installing the four DC cables with suitable spacing between taking in to account the maximum burial depth) has been assumed to be approximately 60 m.

3.3.6 FIBRE OPTIC CABLES

3.3.6.1 Two FOC will be installed, one for each circuit. The FOC are used for communications between the French and UK Converter Stations in connection with the control and protection systems, and hence are required to be installed with both AC and DC cables. Additionally, the FOC are used to monitor the condition of the cables, using Distributed Temperature Sensing ('DTS') technology. Spare strands of fibre within the FOC may be leased to third parties for commercial telecommunication purposes.

3.3.6.2 For the Onshore Cable Route, the FOC will be installed in a 35-45 mm diameter duct. For the Marine Cable Route, the FOC will be bundled with the DC marine cables.

3.3.6.3 To boost the signal of the FOC across the full distance of the HVDC cable between the French and UK Converter Stations up to two Optical Regeneration Stations ('ORS') (potentially one for each circuit) are required within approximately 1 km of the UK Landfall. An Optical Regeneration Station would be provided in a building with dimensions of approximately 4 m x 5 m long x 3 m high (20 m^2 footprint), which would house signal amplification and control equipment associated with the FOC and is required to ensure the signal strength is adequate between the two Converter Stations. For operational purposes, if there are two ORS buildings, it would be necessary for them to be located approximately 10-20 m apart.

3.3.6.4 An ORS building would be located within a securely fenced compound, which would also contain auxiliary power generation equipment and a fuel tank. It is currently anticipated that the compound for an ORS would have a maximum size of 15 m x 15 m. Further work is being undertaken to find an appropriate design solution for this infrastructure which takes in to account the locational context and limits, in so far as is possible, the impacts on the area where it is located. An auxiliary power supply would be required to provide back-up power in the event of a disruption in the local mains power supply to an ORS. Outside the compound, it is anticipated that there will be parking for up to two vehicles for maintenance purposes.

3.3.6.5 The location of the ORS infrastructure has not yet been determined, however it is anticipated this will be located within the Site Boundary and the detail of what is to be developed and where this is to be located will be confirmed in the final proposals for the Proposed Development and assessed as part of the EIA.

3.3.6.6 The Converter Station will act as the FOC termination point, where the additional capacity FOC will terminate until further agreements are in place with the customers.

3.3.6.7 It is anticipated that up to two Telecommunications buildings (potentially one for each circuit) would be located adjacent to the Converter Station to house equipment for telecommunications purposes. Telecommunications equipment is also potentially required at this location to enable the spare capacity in each FOC to be used for commercial telecommunications purposes. The Telecommunication infrastructure associated with the FOC is anticipated to be located outside the main Converter Station security fence, so that it can be accessed by third parties who may lease the spare fibres within the FOC for commercial purposes.

3.3.6.8 It is anticipated that a Telecommunications building would have a building footprint of approximately 50 m^2, (approx. 10 m x 5 m), would have secure fencing, access and parking for up to two vehicles for maintenance purposes.

3.3.6.9 It is anticipated that a Telecommunications building would contain a shared internal space where FOC customers' equipment could be installed within separate caged areas (each customer would have their own caged area, and only be able to access their own dedicated equipment). It is also anticipated that the building will accommodate shared facilities including: an office; welfare facilities; and storage areas. It is anticipated that a Telecommunications building would have a mains power supply (via the Converter Station) and an auxiliary power supply provided by batteries (to provide backup power) contained in a separate room within the building. Air conditioning units are also proposed to ensure that the building is cooled all year round. In addition, it may contain a power converter which converts AC to DC power for use with power electronic equipment which will support the battery room.

3.3.7 LANDFALL

3.3.7.1 The UK Landfall at Eastney was chosen following a detailed site selection process which is described in Chapter 2 - Consideration of Alternatives. The UK Landfall forms the transitional area between onshore and marine environments. The marine cables will be pulled ashore and jointed to the onshore cables at the Transition Joint Bays ('TJBs').

3.3.7.2 HDD has been identified as the most suitable cable installation method at the Landfall, as opposed to open trenching methods.

3.3.7.3 The landward ends of the ducts will be above the MHWS mark. Section 3.2.8 provides further information on the HDD methodology specific to the shore landing.

Baseline Principles and Construction Works

3.3.7.1 There will be two TJBs, one per pair of HVDC cables. Each TJB will require an excavation of approximately 15 m x 5 m, to a depth of up to 1.75 m. Once the joint is complete, these excavations are backfilled and the land reinstated. During the construction works, an area of approximately 15 m x 5 m adjacent to the TJBs is required for the jointing workshop, storage, parking, generator, welfare and security.

3.3.7.2 The cables will be pulled into the TJB, ready for jointing. During the cable pulling operation, an area of approximately 15 m x 12 m at either end of the TJBs are required for the cable drum and stand, plus space for delivery and offloading of cable drums (at one end) and the winch and anchor (at the other end).

