The Great Grid Upgrade

Sea Link

Preliminary Environmental Information Report

Volume: 1

Part 1 Introduction

Chapter 4 Description of the Proposed Project

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1.4 Description of the Proposed Project

1.4.1 Introduction

1.4.1.1 Sea Link hereafter referred to as the ‘Proposed Project’ involves the reinforcement of the electricity transmission network between the proposed Friston Substation in Suffolk to the existing Richborough to Canterbury 400 kV overhead line in Kent. This reinforcement would be approximately 145 km long, comprising primarily of a High Voltage Direct Current (HVDC) offshore transmission link, with both HVDC and High Voltage Alternating Current (HVAC) onshore elements.

1.4.1.2 This chapter sets out the description of the Proposed Project and has been split into the following sections, which describe:

- the infrastructure proposed in Suffolk, Kent and in the marine environment;
- the construction methods that are proposed for installing the infrastructure associated with the Proposed Project;
- operation and maintenance requirements; and
- how the Proposed Project is proposed to be decommissioned if required.

1.4.1.3 This chapter should be read in conjunction with:

- **Volume 1, Part 1, Chapter 1: Introduction**; and
- **Volume 1, Part 1, Chapter 5: PEIR Approach and Methodology**.

1.4.1.4 This chapter is supported by the following figures:

- **Volume 3, Figure 1.4.1 Lateral Limits of Deviation**;
- **Volume 3, Figure 1.4.2 Saxmundham Converter Station Indicative Location**;
- **Volume 3, Figure 1.4.3 Saxmundham Converter Station Indicative Landscaping Strategy**;
- **Volume 3, Figure 1.4.4 Saxmundham Converter Station Permanent Access Arrangements**;
- **Volume 3, Figure 1.4.5 Saxmundham Converter Station Indicative Location with Co-location**;
- **Volume 3, Figure 1.4.6 Saxmundham Converter Station Indicative Landscaping Strategy with Co-location**;
- **Volume 3, Figure 1.4.7 Suffolk Landfall Indicative Location**;
- **Volume 3, Figure 1.4.8 Suffolk Landfall Indicative Location with Co-location**;
- **Volume 3, Figure 1.4.9 Kent Onshore Scheme HVAC Connection Option 1**;
- **Volume 3, Figure 1.4.10 Kent Onshore Scheme HVAC Connection Option 2**;
- **Volume 3, Figure 1.4.11 Kent Onshore Scheme HVAC Connection Option 3**;

- **Volume 3, Figure 1.4.12 Minster 400kV Substation and Minster Converter Station Indicative Location**;
- **Volume 3, Figure 1.4.13 Minster 400kV Substation and Minster Converter Station Indicative Landscaping Strategy**;
- **Volume 3, Figure 1.4.14 Minster 400kV Substation and Minster Converter Station Permanent Access Arrangements**;
- **Volume 3, Figure 1.4.15 Kent Landfall Indicative Location**;
- **Volume 3, Figure 1.4.16 Suffolk Onshore Scheme Indicative Construction Compound Locations – Proposed Project**;
- **Volume 3, Figure 1.4.17 Suffolk Onshore Scheme Indicative Construction Compound Locations – Proposed Project with Co-location**;
- **Volume 3, Figure 1.4.18 Kent Onshore Scheme Indicative Construction Compound Locations**;
- **Volume 3, Figure 1.4.19 Suffolk Onshore Scheme Construction Traffic Routes During Construction and Operation**;
- **Volume 3, Figure 1.4.20 Kent Onshore Scheme Construction Traffic Routes During Construction and Operation**;
- **Volume 3, Figure 1.4.21 Saxmundham Converter Station Construction Access**; and
- **Volume 3, Figure 1.4.22 Indicative Rock Placement**.

1.4.1.5 This chapter should be read in conjunction with the following design drawings:

- **Design drawing S42_S/TDD/SS/0003 (Typical Friston 400kV GIS substation in scenario where not construction by third party)**;
- **Design drawing S42_S/TDD/SS/0001 (Typical Sea Link works should Friston 400kV GIS substation be developed by others)**;
- **Design drawing S42_S/TDD/SS/0010 (Typical HVAC direct buried cross section and construction area)**;
- **Design drawing S42_S/TDD/SS/0011 (Typical 400kv HVAC joint bay arrangement)**;
- **Design drawing S42_S/TDD/SS/0012 (Typical HVAC and HVDC combined construction area)**;
- **Design drawing S42_S/TDD/SS/0013 (Typical HVDC construction area for Sea Link plus ducts for up to two further projects)**;
- **Design drawing S42_S/TDD/SS/0014 (Typical HVAC and HVDC combined construction area for Sea Link plus ducts for up to two further projects)**;
- **Design drawing S42_S/TDD/SS/0015 (Typical Saxmundham converter station layout plan (GIS))**;
- **Design drawing S42_T/TDD/SS/3001 (Typical HVDC direct buried cross section and construction area)**;
- **Design drawing S42_T/TDD/SS/3003 (Typical HVDC joint bay arrangements)**;

- **Design drawing S42_S/TDD/SS/0018 (Typical HVAC and HVDC combined construction area for Sea Link plus ducts for up to two)**;
- **Design drawing S42_T/TDD/SS/3006 (Typical Overhead Line (OHL) pylon detail)**;
- **Design drawing S42_K/TDD/SS/2001 (Typical Minster 400kV GIS substation - overall layout)**;
- **Design drawing S42_K/TDD/SS/2002 (Typical Minster converter station - layout plan (GIS))**;
- **Design drawing S42_T/TDD/SS/3005 (Typical converter and substation works construction compounds)**;
- **Design drawing S42_T/TDD/SS/3004 (Typical OHL and construction works construction compound)**;
- **Design drawing S42_T/TDD/SS/3002 (Typical bellmouth arrangement details)**;
- **General arrangement plan S42_S/IGA/PS/0002 (Suffolk)**;
- **General arrangement plan S42_S/IGA/SS/0008 (Suffolk co-location of converter stations)**;
- **General arrangement plan S42_K/IGA/PS/2002 (Kent);**
- **Design drawing S42_M/TDD/SS/1030 (Illustration of unexploded ordnance, removal and detonation)**;
- **Design drawing S42_M/TDD/SS/1027 (Illustration of boulder clearance)**;
- **Design drawing S42_M/TDD/SS/1028 (Illustration of pre-lay grapnel run)**;
- **Design drawing S42_M/TDD/SS/1029 (Illustration of indicative pre-sweeping and sidecasting)**;
- **Design drawing S42_M/TDD/SS/1032 (Illustration of simultaneous lay and burial)**;
- **Design drawing S42_M/TDD/SS/1033 (Illustration of lay and post-lay burial)**;
- **Design drawing S42_M/TDD/SS/1031 (Illustration of illustration of omega and inline joint)**;
- **Design drawing S42_M/TDD/SS/1036 (Illustration of typical marine trench profiles)**;
- **Design drawing S42_M/TDD/SS/1021 (Indicative HVDC bundled cable crossing over unburied fibre optic/telecoms asset)**;
- **Design drawing S42_M/TDD/SS/1022 (Indicative HVDC bundled cable crossing over buried FO/telecoms asset)**;
- **Design drawing S42_M/TDD/SS/1023 (Indicative HVDC bundled cable crossing over buried power cable asset)**;
- **Design drawing S42_M/TDD/SS/1024 (Indicative HVDC bundled cable crossing over pre lay berm)**;

- **Design drawing S42_M/TDD/SS/1025 (Indicative rock berm schematics pre lay and post lay)**;
- **Design drawing S42_M/TDD/SS/1034 (Illustration of cable protective systems)**;
- **Design drawing S42_M/TDD/SS/1035 (Illustration of rock placement sections)**;
- **Design drawing S42_M/TDD/SS/1042 (Indicative horizontal direction drill solution for Sea Link only Aldeburgh)**;
- **Design drawing S42_M/TDD/SS/1044 (Indicative layout of HDD construction compound for Sea Link only Aldeburgh)**;
- **Design drawing S42_M/TDD/SS/1041 (Indicative horizontal directional drill solution for Sea Link plus ducts for up to two further projects Aldeburgh)**;
- **Design drawing S42_M/TDD/SS/1038 (Indicative layout of HDD construction compound for Sea Link plus ducts for up to two further projects Aldeburgh)**;
- **Design drawing S42_M/TDD/SS/1039 (Indicative horizontal directional drill solution Pegwell bay)**;
- **Design drawing S42_M/TDD/SS/1037 (Indicative layout of HDD construction compound Pegwell bay)**; and
- **Design drawing S42_M/TDD/SS/1040 (Indicative direct pipe solution Pegwell bay)**.

1.4.1.6 This chapter is supported by the following appendices:

- **Volume 2, Part 1, Appendix 1.4.A: Outline Code of Construction Practice**;
- **Volume 2, Part 1, Appendix 1.4.B: Suffolk Onshore Scheme Outline Construction Traffic Management Plan**;
- **Volume 2, Part 1, Appendix 1.4.C: Kent Onshore Scheme Outline Construction Traffic Management Plan**;
- **Volume 2, Part 1, Appendix 1.4.D: Crossing Schedules**;
- **Volume 2, Part 1, Appendix 1.4.E: Construction Plant Schedule**; and
- **Volume 2, Part 1, Appendix 1.4.F: Outline Schedule of Environmental Commitments and Mitigation Measures**.

1.4.1.7 As described in **Volume 1, Part 1, Chapter 1: Introduction** for ease of presentation the Proposed Project has been split geographically into the Suffolk Onshore Scheme, Kent Onshore Scheme and the Offshore Scheme, the following sections describe the infrastructure proposed in each of these areas.

1.4.2 Suffolk Onshore Scheme

1.4.2.1 The draft Order Limits in Suffolk (also referred to as 'Suffolk Onshore Scheme Boundary' within the PEIR) are illustrated on **Figure 1.1.2 Suffolk Onshore Scheme Boundary**. The Suffolk Onshore Scheme comprises of:

- A connection from the existing transmission network via the proposed Friston Substation, including the substation itself. Friston Substation already has development consent as part of other third-party projects. If the proposed Friston Substation has already been constructed under another consent, only a connection into the substation would be constructed by the Proposed Project;
- A high voltage alternating current (HVAC) underground cable of approximately 1.7 km in length between the proposed Friston Substation and a proposed converter station (below);
- A 2 GW high voltage direct current (HVDC) converter station up to 26 m high plus external equipment (such as lightning protection & railings for walkways) near Saxmundham;
- A HVDC underground cable connection of approximately 10 km in length between the proposed converter station near Saxmundham, and a transition joint bay (TJB) approximately 900m inshore from a landfall point where the cable transitions from onshore to offshore technology; and
- A landfall on the Suffolk coast (between Aldeburgh and Thorpeness).

Coordination with third party projects

1.4.2.2 Feedback received during early discussions with LPA's as well as during non-statutory consultation and through the Scoping Opinion identified the need to explore coordination with other energy infrastructure projects that are proposed in the same locality.

1.4.2.3 Coordination may mean a variety of different things, from sharing of data and site survey information, sharing construction materials such as stone for temporary access tracks (if projects are constructed in sequence) through to physical co-location or even sharing of infrastructure.

1.4.2.4 Whilst it is possible to share certain types of infrastructure, for example car parks, accesses, and landscaping, the sharing of large-scale infrastructure would not necessarily realise benefits as there would be no reduction in the size of development or its footprint.

1.4.2.5 National Grid Electricity Transmission plc (National Grid) and National Grid Ventures (NGV) have undertaken discussions to explore the opportunities for coordination of their proposed projects in Suffolk, one part of which is co-location of infrastructure. The Proposed Project therefore includes an option to facilitate co-location of infrastructure with NGV's proposed Nautilus and LionLink (formally known as EuroLink) interconnector projects to the extent currently possible under the Planning Act 2008.

1.4.2.6 It is important to note that the feasibility and deliverability of co-location is still being explored. It is also important to note that the opportunities being explored to co-locate infrastructure are based on the current known information within regards to the development of NGV's proposed projects.

1.4.2.7 The description of the Suffolk Onshore Scheme in the following sections includes a description of the Proposed Project in isolation, and also, where relevant, a description of the Proposed Project including co-location with the NGV projects. Co-location can take different forms depending on the specific element of infrastructure being considered. For example, in the case of HVAC/DC cables and landfall, co-location would involve installation of additional ducts to accommodate the NGV projects as part of the Proposed Project (the actual installation of the cables would be the subject of separate consent to be obtained by the NGV projects). In the case of the Saxmundham Converter Station, co-location would involve coordination with NGV projects so that up to three converter stations can be located in the same site; however the additional converter station(s) at Saxmundham would be subject to their own consent and would not form part of the Proposed Project. Further detail on the approach taken for co-location of specific Proposed Project elements is provided, where relevant, in the sections below. In addition, **Volume 1, Part 1, Chapter 5: PEIR Approach and Methodology** provides a description of how these options have been assessed within the technical chapters in Parts 2-5.

Proposed Friston Substation

1.4.2.8 The proposed Friston Substation is located to the north of the village of Friston adjacent to the existing 4ZW and 4ZX overhead lines and centred on Grid Reference TM 413 613.

Proposed Project

1.4.2.9 The proposed Friston Substation would comprise a 400 kV substation, anticipated to contain primarily gas insulated switchgear (GIS) within a GIS building, but also including air insulated elements. The various primary plant and secondary equipment includes, but is not limited to, circuit breakers, disconnectors, earth switches, busbars, and cable interface.

1.4.2.10 The substation is likely to comprise one or more buildings which could house services, storage workshop, and relay room, along with a backup diesel generator. The substation compound would include hard and soft landscaping, the substation will be enclosed by a fence and would contain a parking area and access road.

1.4.2.11 The proposed infrastructure required for the Proposed Project is shown indicatively in red on **Design Drawing S42_S/TDD/SS/0003** .

1.4.2.12 Delivery of the Friston Substation would also require the removal of one existing 4ZW 400 kV overhead line pylon, and installation of two new pylons on the 4ZW 400 kV overhead line. It could also include the re-conductoring of a short length of the 4ZW 400 kV overhead line and minor alterations to the pylons approaching Friston Substation

1.4.2.13 Friston Substation already benefits from development consent granted to Scottish Power Renewables (SPR), pursuant to 'The East Anglia ONE North Offshore Wind Farm Order 2022' and 'The East Anglia TWO Offshore Wind Farm Order 2022'. Given that these consents have yet to be implemented, the Friston Substation is included in the Proposed Project to achieve a comprehensive consenting position.

1.4.2.14 Should the proposed Friston Substation be installed under the current consent secured by SPR, the works required for the Proposed Project would be limited to the installation of new GIS bays and additional switch gear, cable connections and bus bars, all within the boundary of the substation. This is illustrated indicatively in red on **Design Drawing S42_S/TDD/SS/0001.**

Proposed Project with Co-location

1.4.2.15 Under this option the Proposed Project does not include alterations to Friston Substation to accommodate co-location. Any changes required to the proposed Friston substation to connect the NGV projects would be subject to their own individual and separate project consents for the NGV projects.

1.4.2.16 The indicative works required to connect the NGV projects into the proposed Friston Substation are described in **Volume 2, Part 2, Appendix 2.14.A: Description of Other Developments** and assessed cumulatively in **Volume 1, Part 2, Chapter 14: Inter-project Cumulative Effects**.

1.4.2.17 These will be assessed as part of the cumulative assessment as explain in **Volume 1, Part 1, Chapter 5: PEIR Approach and Methodology**.

Limit of Deviation

1.4.2.18 The lateral Limit of Deviation (LoD) is illustrated on **Figure 1.4.1 Lateral Limits of Deviation**. The vertical LoD for Friston Substation is 18 m. No lowest below ground vertical LoD has been specified. Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

Proposed HVAC Connection

1.4.2.19 The proposed HVAC connection would be located between the proposed Friston Substation and the proposed Saxmundham Converter Station. It would be routed northwest from the proposed Friston Substation for approximately 1.7 km to the south of the B1119 and north of the B1121.

Proposed Project

1.4.2.20 The HVAC connection from Saxmundham Converter Station to the proposed Friston Substation would be via HVAC underground cables.

1.4.2.21 A typical HVAC construction swathe is illustrated on **Design Drawing S42_S/TDD/SS/0010** and a typical joint bay arrangement is illustrated on **Design Drawing S42_S/TDD/SS/0011**.

1.4.2.22 Between the proposed Friston Substation and Saxmundham Converter Station the HVAC and HVDC cables for the Proposed Project would be combined within the same construction swathe, this is illustrated on **Design Drawing S42_S/TDD/SS/0012** .

1.4.2.23 Table 1.4.1 provides a summary of the typical characteristics of the HVAC connection.

Table 1.4.1: Typical characteristics of the Proposed Project HVAC connection

Characteristic	Proposed Project Indicative Description
Working width	Typically 63 m
Permanent easement	Typically 63 m
No of HVAC cables	Up to six cables
No of trenches	Up to two
Trench width	Typically 2.5 m
Trench depth	Typically 1.5 m
Number of ducts	Eight ducts (six cable and two fibre optic split over the two trenches) two Distributed Temperature Sensing (DTS) tubes.
Minimum depth of cover	Agricultural land – typically 0.9 m (900 mm) Watercourses – typically 2.0 m (2000 mm) Roads – typically 0.75 m (750 mm) Railways – typically 5 m (5000 mm)
Backfill material	Soil and cement bound sand (CBS) or other thermally suitable material. Typically, all topsoil would be retained and used during reinstatement. Where suitable, subsoil is retained and used to backfill the trenches above the duct and CBS installation. As the installation of the ducts and CBS surround would typically take up approximately half the volume of the sub soil excavated, there would be excess sub soil following reinstatement. Any excess subsoil will either be retained for use on site, such as for landscaping or removed from site.
Cable section length	Typical cable section length: 550m–1200 m
Above ground infrastructure	At each cable joint bay there would be an above ground kiosk, which would be used to monitor and occasionally test the underground cables. For the Proposed Project, it is likely that there would be two HVAC circuits each containing three cables, there would be a joint bay per circuit wherever cables need to be jointed and a kiosk per joint bay. Generally, the joint bays for the circuits would be aligned so that they are roughly in the same location, therefore in each of these locations you would expect to see two above ground kiosks, (typically 1.2 m high and 1 m wide), one for each circuit.

Proposed Project with Co-location

1.4.2.24 Under the co-location option the Proposed Project would include the installation of up to a total of 16 additional ducts for the two NGV projects split over an additional four trenches. Works to install the NGV cables within the ducts would be subject to separate project consents obtained for the NGV projects.

1.4.2.25 The typical arrangement of the working width would remain as described above but extra space would be required for the additional four trenches and associated stockpiles of topsoil and subsoil. As a result, the working width, therefore, would typically increase from 63 m to 95 m to install the ducts required for one of the NGV projects and from 63 m to 112 m to install the ducts required for the two NGV projects. Co-located HVAC corridors are illustrated on **Design Drawing S42_S/TDD/SS/0013**.

1.4.2.26 For the scenario where the Proposed Project's combined HVAC and HVDC corridor is co-located with a HVAC and HVDC corridor for up to two NGV projects, the typical arrangement of the working width would remain as described above but extra space would be required for the additional six trenches and associated stockpiles of topsoil and subsoil. As a result, the working width, therefore, would typically increase from 63 m to 106 m to install the ducts required for one of the NGV projects and from 63 m to 131 m to install the ducts required for the two NGV projects. A typical working width for this co-located option is illustrated on **Design Drawing S42_S/TDD/SS/0014**.

1.4.2.27 Table 1.4.2 provides a summary of the typical characteristics of the HVAC connection plus the additional ducts required to accommodate the two NGV projects.

Table 1.4.2: Typical characteristics of the Proposed Projects HVAC connection with co-location

Characteristic	Proposed Project Indicative Description	Proposed Project with co-location Indicative Description
Working width	Typically 63 m (HVAC corridor only) Typically 78 m (combined HVDC and HVAC corridors)	Up to 95 m with one NGV project Up to 112 m with two NGV projects (HVAC corridor only) Up to 131 m with two NGV projects (combined HVAC and HVDC corridors)
Permanent easement	Typically 63 m Typically 78 m (combined HVDC and HVAC corridors)	Up to 95 m with one NGV project (depending on the contractual relationship) Up to 112 m with two NGV projects (HVAC corridor only)(depending on the contractual relationship) Up to 131 m with two NGV projects (combined

Characteristic	Proposed Project Indicative Description	Proposed Project with co-location Indicative Description
		HVAC and HVDC corridors) (depending on the contractual relationship)
No of HVAC cables	Up to six cables	The additional cables for the NGV projects would be installed under their own separate project consent.
No of trenches	Up to two (HVAC corridor only) Up to three (combined HVAC and HVDC corridors)	Up to four with one NGV project Up to six with two NGV projects Up to nine with two NGV projects (combined HVAC and HVDC corridors)
Trench width	Typically 2.5 m	No change
Trench depth	Typically 1.5 m	No change
Number of ducts	Eight ducts (six cable and two fibre optic split over the two trenches) two DTS tubes.	An additional eight ducts and two DTS tubes with one NGV project An additional 16 ducts and four DTS tubes with two NGV projects An additional 27 ducts and seven DTS tubes with two NGV projects (combined HVAC and HVDC corridors)
Minimum depth of cover	Agricultural land – typically 0.9 m (900 mm) Watercourses – typically 2.0 m (2000 mm) Roads – typically 0.75 m (750 mm) Railways – typically 5 m (5000 mm)	No change
Backfill material	CBS or other thermally suitable material Typically, all topsoil would be retained and used during	No change

Characteristic	Proposed Project Indicative Description	Proposed Project with co-location Indicative Description
	reinstatement. Where suitable sub soil is retained and used to backfill the trenches above the duct and CBS installation. As the installation of the ducts and CBS surround would typically take up approximately half the volume of the sub soil excavated, there would be excess sub soil following reinstatement. Any excess sub soil will either be retained for use on site, such as for landscaping or removed from site.	
Cable section length	Typical cable section length: 550 m–1200 m	No change
Above ground infrastructure	At each cable joint bay there would be an above ground kiosk, which would be used to monitor and occasionally test the underground cables. For the Proposed Project, it is likely that there would be two HVAC circuits each containing three cables, there would be a joint bay per circuit wherever cables need to be jointed and a kiosk per joint bay. Generally, the joint bays for the circuits would be aligned so that they are roughly in the same location, therefore in each of these locations you would expect to see two above ground kiosks, one for each circuit.	One kiosk would likely be required for each NGV circuit. The additional kiosks for the NGV projects would be installed under their own separate project consent.

Limit of Deviation

1.4.2.28 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation**. The minimum burial depths are detailed in Table 1.4.1 and Table 1.4.2. No lowest below ground vertical LoD has been specified, this is because to place a limit may unnecessarily restrict below ground works where there is little or no chance of likely significant effects resulting. For example, it may be necessary to undertake archaeological excavation, and to have placed a limit on the depth of such exaction works would be unnecessarily restrictive. A standard below ground LoD is not therefore proposed. Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

Proposed Saxmundham Converter Station

1.4.2.29 The proposed Saxmundham Converter Station is located to the east of the settlement of Saxmundham and south of the B1119, centred on Grid Reference TM 396 627.

Proposed Project

1.4.2.30 A typical arrangement for the Saxmundham Converter Station is illustrated on **Design Drawing S42_S/TDD/SS/0015**. The proposed Saxmundham Converter Station would include a DC hall, converter transformers, valve hall, reactor hall, AC switchyard, control building, strategic spare parts building, Low Voltage (LV) electricity supply, fire deluge pump house, car parking, a permanent access road and landscaping.

1.4.2.31 The Saxmundham Converter Station would be up to 6.5 ha in area (excluding landscaping) and the valve halls could be up to 26 m in height excluding lightning protection, aerials, walkways, fall arrest equipment and potential architectural treatments (such as soft landscaping).

1.4.2.32 An indicative location of the Saxmundham Converter Station within the proposed site is illustrated on **Figure 1.4.2 Saxmundham Converter Station Indicative Location** and the indicative landscaping strategy is illustrated on **Figure 1.4.3 Saxmundham Converter Station Indicative Landscaping Strategy.** These figures demonstrate one way in which the Saxmundham Converter Station could be located within the wider lateral LoD.

1.4.2.33 There are three options being considered for the permanent access arrangement to Saxmundham Converter Station these are:

- permanent access is taken off the B1121 South Entrance (bellmouth BM09);
- permanent access is taken off B1121 Main Road (bellmouth BM12 via BM11 and BM10); or
- permanent access is taken off the B1121 The Street (bellmouth BM13).

1.4.2.34 These potential accesses and bellmouths are shown on **Figure 1.4.4 Saxmundham Converter Station Permanent Access Arrangements**.

1.4.2.35 The indicative permanent drainage arrangement is illustrated on **General Arrangements Plan S42_S/IGA/PS/0002**.

Lighting

1.4.2.36 Permanent external lighting at Saxmundham Converter Station would likely comprise security lighting on sensors and low level egress lighting.

Design

1.4.2.37 The architectural design of Saxmundham Converter Station can vary within the physical parameters and LoDs set out above. The design of this structure, in terms of the building form and the external materials, will be developed alongside consultation and stakeholder feedback. A Design Code for the building will be provided with the application for development consent. The Design Code will provide guidance regarding the design intent and design principles that will be adopted and embedded into the detail proposals of this structure.

Proposed Project with Co-location

1.4.2.38 Under the co-location option it is assumed that up to three converter stations (the Saxmundham Converter Station needed as part of the Proposed Project, and two further converter stations associated with the NGV projects) would be located on the Suffolk converter station site. The Proposed Project however would not include the delivery of the two further converter stations themselves. The construction, operation, maintenance and decommissioning of the NGV converter stations would be subject to their own individual project consents.

1.4.2.39 **Figure 1.4.5 Saxmundham Converter Station Indicative Location with Co-location** illustrates an indicative arrangement of a co-located site with three converter stations. **Figure 1.4.6 Saxmundham Converter Station Indicative Landscaping Strategy with Co-location** illustrates an indicative landscaping strategy for a co-located site with up to three converter stations. These figures demonstrate one way in which co-location of the Saxmundham Converter Station, with up to two other converter stations for the NGV projects, could be brought forward within the wider lateral LoD.

1.4.2.40 Under this option the permanent access arrangements described under the Proposed Project above and as illustrated on **Figure 1.4.4 Saxmundham Converter Station Permanent Access Arrangements** would remain broadly the same regardless of which location on the site the Saxmundham Converter Station was located. Although, it should be noted that, the final alignment of permanent access road would need to adjusted relative to the final location of the converter stations.

1.4.2.41 The indicative permanent drainage arrangement is illustrated on **General Arrangement Plan S42_S/IGA/SS /0008**.

Limit of Deviation

1.4.2.42 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation**. The extent of the lateral LoD shown at this stage allows for the necessary flexibility for the design process to continue to develop so that the most suitable position for the Saxmundham Converter Station can be delivered, even if up to two other converter stations have already been built on the site by the NGV projects.

1.4.2.43 The vertical LoD for Saxmundham Converter Station is 26 m excluding lightning protection, aerials, walkways, fall arrest equipment and potential architectural treatments (such as soft landscaping). No lowest below ground vertical LoD has been specified. Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

Proposed Underground HVDC Cables

1.4.2.44 The proposed HVDC underground cables would be routed from the proposed Saxmundham Converter Station to the proposed Suffolk Landfall. They would be routed southeast from Saxmundham Converter Station passing to the north of the proposed Friston substation, south of Great Wood and north of the A1094. They would then be routed to the north of Old Broom Covert and Eight Acre Covert crossing the B1122 Leiston Road at approximately Grid Reference TM 455 583 to the TJB located to the north of Warren Hill Lane and south of Sandlings Special Protection Area (SPA) at approximately Grid Reference TM 461 584.