Horizontal Directional Drilling

3.3.7.3 The Landfall HDD operations will drill surface to surface boreholes under the intertidal area. The holes will be lined with ducts through which the marine cables will be pulled into the TJBs at a later date as part of the cable installation activity. It is not determined yet whether the HDD will be onshore to marine, marine to onshore, or drilling from both ends. For the purpose of this description, the onshore entry/exit is referred to as the TJB, with the other end referred to as the marine entry/exit point. The use of HDD avoids the need for any trenching operations on Eastney Beach or in the nearshore area.

3.3.7.4 The HDD is anticipated to comprise four bores, each approximately 1,400 to 2,000 m long. At the TJB they are likely to be 5 – 10 m apart.

3.3.7.5 Marine to onshore HDD requires additional installation equipment e.g. a barge or jack-up rig. However, final technical and operational parameters will determine which option is chosen.

3.3.7.6 Whilst the drilling can take place from either the onshore or marine end, the lining duct will be pulled in from marine to onshore. The duct will be either High Density Polyethylene (‘HDPE’) or steel.

3.3.7.7 The operations will also require a crew transfer vessel, one to three workboats to tow out the ducts, connect the end caps and other operational support. An anchor handling vessel may be required

3.3.7.8 When drilling from the marine end, a temporary casing support lattice will be constructed to support the casing (at an angle of about 10-12 degrees) during drilling operations. Up to two jack up rigs will be used to install/remove the lattice. There may be one lattice that is moved between bores, or four individual ones. The lattice will be removed on completion.

3.3.7.9 Localised excavation/dredging of a pit/trench at the marine entry/exit location may be required for installation of the temporary casing (914 mm / 36 inch diameter steel casing or similar) required for drilling. These may be in the form of four individual pits or a single trench.

3.3.7.10 A pilot hole will be drilled into the seabed and advanced in stages until the required length to the exit point at the TJB is reached. Drilling fluid would be employed to lubricate the drilling process and cool the drill head. Fluid pressures would be monitored throughout activities to reduce the risk for breakout of the drilling fluid.

3.3.7.11 Once complete, the pilot hole will be enlarged through several passes with reamers until the required diameter for duct installation is reached.

3.3.7.12 The jack-up rig may stay in one location or be moved between bores i.e. located at four different locations, one for each bore, depending on the final cable separation and specific barge deck space.

3.3.7.13 The ducts will be floated out to the marine location for installation. Once installed, there may be a period of time between duct installation and cable pull. If that is the case, the ducts would be protected by mattressing or placed rock. This would be within the previously excavated marine entry/exit pits, thereby ensuring that navigable depth is maintained.

3.3.7.14 Pulling winches, located onshore, will be used to pull the cable though the ducts using a pulling wire.

3.3.7.15 To the seaward side of the marine entry/exit point the four cables will be bundled in to two pairs and then be trenched, in that form, for the remainder of the marine route. Trenches and non-burial protection may be required for the transition from four HDD ducts to two bundled pairs of buried cables.

3.3.8 PROGRAMME OF ONSHORE CONSTRUCTION WORKS

3.3.8.1 Table 3.8 outlines the indicative programme for the construction works associated with the UK onshore elements of the Proposed Development.

Table 3.8 - Indicative onshore construction programme

Activity	Indicative Programme*
Onshore Cable Manufacture	Q1 2021 – Q3 2022
Converter Technical Equipment Manufacture	Q1 2021 – Q1 2022
Converter Station Enabling Works	Q2 2021 – Q3 2021
Converter Station Civils and Construction Works	Q4 2021 – Q3 2023

Activity	Indicative Programme*
HDD Landfall installation	Q2 2022 – Q3 2022
Onshore HVDC Duct Installation	Q2 2021 – Q3 2022
Onshore HVDC Cable Installation	Q4 2022 – Q2 2023
Onshore HVAC Duct and Cable Installation	Q1 2023 – Q3 2023
Commissioning (Both Poles) and Energisation	Q3 2023 – Q4 2023

*This indicative programme assumes a DCO determination in Q4 2020.

3.3.9 OPERATION AND MAINTENANCE

Operation

3.3.9.1 The design life of all equipment, buildings and infrastructure would be up to 40 years. After approximately 15-20 years, the control system and proposed converter technology is normally updated and overhauled.

3.3.9.2 The proposed Converter Station will be designed for unmanned operation, but a small team of maintenance staff (typically 3-4) will be responsible for maintaining the plant and will be on 24/7 callout if required.

3.3.9.3 The interior roads (i.e. those associated with access to the Converter Station from existing highway network) will be provided during the construction stage and maintained during the Operational Stage of the Proposed Development. These roads will allow the movement of vehicles around the station during the Construction Stage and during normal operation or routine maintenance.

3.3.9.4 The Converter Station will be enclosed by a perimeter security fence, likely an external steel palisade fence and inner electrified fence of approximately 2.4 m and 3.4 m in height, respectively. Access to the Converter Station will be strictly controlled and only permitted to those with the appropriate training and authorisation.