Proposed Project

1.4.2.45 A typical HVDC construction swathe is illustrated on **Design Drawing S42_T/TDD/SS/3001** and a typical joint bay arrangement is illustrated on **Design Drawing S42_T/TDD/SS/3003**.

1.4.2.46 Between the proposed Friston Substation and the proposed Saxmundham Converter Station the HVAC and HVDC cables for the Proposed Project would be combined within the same construction swathe, this is illustrated on **Design Drawing S42_S/TDD/SS/0012**.

1.4.2.47 Table 1.4.3 provides a summary of the typical characteristics of the HVDC underground cables.

Table 1.4.3: Typical characteristics of the Proposed Project HVDC underground cables

Characteristic	Proposed Project Indicative Description
Working width	Typically 40 m
Permanent easement	Typically 40 m
No of HVDC cables	Up to two
No of trenches	Up to one
Trench width	Typically 2.3 m
Trench depth	Typically 1.5 m
Number of ducts	Three (two cables and one fibre)
Minimum depth of cover	Agricultural land – typically 0.9 m (900 mm) Watercourses – typically 2.0 m (2000 mm) Roads – typically 0.75 m (750 mm) Railways – typically 5 m (5000 mm)

Characteristic	Proposed Project Indicative Description
Backfill material	Soil and CBS or other thermally suitable material Typically, all topsoil would be retained and used during reinstatement. Where suitable sub soil is retained and used to backfill the trenches above the duct and CBS installation. As the installation of the ducts and CBS surround would typically take up approximately half the volume of the sub soil excavated, there would be excess sub soil following reinstatement. Any excess sub soil will either be retained for use on site, such as for landscaping or removed from site.
Cable section length	Typical cable section length: 800 m–1200 m
Above ground infrastructure	None

Proposed Project with Co-location

1.4.2.48 Under the co-location option the Proposed Project would include the installation of up to a total of eight additional ducts for the two NGV projects. The typical arrangement of the working width would remain as described above but extra space would be required for up to an additional two trenches and their associated stockpiles of topsoil and subsoil. As a result, the working width would typically increase from 40 m to 59 m to allow installation of the ducts required for one of the NGV projects and from 40 m to 69 m to allow installation of the ducts required for the two NGV projects. A typical working width for a co-located option is illustrated on **Design Drawing S42_S/TDD/SS/0018**.

1.4.2.49 As set out above between the proposed Friston Substation and the proposed Saxmundham Converter Station the HVAC and HVDC cables for the Proposed Project would be co-located within the same construction swathe. The inclusion of co-location with the NGV projects within this swathe is illustrated on **Design Drawing S42_S/TDD/SS/0014**.

1.4.2.50 Table 1.4.4 provides a summary of the typical characteristics of HVDC connection with the addition of co-location.

Table 1.4.4: Typical characteristics of the Proposed Project HVDC cables with co-location

Characteristic	Proposed Project Indicative Description	Proposed Project with Co-location Indicative Description
Working width	Typically 40 m	Up to 59 m with one NGV project Up to 69 m with two NGV projects

Characteristic	Proposed Project Indicative Description	Proposed Project with Co-location Indicative Description
Permanent easement	Typically 40 m	Up to 59 m with one NGV project (depending on the contractual relationship) Up to 69 m with two NGV projects (depending on the contractual relationship)
No of HVDC cables	Up to two	The additional cables for the NGV projects would be installed under their own separate project consent.
No of trenches	Up to one	Up to two with one NGV project Up to three with two NGV projects
Trench width	Typically 2.3 m	No change
Trench depth	Typically 1.5 m	No change
Number of ducts	Three (two cables and one fibre)	Up to 11 for co-location (eight in addition to the three Proposed Project ducts)
Minimum depth of cover	Agricultural land – typically 0.9 m (900 mm) Watercourses – typically 2.0 m (2000 mm) Roads – typically 0.75 m (750 mm) Railways – typically 5 m (5000 mm)	No change
Backfill material	Soil and CBS or other thermally suitable material Typically, all topsoil would be retained and used during reinstatement. Where suitable sub soil is retained and used to backfill the trenches above the duct and CBS installation. As the installation of the ducts and CBS surround would typically take up approximately half the volume of the sub soil excavated, there would be excess sub soil following	No change

Characteristic	Proposed Project Indicative Description	Proposed Project with Co-location Indicative Description
	reinstatement. Any excess sub soil will either be retained for use on site, such as for landscaping or removed from site.	
Cable section length	Typical cable section length: 800 m–1200 m	No change
Above ground infrastructure	None	No change

Limit of Deviation

1.4.2.51 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation** and provides sufficient flexibility to allow for co-location of the Proposed Project with up to two other NGV projects as described above. The minimum burial depths are detailed in Table 1.4.3 and Table 1.4.4. No lowest below ground vertical LoD has been specified, this is because to place a limit may unnecessarily restrict below ground works where there is little or no chance of likely significant effects resulting. For example, it may be necessary to undertake archaeological excavation, and to have placed a limit on the depth of such exaction works would be unnecessarily restrictive. A standard below ground LoD is not therefore proposed. Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

Suffolk Landfall

1.4.2.52 This is the transition point from the underground HVDC cable to marine HVDC cable. The Suffolk landfall is located north of the settlement of Aldeburgh and south of the settlement of Thorpeness. The TJB would be located at approximately Grid Reference TM 461 584 and the marine HVDC cables would cross under Leiston-Aldeburgh Site of Special Scientific Interest (SSSI), North Warren Royal Society for the Protection of Birds (RSPB) Reserve and Thorpe Road.

Proposed Project

1.4.2.53 The indicative location of the TJB and cable ducts is illustrated on **Figure 1.4.7 Suffolk Landfall Indicative Location**. Whilst this is indicative within the LoD there is a commitment to make landfall using a trenchless crossing technique beneath designated sites, the location of the transition joint bay will be located outside of the coastal designated sites of Leiston Aldeburgh Site of SSSI and North Warren RSPB Reserve.

1.4.2.54 For the Proposed Project four ducts would be installed, one more duct would be installed than for the underground HVDC cable to allow for a spare. Should a section of cable need to be replaced at the landfall this spare duct would allow for a new section of cable to be pulled through rather than a repair to the existing or needing to re install ducts at the landfall.

Proposed Project with Co-location

1.4.2.55 Under the co-location option the Proposed Project would include an additional six cable ducts. These would be installed using a trenchless crossing technique beneath designated sites, the location of the transition joint bay will be located outside of the coastal designated sites of Leiston Aldeburgh Site of SSSI and North Warren RSPB Reserve.

1.4.2.56 The indicative location of the TJB and cable ducts are illustrated on **Figure 1.4.8 Suffolk Landfall Indicative Location with Co-location**.

Limit of Deviation

1.4.2.57 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation** and provides sufficient flexibility to allow co-location of the Proposed Project with up to two other NGV projects as described above. No lowest below ground vertical LoD has been specified. Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

1.4.3 Kent Onshore Scheme

1.4.3.1 The draft Order Limits in Kent (also referred to as ‘Kent Onshore Scheme Boundary’ within the PEIR) are illustrated on **Figure 1.1.3 Kent Onshore Scheme Boundary**. The Kent Onshore Scheme would comprise of:

- A landfall point on the Kent coast at Pegwell Bay;
- A TJB approximately 800 m inshore to transition from offshore HVDC cable to onshore HVDC cable, before continuing underground for approximately 2 km to a new converter station (below).
- A 2 GW HVDC converter station, up to 26 m high plus external equipment (such as lightning protection and railings for walkways), near Minster. A new substation would be located immediately adjacent.
- Removal of approximately 1 km of existing HVAC overhead line, and installation of approximately 2.25 km of new HVAC overhead line from the substation near Minster and the existing Richborough to Canterbury overhead line.

Proposed HVAC Connection

1.4.3.2 The HVAC connection from the existing Richborough to Canterbury 400 kV overheard line to the proposed Minster 400 kV substation would be made via a new approximately 2.25 km overhead line (of which 1 km is replacement of exisitng line on the Canterbury to Richborough connection). The proposed new section of overhead line would be routed to the northeast from the existing Richborough to Canterbury overhead line, crossing the River Stour and a section of railway, and connecting into the proposed Minster 400 kV substation at approximately Grid Reference TR321 629.

1.4.3.3 Two different pylon types are being considered for this connection, either steel lattice standard height or steel lattice low height.

1.4.3.4 Table 1.4.5 provides a summary of the typical characteristics of an overhead line.

Table 1.4.5: Typical characteristics of an overhead line

Characteristic	Proposed Project Indicative Description
Pylon type	Steel lattice – typical standard height or low height
Pylon height	Typically, 46.5 m (standard height) and 35.5 m (low height)
Pylon footprint	Typically 113.54 m^2 standard height Typically 105 m^2 (low height)
Conductor type	2 x 700 mm^2 Araucaria (AAAC) per phase or 2x 620 mm^2 Matthew per phase or 2x 591 mm^2 Curlew (ACCR) per phase or similar.
Turn in	There are currently three options being considered: • Option 1 – Low height pylons • Option 2 – Standard height pylons – 60 degree bends • Option 3 – Standard height pylons – 90 degree bends <u>Option 1</u> This would require the installation of approximately seven new low height pylons and two standard height pylons connecting to two new terminal towers at the proposed Minster 400 kV substation. The two standard height pylons are required to achieve the appropriate clearance over the railway line. This is illustrated on **Figure 1.4.9 Kent Onshore Scheme HVAC Connection Option 1**. <u>Option 2</u> This would require the installation of approximately five new standard height pylons connecting to two new terminal pylons at the proposed Minster 400 kV substation. One existing low height pylon would be removed. This is illustrated on **Figure 1.4.10 Kent Onshore Scheme HVAC Connection Option 2**.

Characteristic	Proposed Project Indicative Description
	<u>Option 3</u> This would require the installation of one new low height pylon approximately four new standard height pylons connecting to two new terminal pylons at the proposed Minster 400 kV substation. This is illustrated on **Figure 1.4.11 Kent Onshore Scheme HVAC Connection Option 3**.

1.4.3.5 Option 1 is illustrated on **Figure 1.4.9 Kent Onshore Scheme HVAC Connection Option 1,** a typical low height pylon is illustrated on **Design Drawing S42_T/TDD/SS/3006** and the indicative pylon types and heights are detailed in Table 1.4.6 which would be subject to the LoD defined below.

Table 1.4.6: Indicative pylon types and heights for option 1

Pylon name	Indicative Pylon type	Indicative Height
PC 053B	L12 LD30 E6	41 m
PC 053C	L12 LD30 E6	41 m
PC 053D	L12 LD E6	41 m
PC 053E	L8(C) D STD	46 m
Ebbsfleet Terminal Tower 1	L8(C) DT STD (Extended x-arm)	46 m
Ebbsfleet Terminal Tower 2	L8(C) DT STD(Extended x-arm)	46 m
PC 056A	L8(C) D STD	46 m
PC 056B	L12 LD30 E6	41 m
PC 056C	L12 LD30 E6	41 m
PC 056D	L12 LD30 E6	41 m
PC 056E	L12 LD30 E6	41 m

1.4.3.6 Option 2 is illustrated on **Figure 1.4.10 Kent Onshore Scheme HVAC Connection Option 2**, a typical standard height pylon is illustrated on **Design Drawing S42_T/TDD/SS/3006** and the indicative pylon types and heights are detailed in Table 1.4.7 which would be subject to the LoD defined below.

Table 1.4.7: Indicative pylon types and heights for option 2

Pylon name	Indicative Pylon type	Indicative Height
PC 053A	L8(C) D60 E3.7	48 m
PC 053B	L8(C) D E4.9	51 m

Pylon name	Indicative Pylon type	Indicative Height
Ebbsfleet Terminal tower 1	L8(C) DT STD(Extended x-arm)	46 m
Ebbsfleet Terminal tower 2	L8(C) DT STD(Extended x-arm)	46 m
PC 055A	L8(C) D STD	46 m
PC 055B	L8(C) D60 STD	45 m
PC 055C	L8(C) D60 STD	45 m

1.4.3.7 Option 3 is illustrated on **Figure 1.4.11 Kent Onshore Scheme HVAC Connection Option 3**, a typical standard height pylon is illustrated on **Design Drawing S42_T/TDD/SS/3006** and the indicative pylon types and heights are detailed in Table 1.4.8 which would be subject to the LoD defined below.

Table 1.4.8: Indicative pylon types and heights for option 3

Pylon name	Indicative Pylon type	Indicative Height
PC 053A	L8(C) D60 E3.7	48 m
PC 053B	L8(C) D E4.9	51 m
Ebbsfleet Terminal tower 1	L8(C) DT STD(Extended x-arm)	46 m
Ebbsfleet Terminal tower 2	L8(C) DT STD(Extended x-arm)	46 m
PC 056A	L8(C) D STD	46 m
PC 056B	L8(C) D90 STD	49 m
PC 056C	L8(C) D60 STD E3.7	48 m

Limit of Deviation

1.4.3.8 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation.** The vertical above ground LoD for all three options is 6 m above the indicative height. No vertical below ground LoD has been specified, this is because to place a limit may unnecessarily restrict below ground works where there is little or no chance of likely significant effects resulting. For example, it may be necessary to undertake archaeological excavation, and to have placed a limit on the depth of such exaction works would be unnecessarily restrictive However the difference in the effects caused by such depth differences, (largely dependent upon the type of foundation used) would be likely to be very small. A standard LoD below ground is not therefore proposed. Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

Proposed Minster 400 kV Substation and Minster Converter Station

1.4.3.9 As the HVAC connection in Kent is being made directly onto the existing Richborough to Canterbury overhead line there is a requirement for a new substation (hereafter referred to as Minster 400 kV substation) to be sited adjacent to Minister Converter Station. The proposed Minster 400 kV substation and Minster Converter Station are located to the north of Richbourgh Energy Park and a section of Sandwich Bay to Hacklinge Marshes SSSI, and to the west of the A256. Minster 400 kV substation is approximately centred on Grid Reference TR 321 629 and Minster Converter Station on approximately Grid Reference TR 324 630.

1.4.3.10 The indicative location of the Minster 400 kV substation and Minster Converter Station within the proposed site is illustrated on **Figure 1.4.12 Minster 400 kV Substation and Minster Converter Station Indicative Location** and the indicative landscaping strategy is illustrated on **Figure 1.4.13 Minster 400 kV Substation and Minster Converter Station Indicative Landscaping Strategy**..

Minster 400kV substation

1.4.3.11 An indicative arrangement for the proposed Minster 400 kV substation is illustrated on **Design Drawing S42_K/TDD/SS/2001** and would comprise a 400 kV substation, anticipated to contain primarily gas insulated switchgear (GIS) within a GIS building, but also including air insulated elements. The various primary plant and secondary equipment includes, but is not limited to, circuit breakers, disconnectors, earth switches, busbars, and cable interface.

Minster Converter Station

1.4.3.12 A typical arrangement for the proposed Minster converter station is illustrated on **Design Drawing S42_K/TDD/SS/2002**.The proposed Minster Converter Station would comprise of a DC hall, converter transformers, valve hall, reactor hall, AC switchyard, control building, strategic spare parts building, Low LV electricity supply, fire deluge pump house, car parking, a permanent access road and landscaping.

1.4.3.13 There are two options being considered for permanent access to Minster 400 kV substation and Minster Converter Station these are:

- permanent access is taken off the A256 (via bellmouth BM02); or
- permanent access is taken off Jutes Lane (via bellmouth BM03) with bellmouth BM02 retained in case of future Abnormal Indivisible Loads (AIL) movements.

1.4.3.14 These are illustrated on **Figure 1.4.14 Minster 400 kV Substation and Minster Converter Station Permanent Access Arrangements**.

1.4.3.15 The indicative permanent drainage arrangement is illustrated on **General Arrangement Plan S42_K/IGA/PS/2002**.

Lighting

1.4.3.1 Permanent external lighting at Minster Converter Station would likely comprise security lighting on sensors and low level egress lighting.

Design

1.4.3.2 The architectural design of Minster Converter Station can vary within the physical parameters and LoDs set out above. The design of this structure, in terms of the building form and the external materials, will be developed alongside consultation and stakeholder feedback. A Design Code for the building will be provided with the application for development consent. The Design Code will provide guidance regarding the design intent and design principles that will be adopted and embedded into the detail proposals of this structure.

Limit of Deviation

1.4.3.3 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation**. The vertical LoD for the proposed Minster 400 kV substation is 18 m and the vertical LoD for the proposed Minster Converter Station is 26 m excluding lightning protection, aerials, walkways, fall arrest equipment and potential architectural treatments (such as soft landscaping). Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

Proposed Underground HVDC Cables

1.4.3.4 The proposed underground HVDC cables would be routed from the proposed Minster Converter Station to the Kent landfall. From the proposed Minster Converter Station would be routed east to the north of Richborough Energy Park and the sewage works crossing the A256 to a TJB located to the west of St Augustine's and Stonelees Golf Club at approximately Grid Reference TR 338 637.

1.4.3.5 A typical HVDC construction swathe is illustrated on **Design Drawing S42_T/TDD/SS/3001** and a typical joint bay arrangement is illustrated on **Design Drawing S42_T/TDD/SS/3003**.

1.4.3.6 Table 1.4.9Table 1.4.9 provides a summary of the typical characteristics of the HVDC underground cables.

Table 1.4.9: Typical characteristics of HVDC underground cables

Characteristic	Proposed Project Indicative Description
Working width	Typically 40 m
Permanent easement	Typically 40 m
No of HVDC cables	Up to two
No of trenches	Up to one
Trench width	Typically 2.3 m
Trench depth	Typically 1.5 m
Number of ducts	Three (two cables and one fibre)
Minimum depth of cover	Agricultural land – typically 0.9 m (900 mm) Watercourses – typically 2.0 m (2000 mm) Roads – typically 0.75 m (750 mm) Railways – typically 5 m (5000 mm)

Characteristic	Proposed Project Indicative Description
Backfill material	Soil and cement bound sand (CBS) or other thermally suitable material Typically, all topsoil would be retained and used during reinstatement. Where suitable sub soil is retained and used to backfill the trenches above the duct and CBS installation. As the installation of the ducts and CBS surround would typically take up approximately half the volume of the sub soil excavated, there would be excess sub soil following reinstatement. Any excess sub soil will either be retained for use on site, such as for landscaping or removed from site.
Cable section length	Typical cable section length: 800 m–1200 m
Above ground infrastructure	None

Limit of Deviation

1.4.3.7 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation**. The minimum burial depths are detailed in Table 1.4.9. No lowest below ground vertical LoD has been specified, this is because to place a limit may unnecessarily restrict below ground works where there is little or no chance of likely significant effects resulting. For example, it may be necessary to undertake archaeological excavation, and to have placed a limit on the depth of such exaction works would be unnecessarily restrictive. A standard below ground LoD is not therefore proposed. Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

Kent Landfall

1.4.3.8 This is the transition point from underground HVDC cable to marine HVDC cable. The proposed Kent landfall is located within Pegwell Bay to the south of the settlement of Cliffsend. The proposed TJB would be located to the west of St Augustine’s and Stoneslees Golf Club at approximately Grid Reference TR 341 637 and the Kent marine HVDC cables would cross St Augustine’s Golf course, Sandwich Road, Thanet Coast and Sandwich Bay SPA and Ramsar, Sandwich Bay Special Area of Conservation (SAC), Sandwich Bay to Hacklinge Marshes SSSI and Sandwich and Pegwell Bay National Nature Reserve (NNR).

1.4.3.9 The indicative location of the TJB and cable ducts is illustrated **on Figure 1.4.15 Kent Landfall Indicative Location**. Whilst this is indicative within the LoD there is a commitment to make landfall using a trenchless crossing technique beneath the saltmarsh habitat within the Pegwell Bay. The location of the TJB and the exit of the trenchless crossing seaward of the mean highwater springs mark (MHWS) would be located outside of the sensitive saltmarsh habitat.

1.4.3.10 Four ducts would be installed, one more duct would be installed than for the terrestrial HVDC underground cables to allow for a spare. Should a section of cable need to be replaced at the landfall, this spare duct would allow for a new section of cable to be pulled through rather than a repair to the existing or needing to re install ducts.

Limit of Deviation

1.4.3.11 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation**. No lowest below ground vertical LoD has been specified. Whilst a standard below ground LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

1.4.4 Offshore Scheme

1.4.4.1 The Offshore Scheme boundary is illustrated on **Figure 1.1.4 Offshore Scheme Boundary**.

1.4.4.2 The proposed marine HVDC cables would be routed from the TJB at the Suffolk landfall located between the settlements of Aldeburgh and Thorpeness at approximately Grid Reference TM 461 584 to the TJB at the Kent landfall at approximately Grid Reference TR 338 637 located within Pegwell Bay to the south of the settlement of Cliffsend. The marine HVDC cables would be routed south from the Suffolk landfall through a section of the Outer Thames Estuary SPA and to the west of the existing Greater Gabbard and Galloper offshore wind farms. They head east through the Sunk Traffic Separation Scheme (TSS) turning south to route around Margate and Long Sands SAC and between a number of mineral aggregate sites. The marine HVDC cables would then continue south to the east of London Array offshore wind farm and west of Thanet offshore windfarm before turning west to make landfall in Pegwell Bay.

1.4.4.3 The Offshore Scheme includes three distinct components, which are summarised below:

- Suffolk landfall: This is the area where the cable route transitions between the marine and terrestrial environment in Suffolk. This is located between the settlements of Aldeburgh and Thorpeness (further detail provided under Suffolk Landfall section above);
- Marine HVDC cable route: This is the cable route from the TJB at the landfall in Suffolk to the TJB at the landfall in Kent. The marine HVDC cable route is up to 130 km in length; and
- Kent landfall: this is the area where the cable route transitions between the marine and terrestrial environment in Kent, located in the Pegwell Bay area to the south of the settlement of Cliffsend (further detail provided under Kent Landfall section above).

1.4.4.4 Table 1.4.10 provides a summary of the Offshore Scheme characteristics.

Table 1.4.10: Offshore Scheme characteristics

Characteristic	Proposed Project Indicative Description
Number of HVDC cables	Two (one bundled pair)

Characteristic	Proposed Project Indicative Description
HVDC cable diameter	Typically up to 200 mm
Number of fibre optic cables	one (bundled)
Fibre optic cable diameter	Typically 20 mm to 30 mm
Number of HVDC joints	Up to one
Number of Fibre Optic joints	Up to one
Transmission Capacity	2 GW
Operating Voltage	Up to ±550 kV
Number of cable trenches	One for main offshore route
Offshore Trench Width	Trench width along the offshore route would be dependent on final engineered cable/bundle dimensions as well as the trenching methodology and sediment type, but would be in the range of 0.3 m–1.5 m.
Cable separation distances	Cable separate distances offshore are dependant on trench width (see above). Generally, higher spacing reduces the likelihood of more than one cable to be damaged by a single source and provides space for potential cable repair/bights/replacements on the approaches to the landfall. Cable separation distances at landfall are dependent on the trenchless solution and number of conduits that would be installed. The bundled/fibre optic cables may be up to 50 m offset at the seaward bellmouths (bell shaped opening which provides guidance for a cable), and minimum 10 m offset at the landward entry point, into the relevant Transition Joint Bay.
Suffolk landfall (Proposed Project only)	Four ducts (one per cable and one spare).
Suffolk landfall (with co-location)	Up to ten ducts.
Kent landfall (Proposed Project only)	Four ducts (one per cable and one spare).

Cable configuration

1.4.4.5 The cable configuration for the Offshore Scheme is assumed to be one bundled HVDC and one fibre optic cable (two cables) in one trench. With a bundled approach, the two cables and the fibre optic cable would be combined into a single bundle as shown in **Design Drawing S42_M/TDD/SS/1-26.**

Limits of deviation

1.4.4.6 The lateral LoD is illustrated on **Figure 1.4.1 Lateral Limits of Deviation**. No lowest below seabed vertical LoD has been specified. Whilst a standard below seabed LoD is not proposed, the Proposed Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

1.4.5 Construction

1.4.5.1 This section describes how the infrastructure described above would typically be constructed and installed. An outline Code of Construction Practice (CoCP) has been produced and is included at **Volume 2, Part 1, Appendix 1.4.A Outline Code of Construction Practice**. The technical chapters within Parts 2-5 have taken account of the control and management measures which are set out in the outline CoCP when undertaking their preliminary assessments.

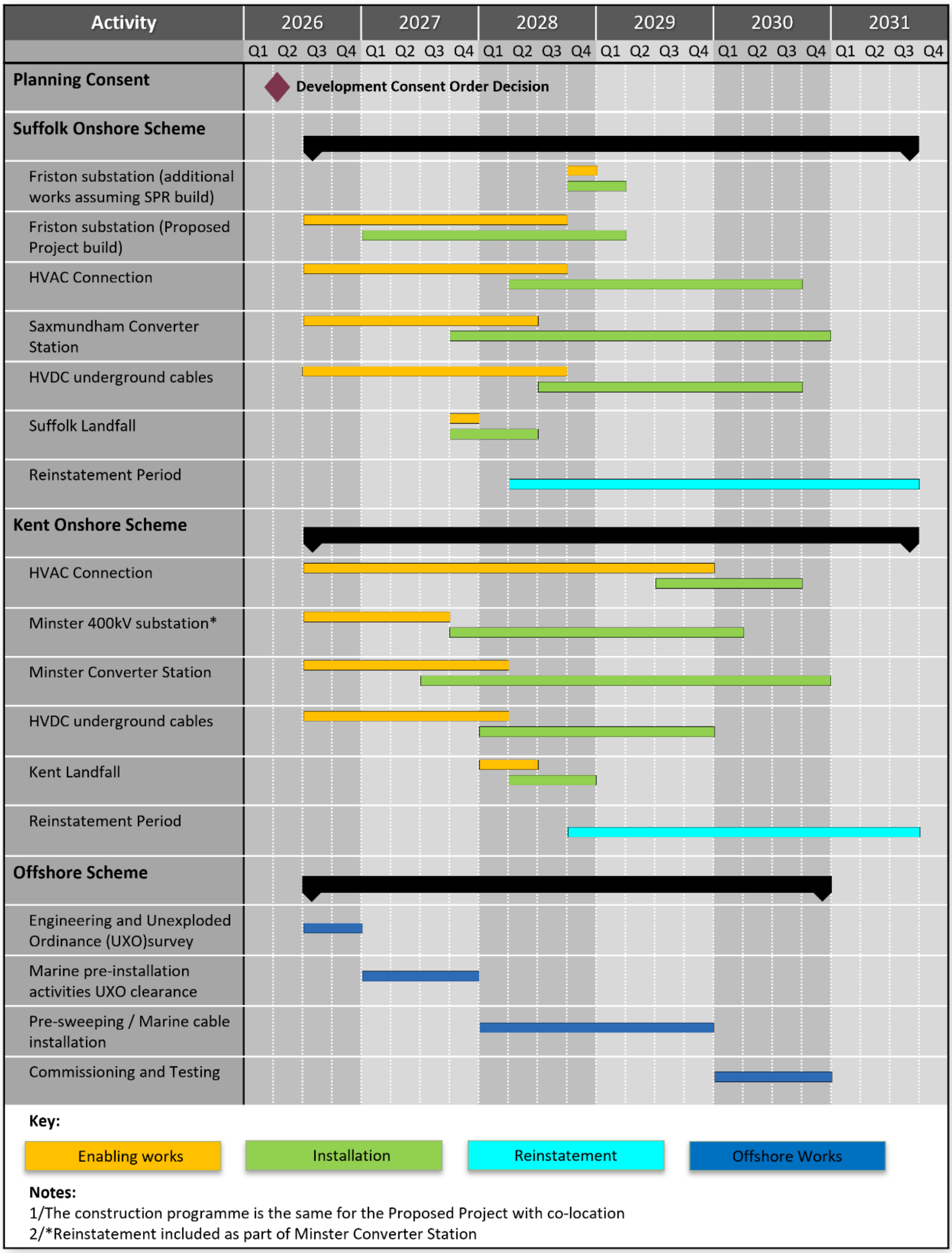
Construction Programme

1.4.5.2 Subject to gaining development consent, construction works would be expected to start in 2026 and be functionally completed by the end of 2030 with reinstatement potentially continuing into 2031. Certain advance works (such as archaeological trial trenching or protected species mitigation) may take place in advance of the main construction period.