3.3.9.5 The main equipment access gate would be controlled by staff in the Converter Station control room. A personnel access gate would be operated by a key card or key pad security system.

3.3.9.6 Lighting columns will be installed along the perimeter fence and around the outdoor equipment areas. In normal night time operation there will be no illumination of the site. Lighting would only be used in the event of unauthorised access to the site or if emergency repair work was required on the outdoor equipment. The light fittings will be appropriately designed to ensure that light is only directed only to the necessary areas.

3.3.9.7 The Converter Station will contain the following substances that would be subject to Control of Substances Hazardous to Health ('CoSHH') regulations (see Table 3.9).

3.3.9.8 Appropriate storage and handling measures will be in place. The transformers and diesel generator(s) will be bunded to ensure any oil leakage is safely contained.

3.3.9.9 There are no operational requirements associated with the Onshore Cable Route and the associated cable equipment along Onshore Cable Route.

Table 3.9 – Substances subject to CoSHH Regulations to be contained within the Converter Station

Substance	Application
Mineral oil	Insulation medium in AC capacitor units, if the project requires harmonic filters.
Transformer oil	Provides insulation and cooling for power and instrument transformers
Diesel	Diesel generator
Monoethylene glycol	Anti-freeze
SF6	Used in circuit breakers as an arc extinguishing medium
Sulfuric acid	Sealed lead acid batteries

3.3.10 MAINTENANCE

3.3.10.1 Cable systems are reliable and require very little maintenance. However, repairs and/or replacements of cables might be required in the case of cable failures or damage. The maintenance that is required includes, but is not limited to, cleaning of the air insulated terminations, visual inspection of pressure gauges at the cable terminations to check for oil leaks and visual inspection of the steel work at terminations to check for corrosion e.g. structure, cable cleats and link-boxes.

3.3.10.2 At the link-box locations, electrical connections between the metallic sheaths of cables can be removed, enabling tests to establish the integrity of the cable oversheaths during commissioning, regular maintenance, and in the event of suspected damage. Cable tests would be carried out approximately every two years or before re-energisation of the interconnector after an outage period.

3.3.10.3 Visual inspection of the output of the DTS hardware which is located within the Converter Station would be required. Changes in the temperature profile (either hot spots or cold spots) could indicate that changes have occurred along the Cable Route. Hot spots could indicate that ground levels have increased or that another heat source has been installed adjacent to the power cables. Cold spots could indicate that marine cables have become exposed.

3.3.10.4 The onshore cables will not require any maintenance; however, cable failures are possible, albeit rare in occurrence; onshore cable damage can typically leave the interconnector out of service for approximately 2 weeks during repair.

3.3.10.5 Although operated remotely (i.e. unmanned, regular access to the proposed equipment, both within the Telecommunications infrastructure at the proposed Converter Station and the proposed FOC amplification equipment within the ORS near the coast, will be required during the Operational Stage.

3.3.11 DECOMMISSIONING

3.3.11.1 AQUIND Limited are seeking consent for installation of an Interconnector for an indefinite period. The Converter Station will have a design life of at least 40 years. Major items of equipment (e.g. transformers, circuit breakers, reactors) are designed to meet the lifetime of the Proposed Development and should remain operational for that time subject to regular maintenance, inspection and availability of spare parts. However, some components within the station are consumable items, which will need replacement from the spares holding as required (e.g. valves). Some equipment may become obsolete, due to advancements in technology and may no longer be supported by suppliers and will need to be replaced by the latest versions available. If/when the Interconnector and associated equipment becomes obsolete, all the equipment will be decommissioned in an appropriate manner, and all materials reused and recycled where possible. Further information on decommissioning is provided below.

3.3.11.2 There is a current worldwide trend for the refurbishment of interconnectors due to technological advancement and obsolescence of some equipment parts during the operational lifetime of the Converter Station to maintain the efficient lifetime of the Proposed Development.

3.3.11.3 Whilst the Project is designed to provide permanent electrical infrastructure, there may come a time where it may be appropriate to decommission the equipment. When it is considered suitable, the decommissioning of the station will involve each item of equipment being removed for recycling or disposal, as appropriate. Many plant items contain metals such as copper, steel and aluminium which are valuable and would be recycled. Other material such as plastics and rubber will need to be disposed of, according to the relevant environmental legislation effective at the time. Civil works e.g. concrete and steel structures (including link boxes/pillars, joint bays, buildings, outdoor electrical infrastructure) would be removed to return the site to its previous state (agricultural or other), as far as practicable.

3.3.11.4 It is anticipated that the cable's operational lifetime will exceed that of the Converter Station equipment, however at the end of the cable's life, the options for decommissioning will be evaluated. In some instances, the least environmentally impacting option may be to leave the cable in-situ. The final cable decommissioning plan is still to be determined, and may depend on requirements at the time. When decommissioning the onshore cables, every effort would be made to recycle as much material as possible. The FOC would be decommissioned in the same way as identified for the onshore cables.