1.4.5.3 The construction schedule will be developed as the Proposed Project progresses and will take account of seasonal constraints such as protected species breeding or hibernation seasons and reducing impacts associated with flood zones.

1.4.5.4 An indicative construction programme for the Proposed Project is presented in Table 1.4.11.

Table 1.4.11: Indicative Construction Programme



Construction Workforce

1.4.5.5 It is anticipated that the peak workforce for the Suffolk Onshore Scheme would be approximately 414 increasing to approximately 454 with co-location included. The peak workforce in Kent would be approximately 292 and the peak Offshore Scheme workforce would be 250.

Construction Working Hours

1.4.5.6 The proposed construction working hours are:

- Monday – Friday: 0700am–1900pm;
- Saturday: 0700am–1700pm; and
- Sundays/Bank Holidays – non working.

1.4.5.7 Exceptions to the above include but not limited to:

- Continuous periods of operation such as concrete pouring, dewatering, cable pulling, cable jointing and drilling during the operation of a trenchless technique (e.g. Horizontal Directional Drill (HDD)), installation and removal of conductors, pilot wires and associated protective netting across highways or public footpaths;
- Internal fitting out works within buildings associated with the onshore substations and converter stations;
- Delivery to the transmission works of abnormal loads that may cause congestion on the local road network (e.g. Transformer delivery vehicles, Cable Drum delivery) or any other highway works requested by the highway authority to be undertaken on a Saturday, Sunday or Bank Holiday outside of core working hours;
- Testing or commissioning;
- Completion of construction activities commenced during the approved working hours which cannot safely be stopped;
- Activities necessary in the instance of an emergency where there is a risk to persons, delivery of electricity or property;
- Marine works (all works below the mean high water springs line); and
- Survey works.

1.4.5.8 For the marine cable, construction will be a 24 hour operation where viable to minimise overall installation time, maximise the use of suitable weather windows and take advantage of vessel and equipment availability.

Terrestrial Enabling Works, Access and Site Preparation

1.4.5.9 In order for the elements of the Suffolk and Kent Onshore Schemes to be constructed, enabling works are required such as the establishment of construction compounds, temporary bellmouths and access tracks and drainage works. The enabling works are consistent across all elements of the Onshore Schemes and have therefore been described once below rather than for each individual element.

1.4.5.10 Construction compounds would be established at the converter station and substation sites as well as along the HVDC and HVAC underground cable and overhead line routes. A typical layout plan of a converter station construction compound is illustrated on **Design Drawing S42_T/TDD/SS/3005** and a typical layout plan of a cable construction compound is illustrated on **Design Drawing S42_T/TDD/SS/3004**. The indicative location of the construction compounds for the Suffolk Onshore Scheme are illustrated on **Figure 1.4.16 Suffolk Onshore Scheme Indicative Construction Compound Locations – Proposed Project** and with co-location on **Figure 1.4.17 Suffolk Onshore Scheme Indicative Construction Compound Locations – Proposed Project with Co-location**. The indicative locations of the construction compounds for the Kent Onshore Scheme are illustrated on **Figure 1.4.18 Kent Onshore Scheme Indicative Construction Compound Locations**.

1.4.5.11 Prior to any installation works, vegetation clearance and the erection of stockproof fencing or equivalent would be undertaken in the proposed area of construction. These works are usually undertaken using existing field entrances and are illustrated by the mobilisation and trenchless works accesses shown on **Figure 1.4.19 Suffolk Onshore Scheme Construction Traffic Routes During Construction and Operation** and **Figure 1.4.20 Kent Onshore Scheme Construction Traffic Routes During Construction and Operation**. Utility diversions by 3rd party utility providers are also often undertaken ahead of the main access works commencing, these works are often undertaken using the pre-existing access arrangements the providers hold with landowners or via the mobilisation and trenchless works accesses as shown on **Figure 1.4.19 Suffolk Onshore Scheme Construction Traffic Routes During Construction and Operation** and **Figure 1.4.20 Kent Onshore Scheme Construction Traffic Routes During Construction and Operation**.

1.4.5.12 Bellmouths would be installed where new accesses or widening of existing accesses from the public highway are required. The installation of bellmouths may require realignment of existing overhead or underground services and clearance works along visibility splays to create a line of sight for the safe use of the junction. Visibility splays will need to be maintained throughout the duration of construction. Typically, a bellmouth would take approximately four weeks to install. Temporary bellmouths off the public highways would usually be constructed with a bound material surface (concrete or bitumen). The size of the bellmouth will vary subject to the vehicle access requirements. A typical bellmouth is illustrated on **Design Drawing S42_T/TDD/SS/3002** and indicative bellmouth locations are sown on **Figure 1.4.19 Suffolk Onshore Scheme Construction Traffic Routes During Construction and Operation** and **Figure 1.4.20 Kent Onshore Scheme Construction Traffic Routes During Construction and Operation**. Bellmouth installation would typically require traffic management that could include contraflows, lane closures and traffic lights or road closures and diversions. The works would typically include vegetation clearance, earthworks, drainage works, pavement laying, kerbing, footway, fencing, signage and gate installation.

1.4.5.13 Once a new or widened access point has been created the proposed access tracks and working areas would be fenced off using approximately 1.2 m high stock proof fencing or equivalent. Gates or equivalent would be incorporated into the fencing to maintain access to farmland where possible and to maintain access to Public Rights of Way (PROWs) where possible. The topsoil would be stripped from the access tracks, cable working width and pylon working areas. The topsoil would be stored carefully to one side; typically, topsoil would be stored in bunds up to 2.5 m high. Temporary drainage would be installed as required, with silt fences installed where required. Topsoil stripping is typically undertaken at a rate of approximately 50 m to 100 m per day for access tracks, usually programmed to align with the construction rate of the haul road so as not to leave formation levels exposed for significant lengths of time. Soil stripping rates for the cable working width are typically 20 m to 40 m and two days per pylon construction area depending on the excavator chosen, soil type and location.

1.4.5.14 Temporary drainage would be required during construction, to deal with rainfall and water encountered during excavation where appropriate. Construction sustainable drainage systems (SuDS) would be used if necessary and where appropriate to do so.

1.4.5.15 There are three principal types of access track typically used. Stone tracks, interlocking panels and subsoil stabilisation. The choice of access track construction depends largely on the ground conditions and the duration and type of use (weight/load) required.

1.4.5.16 Stone access tracks would be constructed using primary or secondary aggregates laid over a separation membrane and generally including one or more layers of geotextile strengthening. Stone tracks are generally used where there is a high volume of construction traffic expected over a longer duration, they are typically 7 m wide to allow for two-way traffic movements and are typically installed at a rate of approximately 50 m per day. On completion of construction, the access tracks would be removed, and aggregates taken to an appropriate facility which could include recycling, or onward use, for example as secondary aggregate in the construction industry.

1.4.5.17 Access tracks formed of interlocking panels, commonly referred to as 'trackway' or 'metal roads' are usually laid straight on the surface with no prior excavation. They can be layered and overlapped to increase rigidity and spread the vehicle loading in areas of poor ground conditions. The panels can be metal or high density plastic and can be installed quicker than stone tracks. Interlocking panels are usually used where the duration of works is lower and where vehicle loading and frequency is predicted to be lower.

1.4.5.18 Subsoil stabilisation is a chemical treatment of the subsoil to improve its bearing capacity to a suitable level for supporting the predicted construction traffic. Its suitability for use is heavily dependant on the condition and chemical composition of the native subsoil and requires specific ground investigations to determine the suitability of use. The process involves mixing chemical additives with the subsoil and rolling the soil to form a track. Once the works are complete additional chemicals are added and the ground is ploughed to return it to its original state.

1.4.5.19 Culvert installations would be required for temporary access tracks to cross ditches and watercourses. The size of each culvert would vary depending on the dimensions of the crossing, and sensitivity and importance of the watercourse. To install a culvert, typically the banks are first strimmed at the proposed culvert location. Bunds would then be installed upstream and downstream to prevent water from entering the work site, water contained between the two bunds would be pumped downstream to clear the work area. To maintain the flow of the watercourse during installation of the culvert, a pump would be used to pump water from upstream to downstream, bypassing the work site. The bottom of the ditch or watercourse would be excavated to the size of the proposed foundation and, if required lined with a geotextile separation membrane overlain by bedding material. If required, a geotextile separation membrane would be placed on top of the ditch banks, prior to backfilling. The culvert would then be installed and backfilling commenced. The backfill would be laid to provide minimum cover over the culvert based on maximum loadings. A sand/concrete bag or precast concrete headwall and temporary fencing would subsequently be installed after which the bunds upstream and downstream would be removed and the over-pumping stopped to allow water to flow through the culvert. The installation of culverts would typically take approximately ten days per culvert.

1.4.5.20 Should culverts not be suitable for a particular crossing, due to either the sensitivity of the watercourse or engineering requirements, a temporary bridge would be installed. Temporary bridge support requirements would be assessed on a site-by-site basis. Most bridge crossings would be of a short span and flat deck construction; however, Bailey style bridges may also be used. All bridges would be a clear span and the foundations would be placed clear of the banks of the watercourse. Once the foundations were in place the temporary bridge would be fitted. Although the installation method is dependent on the type of bridge being installed, a typical bridge would be delivered in sections. Each bridge component would be assembled on site and lifted into position by crane. With the bridge in position, decking panels would be lifted and fixed into position. The installation duration would depend largely on the type of structure used and the foundation requirements, installation could take up to 12 weeks with potentially additional time required for concrete curing if in situ concrete foundations are required.

1.4.5.21 In the case of culvert and bridge installation, access is required to both sides of the watercourse, therefore mobilisation and trenchless works accesses as shown on **Figure 1.4.19 Suffolk Onshore Scheme Construction Traffic Routes During Construction and Operation** and **Figure 1.4.20 Kent Onshore Scheme Construction Traffic Routes During Construction and Operation** using existing tracks and field accesses would be used for site clearance and potentially foundation and abutment construction.

1.4.5.22 A watercourse crossing Schedule is provided at **Volume 2, Part 1, Appendix 1.4.D: Crossing Schedules** which confirms where bridge crossings have been committed to.

Saxmundham Converter Station – construction access

1.4.5.23 There are currently two alternative options to facilitate the construction access to Saxmundham Converter Station, construction access is taken off the B1121 South Entrance (bellmouth BM09) or the B1121 Main Road (bellmouth BM12 via BM11 and BM10). These two options are shown on **Figure 1.4.21 Saxmundham Converter Station Construction Access**. Access off the B1121 South Entrance (bellmouth BM09) would require a crossing of the River Fromus and access off the B1121 Main Road (bellmouth BM12 via BM11 and BM10) would require a crossing of the railway and the River Fromus. Both options have been assessed by the preliminary assessments.

Proposed Friston Substation

1.4.5.24 As set out earlier in this Chapter, the proposed substation at Friston already benefits from development consent pursuant to 'The East Anglia ONE North Offshore Wind Farm Order 2022' and 'The East Anglia TWO Offshore Wind Farm Order 2022'. The construction sequencing would likely be different depending on whether the substation was delivered by SPR pursuant to its development consent(s), or whether it was delivered by National Grid pursuant to a future Development Consent Order (DCO) for the Proposed Project.

1.4.5.25 The typical construction sequence to install the electrical infrastructure required for the Proposed Project would involve:

- OHL works;
- earthworks;
- civil engineering works ;
- building works;
- mechanical and electrical;
- commissioning/energisation; and
- reinstatement.

1.4.5.26 Should the proposed Friston Substation be installed under the current consent secured by SPR, the works required for the Proposed Project would be limited to the installation of new GIS bays and additional switch gear, cable connections and bus bars, all within the boundary of the substation.

Proposed Converter Stations

1.4.5.27 A typical construction sequence for the construction of a converter station following the enabling works would include:

- earthworks;
- civil engineering works;
- building works;
- cable installation;
- provision/installation of permanent services;

- mechanical and electrical works;
- commissioning; and
- site reinstatement and landscape works.

Proposed Overhead HVAC Connection

1.4.5.28 The construction of a section of overhead line following the enabling works would generally be sequenced as follows:

1.4.5.29 Foundations:

- topsoil stripping, temporary drainage installation where required;
- excavation and disposal of excavated soil for pad and chimney foundations;
- installation of pylon foundations (pad and column, mini pile, tube pile or bespoke);

1.4.5.30 Erection of overhead line structure (pylon):

- layout of steelwork in preparation for erection;
- assembly (painting if required) and erection of steelwork;
- installation of insulators strings including fittings;
- installation of protection prior to stringing of conductors, including scaffolding;

1.4.5.31 Stringing of Conductors:

- establishment of machine sites for conductor stringing; including equipotential zones
- conductor stringing;
- conductor sagging and clamping, including damper installation;
- installation of spacers;

1.4.5.32 Re-instatement:

- removal of construction equipment and reinstatement of ground and restoration of soils;
- removal of access tracks and bellmouths; and
- removal of construction compounds and reinstatement of ground.

1.4.5.33 The following sections provide a description of the typical construction of an overhead line.

Foundations

1.4.5.34 There are various types of pylon foundations used for overhead lines, and these will depend on the ground conditions where the pylon is located. Analysing the results of the geological surveys, the design civil engineer will select the most suitable foundation for each pylon location. Normally pad and chimney foundations are selected for soils with good ground (hard soils) and piled foundations are selected for soft ground or where a high water table is present. The foundations of the proposed pylons would either be pad and chimney, mini pile or tube pile (or bespoke if required). The installation of pad foundations would take approximately three weeks for each pylon (four pads). Mini pile or tube pile foundations would typically take approximately four weeks for each pylon. For pylon locations where ground conditions do not easily permit the installation of pad and column, mini-pile or tube pile foundations, a bespoke foundation would be required. The design for each bespoke foundation would be subject to the ground conditions encountered. The construction times mentioned above are estimated and depend on type of soil, number of gangs and equipment available.

Erection of the overhead line structure

1.4.5.35 The steel work would be brought to each pylon working area (approximately 50 m x 50 m) and laid out in pre-constructed sections or in numbered parts prior to assembly and erection of the pylon. Laying out of the steelwork would typically take approximately three days per pylon.

1.4.5.36 The numbered steelwork parts would be bolted together on the ground. The pylon would be assembled in sections beginning with each bottom leg section being fastened to the foundation steelwork. The pylon would be erected using a mobile crane which would lift the assembled steelwork into position. Linesmen would bolt together the pylon, climbing to each part to help guide the next section into place and fasten the bolts. The number of pylon sections required would vary according to the size of the pylon being built and the lifting capacity of the crane. To lift the topmost sections of the taller pylons a crane with a capacity of up to 250 t may be required for the reach and weight of the sections to be positioned into place. A smaller capacity crane could be used to lift pylon sections up to the limit of reach of the crane considering load to be lifted. Though in this instance the larger capacity crane would still be required to complete the pylon.

1.4.5.37 Temporary scaffolding and nets would be installed during construction, where required, as a safety measure to protect assets such as roads, railways, a water treatment works and distribution network overhead lines (where not already moved underground) and could include hedgerows which would be crossed by the proposed overhead line. This is required to protect these features during conductor stringing from the accidental dropping of conductors and any of the associated equipment. The scaffolding would be transported to site using a lorry or tractor and trailer and assembled by hand at either side of the feature being protected. Typically, approximately 8 m^2 of scaffolding would be installed per day.

1.4.5.38 The insulators strings with fittings would be fastened to the cross arms of the pylons, with running wheels hung from the end of the insulators to carry the pilot wires in preparation for installing the conductors. The installation of the insulators would typically take approximately two days per pylon.

Stringing of conductors

1.4.5.39 This is the phase of works where the conductors are installed. This is usually done in sections between appropriate angle/tension pylons. The machine sites for conductor stringing (pulling positions) would be sited on interlocking panels laid directly onto the ground surface reducing disturbance to the underlying soils. The machine sites would be sited to avoid individual trees wherever possible. It would typically take approximately one day to establish the area to receive materials and equipment at each conductor stringing site.

1.4.5.40 The wires (conductors) of the overhead lines would be delivered to the machine sites for conductor stringing using lorries, or tractor and trailer. The conductors are wound onto large cable drums and, depending on the conductor type, each completed drum could weigh up to 8t, although larger and heavier drums are possible depending on the supplier and the length of conductor. A conductor pulling position would be established at each end of the section with a winching machine ('winch') and empty steel reels to accept pilot wires. At the other end of the section the full conductor drums would be arranged near the tensioning machine ('tensioner'). Light pilot wires would be laid at ground level (and over temporary scaffolding protecting assets such as roads and railway lines) along the length of the section between the pulling positions (note that it is not typically necessary to clear hedgerows specifically for this activity, though some vegetation management could be required). The pilot wires would be lifted and fed through running wheels on the cross arms of all the pylons in the section, and then fed around the winch at the pulling position. The light pilot wires are used to pull through heavier, stronger pilot wires which are in turn used to pull conductors through from their drums. The tensioning machine would keep the wires off the ground and prevent the conductors running freely when the winch pulls the pilot wire. When the conductor is fully 'run out', it would be sagged to determine the exact design tension, fastened at its finished tension and height above ground by a linesman working from platforms on the pylons which are suspended beneath the conductors. Additional fittings such as spacers, if required, and vibration dampers, would be fitted to the conductors. To counter balance the out of balance loading at the tension pylons at the end of a conductor stringing section, it is normal to install temporary backstays or concrete blocks for safety of installation. The temporary backstays or concrete blocks are removed after conductor stringing is completed. Stringing the conductors would typically take approximately four weeks per conductor stringing section.

1.4.5.41 To provide protection to personnel from the effects of potential differences that may arise whilst lowering, raising or restringing overhead line conductors, the machine sites are required to sit on Equipotential Zones (EPZ's). The EPZ consists of a mat of linked conducting metal panels, on which all the stringing equipment and machinery would sit. They are then electrically bonded together to a common point, with an earthing bus welded onto one of the panels. An EPZ is required for puller/tensioner sites only. The EPZ is designed to ensure that during fault conditions dangerous potential electrical differences do not occur across the body of personnel working near ground-based machinery whilst lowering, raising or restringing overhead line conductors. The zone must be of sufficient size to enable operatives to operate the winch machine and mount and change the required conductor drums without having to step off the zone.

Removal of existing pylons and outages

1.4.5.42 The construction of the overhead line would be done in a sequence to ensure that the existing overhead line is able to be live at all times, this could include the use of temporary towers or masts to enable the movement of the overhead line conductors from the existing pylon while they are replaced or removed. This could involve a sequence of outages (power turned off) on the overhead line to enable this work to be done safely. Existing and new pylons would be constructed as described above and foundations of any removed pylons would be removed to 1.5 m below ground level where practical.

Reinstatement

1.4.5.43 Once the overhead line is constructed, the access tracks and working areas at the pylon site would be removed and the ground reinstated by removing stone and trackways. Soils would be restored to their previous condition. Other surfaces would be reinstated and widened accesses would be restored to the condition they were in at the commencement of the works.

Proposed Underground HVAC and HVDC Cables

1.4.5.44 Whilst the number of cables and working width vary depending on whether the underground cable is HVAC or HVDC the sequence and method of construction and installation is the same and has therefore been described together below.

1.4.5.45 Installation of the proposed HVAC and HVDC cables would typically be undertaken within an 80 m and 40 m wide working width respectively as shown on **Design Drawing S42_S/TDD/SS/0010 and Design Drawing S42_T/TDD/SS/3001**. The exception to this is where environmental or engineering constraints mean additional land is required such as where the proposed cable routes cross obstacles such as roads or watercourses using a non-open cut technique. In these locations working widths may be required to be larger. In some areas the construction corridor may be narrowed to minimise the impact on environmentally sensitive sites, for example through a woodland or significant hedgerow. Narrowing the corridor is accomplished by relocating the topsoil and sub soil stockpiles and requires larger construction corridors on either side of the sensitive site to accommodate the additional storage of soil.

1.4.5.46 There are several cable installation methods which are summarised below.

Open cut direct buried

1.4.5.47 Typically utilised in open country/agricultural land. Involves the excavation of a trench into which the cables are directly laid. Requires long sections of trenching (typically 800 m – 1000 m) to be excavated and left open to enable the cables to be installed. Dewatering and protection from surface water runoff are specific constraints on this method. Crossings such as at roads or watercourses installation can take the form of the inclusion of a duct block enabling the cables to be installed through the ducts and avoiding the need for these crossing to be left open for significant periods.

1.4.5.48 Underground cable installation using the open cut direct buried method would typically be undertaken in the following sequence:

- trench dug utilising excavators (or by hand in areas of known buried utilities). Excavated sub-soil will be stockpiled separately from the topsoil (see general trenching section below);
- installation of a base layer of cement bound sand (CBS) into the cable trench;
- cables laid in trench by ‘pulling’ from cable drum, with the aid of rollers placed within the trench (see cable installation section below).
- cables are bedded in with CBS;
- protective tiles are placed across the width of the trench;
- trench is back filled with excavated sub-soil or thermally suitable material where required (to avoid the alteration of local environmental temperatures around the cables);
- warning tapes would be placed 100 mm above the protective tiles vertically in line with the cable poles; and
- topsoil will be reinstated to original soil profile and land re-seeded or released to the land owner for cultivation as it was found.

Open cut ducted

1.4.5.49 Typically utilised in open country/agricultural land. Involves the excavation of a trench into which the ducts are installed, and the trench backfilled. The pulling tensions on the cable during installation are a constraint with this method as access along the section length is limited, the condition of the ducts to ensure protection of the cable during pulling is vitally important. The benefits of this option are that excavations are only open for a short duration and over a more limited length.

1.4.5.50 Underground cable installation using the ducted method would typically be undertaken in the following sequence:

- trench dug utilising excavators (or by hand in areas of known buried utilities). Excavated sub-soil will be stockpiled separately from the topsoil (see general trenching section below);
- installation of a base layer of CBS into the cable trench;
- ducts laid in trench;
- ducts are bedded in with CBS;
- protective tiles are placed across the width of the trench;
- trench is back filled with excavated sub-soil or thermally suitable material where required (to avoid the alteration of local environmental temperatures around the cables);
- warning tapes would be placed 100 mm above the protective tiles vertically in line with the cable poles;
- topsoil will be reinstated to original soil profile and land re-seeded or released to the land owner for cultivation as it was found; and
- cables installed by ‘pulling’ from cable drum (see cable installation section below).

General trenching

1.4.5.51 Soft, collapsible soils such as sand based soils would require either temporary trench boarding (direct buried) or trench boxing (ducted) to facilitate the containment construction. In firmer soils, 'battered' excavations become more acceptable for both configurations.

1.4.5.52 Lengths of 'open' trench would be around 800 m - 1000 m for normal direct buried configuration whereas a ducted system can be backfilled on a rolling basis and therefore there is significantly less open trench at any one time (approximately 200-300 m).

1.4.5.53 Construction of an open trench in good soils can progress at +100 m per day, dropping to 30 m per day or less in challenging areas or urban environments. An average value of 80 m per day has been used for the preliminary assessments.

Cable installation

1.4.5.54 Cable laying durations between the main two configurations can vary significantly and use substantially different numbers of operatives to install. With an open trench, direct buried configuration, a significant amount of time is required to set up the system to install – these include flat rollers for straight runs, box rollers for corners and careful calculation of pull forces on the cable. A section can usually be installed (two cables) in around four days including moving of rollers and resetting. This is achievable provided the infrastructure is in place (drum laydown and pulling points).

1.4.5.55 For a ducted system, which may not always be viable due to system constraints, provided that any moves away from the horizontal and vertical planes (bends) are within acceptable parameters, installation can be achieved much quicker – typically two days for a section (approximately 800 m – 1000 m) for two cables is achievable provided the infrastructure is in place (drum laydown and pulling points).

1.4.5.56 Cable installation does not need to be undertaken sequentially along the whole route; as a result, installation could occur in multiple sections of the length of the proposed cable route in parallel. This would limit the extent and duration of construction activity at any given location including the length of time that land remains disturbed for. The exact programme will depend on several factors including the underlying ground conditions and installation methods used.

Trenchless Crossings

1.4.5.57 These would typically be utilised where significant obstacles such as major watercourses, roads, railway lines, flood defences or other utilities need to be crossed, and open cutting is not considered a suitable option. There are multiple techniques available with the choice of technique being dependant on the ground conditions and the parameters of the cable installation required. All techniques typically involve drilling under the obstacle and installing a duct or tunnel opening through which the cables can be pulled. The benefits of this system are that the obstacle is largely unaffected by the installation, the design is undertaken to avoid undue settlement and the surface level is monitored throughout the works to ensure agreed tolerances are adhered to.

1.4.5.59 In the case of a rail or road obstruction there would normally be required to be a partial closure during the works for safety reasons. Trenchless crossings can require significant mobilisation infrastructure at either end of the crossing, requiring a construction compound to be built at either end. The drilling methods are often slower than trenching. Some techniques require drilling fluid to be used at high pressures, this can cause frack out, where drilling fluid escapes to the surface during the drilling process. Due to the need for separation between drills the overall construction corridor at the launch and reception sites and permanent installation is likely to be wider than using an open cut of ducted installation method.

1.4.5.60 Where a constraint is required to be crossed using a trenchless method, there are a number of methods that can be employed depending on the ground conditions and detailed design. A typical description of each is provided below.

Pipe Jacking (Auger Bore)

1.4.5.61 A hydraulic ram or jack and associated boring equipment would be located in a launch pit. The size and depth of the launch pit is dependent upon the depth of the cable (deeper cable requires a deeper and larger pit). A tunnel is then created by progressively inserting clay pipes behind the drill head (driven by the hydraulic jack), with material returned to the launch site (typically via a screw-shaped shaft). One tunnel is required for each cable. The direction of the tunnel is determined by the set-up equipment in the launch pit and it is continuously surveyed. Drilling continues to the reception pit (also constructed prior to drilling, to a depth relative to the depth of cable). The launch and reception pits may require sheet piling and further works to ensure a dry and stable working environment. Following completion of the works, the launch and reception would be backfilled on completion of the crossing and the area reinstated. Topsoil will be reinstated to original soil profile and land re-seeded or released to the land owner for cultivation as it was found.

Horizontal Directional Drilling

1.4.5.62 An HDD rig and associated equipment would be set up at the launch site. This includes electricity supply (portable generator), drill mud filter, control unit and welfare facilities. Drilling utilises a drill bit, drill head and drilling fluid. Drilling fluid (typically bentonite slurry) assists the drilling process, as well as lubricating and cooling the drill head. A pilot hole is typically drilled first, followed by a series of increasing size bores until the final drill diameter that is required is achieved. Location and direction of drilling can be monitored using the HDD locating system to ensure drilling follows the pre-planned path. Ducting is then pulled back through the drilled hole towards the HDD rig. One cable duct is required for each cable. It is likely that spare ducts would be installed to allow for ease of replacement should any faults be identified in future. Ducts can be capped to ensure no attenuation of water or sediment or prevent use by animals if left prior to cable pulling. The launch site would be reinstated on completion. Topsoil will be reinstated to original soil profile and land re-seeded or released to the land owner for cultivation as it was found.

Micro boring (micro-tunnelling)

1.4.5.63 This method is similar to pipe jacking, however, it utilises a steerable tunnel boring machine (TBM) to tunnel between a launch pit and a reception pit. Lengths of pipe are inserted behind the TBM as it progresses, and a hydraulic jack is used to drive the pipe forward. Water or mud mix is utilised to fluidise excavated material which is pumped to the launch pit. Cable ducting is pulled through the pipe tunnel following tunnelling through to the reception pit. The launch pit and reception pit require concrete bases to ensure a clean working environment and prevent water entering the working area. The launch and reception pits also require a concrete back wall for the hydraulic jack to work against. The launch and reception pits would be backfilled on completion of the crossing and the area reinstated. Topsoil will be reinstated to the original soil profile and land re-seeded or released to the land owner for cultivation as it was found.

Joint bays and cable jointing

1.4.5.64 There are limitations on the length of cable that can be transported terrestrially (approximately 1 km), due to its size and weight. Therefore, for installations longer than 1 km a number of cable sections are required, once the cables are installed along these sections they need to be connected via the installation of a joint. Joints are undertaken at joint bays positioned at the ends of each cable. Joint bays are typically pits with a concrete slab installed in the base to provide a working platform. The jointing operation requires a clean and dry environment, so the joint bays are usually covered by a scaffold and sheeting structure or a mobile cabin unit. Joint bays are excavated typically to a depth of 2-3 m during the trench excavation phase of the cable installation process, the base is concreted, and the excavation secured. The joint bays would stay open for the duration of the cable installation and jointing process. Once the jointing has been completed the cables are surrounded by CBS and covered by protective tiles and the excavation backfilled. Warning tape is installed as with the cable section installations. At all HVAC and some HVDC joints monitoring of the cables is required, this is facilitated by bonding leads connected to the joints being routed to a link pillar at the surface. The link pillars are installed above ground and are typically fenced in to protect them from livestock where required. A typical joint bay for a HVAC cable is illustrated on **Design Drawing S42_S/TDD/SS/0011** and a typical joint ay for a HVDC cable is illustrated on **Design Drawing S42_T/TDD/SS/3003**.

Landfalls

1.4.5.65 The cable landfalls form the transition between the underground HVDC cable and the marine HVDC cable. The underground HVDC cable and marine HVDC cables are jointed together at the TJB located as close to the coast as possible whilst taking account of any environmental or technical constraints at a particular landfall.

1.4.5.66 The Suffolk landfall will be installed by trenchless technique from the TJB illustrated on **Figure 1.4.7 Suffolk Landfall Indicative Location** to approximately 5-6 m LAT. The Kent landfall will be installed by a trenchless technique from the TJB illustrated on **Figure 1.4.15 Kent Landfall Indicative Location** to extend as far as practicable, in order to minimise the impact on the intertidal saltmarsh that extends from the shoreline up to 250 m from the shore. The type of trenchless techniques will be confirmed following ground investigation surveys in Autumn 2023. An overview of the different types of trenchless technique that could be used is provided below.

Horizontal Directional Drilling

1.4.5.67 The HDD technique would drill beneath the ground surface to avoid the need to trench the cables on the surface and is an installation option at both landfalls. The final designed depth of the HDD will be chosen to optimise numerous considerations including the suitability for cable thermal performance, the risk of drilling fluid losses to the surface, and the suitability of the geology for drilling. A detailed HDD sequence is described below and indicative alignments for both landfalls presented in **Design Drawing S42_M/TDD/SS/1042, S42_M/TDD/SS/1044, S42_M/TDD/SS/1041, S42_M/TDD/SS/1038, S42_M/TDD/SS/1039, S42_M/TDD/SS/1037,** and **S42_M/TDD/SS/1040.**

1.4.5.68 Based on the available information the HDD methodology is expected to be as follows:

- **Installation of rig anchor:** Either poured concrete block or sheet piled.
- **Installation of Temporary Casing:** 20 m to 40 m length, installed by drilling or hammering.
- **Pilot Drilling:** Typically 15 m – 20 m below surface. Possibly jetted, but potentially via downhole motor drilling. Cuttings will be disposed of appropriately off site.
- **Reaming:** To enlarge the bore, a reamer is pushed or pulled through the pilot bore. Two options exist, forward reaming where drilling fluid flows back to the entry and pull reaming where fluid flows to the exit. The use of forward reaming requires suitable geology and will be determined following ground investigations. The use of pull reaming would result in all drilling fluid being discharged to the sea.
- **Duct Installation:** Two standard duct installation methods are used for landfalls; pushed and pulled. Pushed duct installation requires suitable ground conditions. This is potentially suitable for both landfalls, subject to the results of ground investigations. The duct is assembled behind the drilling rig along the onshore cable route before being pushed in. A pulled installation uses a duct floated to the exit point that is attached to the drilling rods and pulled into the bore. The duct is fabricated to length and stored at a suitable location, either moored or onshore with easy access to the sea, before being towed to site by vessels.
- **Duct End Works**: Following duct installation, a messenger wire would be installed in the duct with sealing flanges attached to the duct ends. The duct ends would then be stabilized and secured until the cable installation.

Drilling fluid

1.4.5.69 The drilling fluid is comprised of bentonite and water. Bentonite is a non-toxic and inert natural clay that forms a gelatinous and viscous fluid. The drilling fluid is 4% bentonite and 96% water. Bentonite is listed by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) as non-CHARMable (Chemical Hazard Assessment and Risk Management), and it is on the Pose Little or No Risk to the Environment (PLONOR) list. To condition the water to the correct pH, soda ash is added at <0.1% of the fluid volume. Small amounts of environmentally approved additives may also be used to fine tune the fluid properties.

1.4.5.70 Unplanned losses of drilling fluid occur when HDD's encounter fractures, fissures, voids, or ground with insufficient strength to resist the pressure imparted by the drilling fluid. Losses to the surface are termed "frac outs" or "breakouts".

1.4.5.71 Mitigation against surface frac out or break out is by:

- ensuring sufficient ground investigations understand the ground strength to inform a suitable design;
- design a profile sufficiently deep for the methodology and conditions, with hydrofracture modelling used to check that there is sufficient factor of safety;
- use of a drilling fluids engineer to design and monitor the fluid properties;
- ensure that the HDD bore is sufficiently clean of cuttings during drilling;
- monitoring fluid pressures in the bore, and returns to the entry pit during drilling; and
- the use of "spotters", personnel stationed above the drill line to look for any frac out or break out.

1.4.5.72 If drilling fluid losses occur, lost circulation material (LCM) may be added to seal the ground. As a last resort, cementitious grout may be used to seal fractures.

Contingency measures for unplanned drilling fluid losses

1.4.5.73 If surface frac out or break outs occur the drilling will immediately stop to prevent any further fluid being pumped. A sump will be dug, or sandbags positioned, to contain the fluid. It will then be pumped back to the HDD site or transported by tractor and bowser. Access routes and methodology to frac out in the intertidal area will need to be assessed.

1.4.5.74 At the Suffolk landfall, access is likely to be on foot, and small boat or pontoon if necessary, with the equipment being carried by hand.

1.4.5.75 At the Kent Landfall, access to the vegetated area is likely to be on foot with the equipment being carried by hand.

1.4.5.76 If bentonite drilling fluid cannot be effectively captured in the intertidal area it will disperse naturally. Bentonite flocculates and breaks down when it comes into contact with seawater with the bentonite clay particles dropping out of suspension over time. For fresh/brackish water, bentonite drilling fluid will need to be pumped out in order to be removed.

1.4.5.77 Following clean-up of the frac out, the drill will be restarted to test if the bentonite drilling fluid has sealed the zone. If the zone has not sealed LCM can be pumped, allowed to set, then tested. This process may need to be repeated a number of times. In extreme cases cementitious grout may need to be pumped into the zone and allowed to set to effect a seal.

Storage of ducts

1.4.5.78 This will depend on the installation methodology. If a pushed installation, 12 m duct lengths will be stored within the landfall construction compound along the onshore cable route behind the HDD and welded to form the string (assuming High Density Polyethylene (HDPE) duct used rather than steel).

1.4.5.79 Table 1.4.12 presents an indicative summary of landfall installation parameters at the Suffolk and Kent landfalls. These parameters will be confirmed once landfall surveys are completed, and Landfall Feasibility Technical Report updated.

Table 1.4.12: Indicative summary of landfall installation parameters

Aspect	Suffolk landfall	Kent landfall
Completed boreholes parameters	Number of boreholes Proposed Project only: - three + one spare. Coordination: Up to ten.	Number of boreholes – three + one spare. Maximum length of boreholes – 920 m/borehole, total length 3280 m. Diameter of boreholes – Typically 500 mm for HVDC boreholes and 150 mm diameter for fibre optic boreholes.
HDD exit pit dimensions	To be confirmed after landfall surveys Autumn 2023.	Footprint associated with excavation of exit pits (incl. equipment spread) – 100 m x 75 m compound, 7500 m^2. Depth of Lowering – Typically 2m–3 m to base of TJB.
Break out point post installation protection requirement	To be confirmed after landfall surveys Autumn 2023.	Area of pre-cut trenching: Typically 15 m^2 per Bellmouth: 60 m^2 for four HDD Ducts (Proposed Project only). Number of concrete mattresses: Up to ten rock bags per HDD exit - up to 40 rock bags for Proposed Project only.
Duration of HDD drilling	Proposed Project 24 hours/7 days estimated 125 days for four HDDs Proposed Project with co-location 24 hours/7 days: 250 days for 10 ducts, (1 HDD rig) or 125 days (2 HDD rigs)	24 hours/7 days estimated 160 days for four HDDs
Depth of HDD	10m–20 m	Typically 15m–20 m.
Duration of cable pull in	12 hours maximum (one daylight tidal cycle) per cable.	12 hours maximum (one daylight tidal cycle) per cable. 36 hours total in three pull-in activity (two HVDC and one fibre optic).

Trenchless - direct pipe

1.4.5.80 Direct pipe is also an option at the Kent Landfall. This is a combination of micro tunnel and HDD techniques where a small tunnelling machine is used to create a larger diameter bore through which a pipe is installed directly behind the machine as it bores out the tunnel. It is a single-pass technique thus reducing the need for a series of increasing size bores to reach the final drill diameter. This may allow more than one cable to be installed in a single duct. This methodology may reduce the needs for drilling fluids and is typically used in soft sediments, although it is being developed for wider application in other ground conditions.

1.4.5.81 The Direct Pipe construction programme will begin with construction of a temporary working area for the equipment. This will be followed by installation of a ramped thrusting pit, entry portal and launch seal, and a construction of a thrust anchor or thrust block.

1.4.5.82 A typical Direct Pipe setup requires 20–25 heavy goods vehicle (HGV) loads of equipment, plus any additional loads for site offices and welfare units. An additional 8 HGV loads of steel pipe will be delivered to site for each bore, but these deliveries will be spaced over the duration of the works.

1.4.5.83 Prior to the commencement of boring, a string of steel pipe will be welded using 12m pipe lengths. At the same time the pipe thruster, TBM, slurry system, and ancillary equipment will be transported to site and set up.

1.4.5.84 When the pipe string is completed, it will then be attached to the TBM, with control lines and slurry pipes installed within the pipe string. A surface mounted pipe thruster then pushes the pipe string while the TBM excavates the ground. The spoil cut by the TBM is transported by slurry back to the tail of the pipe string where it is separated from the boring fluid to enable the fluid to be re-used.

1.4.5.85 During boring there will be a delivery of consumables to the site; on average approximately 2–3 HGV loads per day. There will also be tipper trucks removing bore cuttings from site; on average 2–3 loads per day. HGV and heavy vehicle deliveries to site will be during day shifts.

1.4.5.86 Light vehicles on site typically account for 40 vehicle movements per day, with fuel and liquid waste lorries accounting for 1 vehicle movement per day. The site is expected to be close to a suitable fresh water supply, but if this is not the case, water tankers can add an average of 2–4 trips per day during drilling and reaming phases.

1.4.5.87 When the TBM exits to the seafloor the slurry and control lines are removed from the pipe string, the TBM is then detached from the pipe string and recovered, typically lifted using cranes mounted on a jack up barge.

1.4.5.88 One or more HDPE ducts are then fabricated and pushed into the pipe string. These ducts can carry the power cables and fibre optic cables. Potentially two power cables could be installed in each pipe string, subject to acceptability for cable design and performance.

1.4.5.89 Depending on site conditions and the offshore cable lay programme, the offshore end of the pipe and ducts may be buried or covered with concrete mattresses or rock bags as temporary protection while awaiting cable installation.

1.4.5.90 The majority of the onshore landfall site working area will be reinstated after completion of the bore, with the remainder of the site reinstated following completion of the TJB and marine cable installation into the TJB.

Marine Cable

1.4.5.91 Installation of marine HVDC cable installation typically includes the following activities:

- ground preparation and cable laying activities within the intertidal zone at the landfall sites;
- pre-lay seabed preparation activities along the route below MLWS (including route clearance, removal of Out of Service cables, pre-grapnel run and any pre-sweeping);
- construction of cable crossings;
- installation and burial of the subsea cables; and
- placement of external cable protection (as required).

Installation vessels

1.4.5.92 A range of different vessels are expected to be used during cable installation. These are expected to include:

Cable Lay Vessel (CLV)

1.4.5.93 The CLV will be a specialist ship designed to carry and handle long lengths of heavy power cables, the CLV will be equipped with Dynamic Position (DP) system. The shallowest depth in which the cable ship can operate will depend on the vessel used, however at this stage it has been assumed that larger vessels such as a CLV would not be expected inshore of the 10 m depth contour. Cables may be installed either by simultaneous lay and trenching or cable lay without trenching (Table 1.4.13).

Cable Burial Vessel

1.4.5.94 A dynamically positioned ship carrying post-lay burial equipment, this might include jet or mechanical trenchers or possibly mass flow excavators (MFE) equipment. This is typically supported by a Remotely Operated Vehicle (ROV) to monitor the cable during the protection work.

Guard vessel(s)

1.4.5.95 Guard vessels may be required to accompany the CLV, particularly in areas of high-density other users/shipping and potentially other specialist vessels required to install required cable protection systems (other than rock placement).

Support vessel(s)

1.4.5.96 These may include survey vessels, for pre- during- and post- installation surveys, anchor handler/offshore support vessels, dredgers etc. as required.

Rock placement vessel

1.4.5.97 A rock placement vessel features a large hopper to transport rock and a mechanism for deployment of the rock at the placement location where target burial depth cannot be achieved.

Cable lay barge (CLB)

1.4.5.98 A CLB may be required at landfall, in the event that vessel operation is required in water depths less than 10 m. A CLB may be anticipated to require a four to six-point anchor mooring system covering an area of between 500 m–1,000 m radius from the vessel to allow the barge to hold station whilst the installation work is undertaken.

1.4.5.99 Table 1.4.13 provides a summary of installation vessels.

Table 1.4.13: Summary of installation vessels

Vessel	Description
CLV (simultaneous cable lay and trenching)	Operational speed - 0.5 km to 5 km per day Transit speeds - 6 knots to 12 knots
CLV (cable lay without simultaneous trenching)	Operational speed – 2 km to 7 km per day Transit speeds - 6 knots to 12 knots
CLB/Jack-up Barges	Operational speed - stationery Transit speeds - 4 knots to 10 knots
Trenching Vessels	Operational speed - 0.5 km to 5 km per day Transit speeds - 6 knots to 12 knots
Guard Vessels	Operational speed – 0 km to 7 km per day Transit speeds - 4 knots to 10 knots
Support Vessels	Operational speed - up to 7 km per day Transit speeds - 6 knots to 12 knots
Rock Placement Vessels	Operational speed - 0.5 km to 3 km per day Transit speeds - 6 knots to 12 knots

Marine pre-installation activities

Pre-lay surveys

1.4.5.100 Multiple seabed surveys will be carried out prior to installation to reconfirm existing geotechnical and geophysical information about seabed conditions, bathymetry and other seabed features. The survey equipment may include Multi-Beam Echo Sounder (MBES); Side-Scan Sonar (SSS), Sub-Bottom Profiler (SBP), Magnetometer, cable trackers etc. In addition, visual inspections may also be undertaken using an ROV or other visual inspection system. Pre-lay surveys may also include additional specialist studies, including geotechnical, benthic, and unexploded ordnance (UXO) investigations.

Cable route clearance

1.4.5.101 Route preparation is expected to involve clearance activities to ensure the installation corridor is clear of boulders, dropped object debris and other obstacles. Removal of Out-Of-Service (OOS) cables may be required, along with boulder/debris clearance using either ploughs or ROVs and grabs.

1.4.5.102 Boulders identified and considered as an impediment to the construction during the pre-installation survey are removed by either a subsea grab or a displacement plough or a combination of both depending on site conditions. The grab is deployed from a stationary vessel, and it removes the boulders individually with the assistance of a ROV. The plough is towed by the vessel, and it displaces the boulders along the route as the vessel moves forward (see **Design Drawing S42_M/TDD/SS/1027**).

1.4.5.103 A pre-lay grapnel run (PLGR) is also expected to be completed, involving towing a heavy grapnel with a series of specially designed hooks along the centre line of the route, to confirm the installation route is clear of obstacles. Cable route clearance using the methods described here will seek to avoid areas of known sensitive habitats and/or features and will not be used near live third-party assets (see **Design Drawing S42_M/TDD/SS/1028**).

Pre-sweeping (if required)

1.4.5.104 Pre-sweeping may be required if areas of large sand waves are identified within the cable corridor, during the marine surveys, which cannot be avoided. Pre-sweeping may be performed using a variety of tools including dredgers, ploughs, MFE or controlled flow excavators (CFEs).

1.4.5.105 The amplitude of mobile bedforms need to be reduced to ease cable installation and to achieve an ideal burial depth (installation in the non-mobile section) for the lifetime of the system. The common practice involves the removal of the mobile layer sediments by Trailing Suction Hopper Dredging or Mass Flow Excavation. The Trailing Suction Hopper system involves lowering a dredging arm to the seabed with high pressure water pumps flushing water into the seabed and the resulting loosened sediments are suctioned up into the hopper of the vessel and later disposed of. In the Mass Flow Excavation technique, high volume of water is produced and directed downwards onto the seabed thus loosening and dispersing the mobile sediments (see **Design Drawing S42_M/TDD/SS/1029**).

Unexploded ordinance

1.4.5.106 A high-level desktop study risk assessment of UXO was undertaken in summer 2021 to inform the subsequent geophysical and geotechnical seabed survey undertaken in Autumn 2022. The UXO risk was assessed as High and Medium throughout the Offshore Scheme draft Order Limits. As part of the seabed survey, single source magnetic data was collected to provide an overview of the distribution of magnetic anomalies and to cross-check with the desk-based risk assessment, where areas of known high UXO densities have been identified.

1.4.5.107 A detailed UXO survey; including use of multiple gradiometers, ROV inspections combined with high resolution MBES, is planned to be carried out to better detect and define potential UXOs and to enable rerouting away from targets throughout the route. Micro-routeing around isolated targets will be undertaken, with a closest point of approach to the target, based on the eventual installation methodology.

1.4.5.108 Whilst avoidance will be the preferred approach, if UXO clearance is necessary, the activity will be undertaken in accordance with approved industry practices for removal and disposal/waste management of ordnance. This may include detonating UXO in place or lifting and relocating to a designated storage or demolition area, for safe disposal (see **Design Drawing S42_M/TDD/SS/1030)**

1.4.5.109 Table 1.4.14 provides a summary of pre-installation activities. All areas and lengths of the route for each pre installation activity are indicative and will be confirmed after additional surveys in 2023 and once the final route position list (RPL) has been established.

Table 1.4.14: Summary of pre-installation activities

Method	Description
Boulder Plough or Grab	Clearance Width – Swathe of up to 30 m–40 m per cable trench. Grab technique is site specific per boulder. Length – to be confirmed after final RPL.
Pre-lay Grapnel Run	Width- Swathe of 1 m–3 m per cable trench (to be confirmed after final RPL). Length - ~116.7 km.
Sandwave lowering (Sidecasting/CFE)	Width- Swathe of 30 m–40 m per cable trench (to be confirmed after final RPL). Length - ~7.3 km.
Sandwave lowering (Pre-sweeping)	Removal Width- Swathe of 20 m–25 m basal clearance per cable trench. Length - ~25 km. Deposit To be confirmed after 2023 additional marine surveys.
Sea trials	Width- Swathe of 20 m–40 m. Length – Minimum 1 km. Note: Sea Trials are not currently envisaged. If a sea trial is requested it is likely to be to test installation methodology in the London CLAY and ideally be undertaken for a minimum of 1000 m, with a more effective trial being over 1500 m–2000 m.
UXO Inspection	To be estimated after 2023 landfall UXO UAV survey and after additional marine surveys in 2023.
UXO Removal (Lift and Shift)	To be estimated after 2023 landfall UXO UAV survey and after additional marine surveys in 2023.
UXO Removal (Detonation)	Minimum clearance offset from cable route would be +/- 20 m from the cable lay route. To be estimated after 2023 landfall UXO UAV survey and after additional marine surveys in 2023.

Submarine cable installation

1.4.5.110 Cable installation operations will be performed on a 24 hour basis in order to minimise installation time and therefore the duration of any disruption to sensitive environmental receptors, as well as navigation and other sea users. 24 hour operations will also maximise available weather opportunities, as well as vessel and equipment availability.

Cable lay

1.4.5.111 The following cable laying methodologies may be used:

- Simultaneous cable lay and trenching/burial (SLB); and
- Surface cable lay followed by post lay trenching of cables/burial (PLB).

1.4.5.112 SLB is becoming more widespread as installation contractors design and build their own ploughs. It has the advantage of providing immediate protection to the cable but requires the CLV to be longer on site due to the slower speed compared to surface laying. This may become an issue in areas where weather patterns are unpredictable. It does however reduce the overall duration of lay and protection works (see **Design Drawing S42_M/TDD/SS/1032**).

1.4.5.113 PLB disconnects the lay and protection activities, enabling the CLV to lay quickly and then move onto other operations whilst a separate (and cheaper) spread undertakes the burial activities. This also has advantages in that a wider range of burial tools may be considered, depending on the nature of the seabed (see **Design Drawing S42_M/TDD/SS/1033**).

Cable jointing

1.4.5.114 Depending on vessel size, a CLV or CLB usually cannot carry the entire cable required for the submarine cable route length in a single load. Therefore, the cables tend to be installed in sections, with joints between the sections. It is, however, possible, given the length of the cable, that no field joints will be required during construction, but this will depend on the contractor, capacity of the lay vessels, lay vessel availability.

1.4.5.115 Wet storage of cable may be required if the contractor elects to have a first end pull-in at both landings. This would require a field joint at some point on the cable. The first section of cable would have a length wet-stored for subsequent recovery and jointing.

1.4.5.116 Field joints may be either ‘in-line’ or ‘omega’ (hairpin) types (see **Design Drawing S42_M/TDD/SS/1031**). In-line is used where a second length of cable is joined to the first and lay continues in the same direction. An omega type joint is where the two sections of cable have been laid in opposite directions and require a joint. A cable repair requires two joints and typically has one of each.

1.4.5.117 A single joint takes in the order of 5–7 days to complete. Where the cable is bundled, and depending upon the facilities on the CLV, then simultaneous operations may take place, meaning both cables can be done in a similar time. The time to protect the inline joint by trenching or jetting would be in the order of 8–12 hours.

1.4.5.118 A worst-case scenario for the Proposed Project assumes one inline joint located to avoid the shipping channels and high volume of marine traffic.

Cable trenching

1.4.5.119 The standard post lay burial methods are listed below, followed by an outline description. This is not an exhaustive list and more specialised techniques may be required, such as a barge mounted excavator in the nearshore areas.

Cable burial ploughs

1.4.5.120 Ploughs are large machines towed behind a vessel that create a trench into which the cable is laid . This trench is then normally left to backfill naturally but can sometimes be backfilled manually. Ploughs may be used for simultaneous lay and burial or for pre-lay trenching. Ploughs are best suited for relatively soft sediments.

There are two types of cable ploughs: displacement ploughs (creating an open trench for the cable) and non-displacement ploughs (lowering the cable into the sediment). Non-displacement ploughs are towed either by the CLV or an auxiliary vessel following the CLV.

Jet trenching

1.4.5.121 Jet trenchers use high pressure water jets to fluidise the seabed and bury the cable, they are most effective in soft sediments, non-cohesive and normally consolidated sediments.

1.4.5.122 Jet trenchers may be self-propelled ROVs or they may be towed sledges. Both use water jets to fluidise the seabed in front of, and around the cable, so that the cable sinks into the sediment under its own weight.

1.4.5.123 In medium to coarse sands and in gravels, the reconsolidation of fluidised sediments is significantly faster than in fine sands and silts. Jet trenching is a viable technique in a wide range of sediments, although performance decreased with:

- Increases in sediment shear strength and cohesiveness (e.g., contents of clay);
- Increases in organic content (peat); and
- Increases in particle size (e.g., gravels, cobbles).

1.4.5.124 Systems can achieve burial in excess of 2 m in soft clays and fine sands, while in medium to coarse sands, the burial depth achieved depends on the grain size of the sediment (i.e., on the re-sedimentation velocity). Any trench remaining after re-sedimentation is left to backfill naturally as a result of the natural movement of sediment on the seabed.

Mechanical trenching (rock wheel or chain cutters)

1.4.5.125 Mechanical trenchers are usually mounted on tracked vehicles and use chains or toothed wheels to cut a trench. They are effective in a range of sediments, including weathered softer bedrock and very soft sediment. However, they are less effective in certain types of rock (e.g., chalk with flints), large gravel, glacial till or boulder clays.

1.4.5.126 The mechanical trencher follows the cables that have been pre-laid on the seabed, collects them, keeping them clear of active trenching, before guiding the cables into the trench and backfilling sediment on top of the cable. The backfill material and suspended sediment stays in the direct area of the mechanical trencher and the backfilled trench. In some instances, they may be used to create a pre-lay trench into which the cable is laid.

MFE and CFE

1.4.5.127 MFE may be used for the excavation of the HDD exit pits, sandwave lowering, plough backfill and burial of joints, as well as to increase the depth of lowing (DOL) in sections with medium to coarse sands, where achieved trenching depths using other methods may not meet the minimum depth of lowering.

1.4.5.128 MFE uses low-pressure water to fluidise the seabed around the cable, allowing the cable to sink into the sediment under its own weight. The MFE is kept above the cable and thus mechanical impact on the cable is prevented. Additional cable length is required as the cable sinks and this is achieved via a horizontal ‘S-shape’ of the ‘as-laid’ position of the cable as well as in the vertical ‘S-shape’ of the seabed terrain.

In medium to coarse sand, MFE creates a depression with fluidised sediment as it moves over the cable. The majority of the fluidised sediment re-settles to the rear of the operation, thus backfilling the trench and covering cable. In fine sand and silt, MFE leaves behind an open trench with very little cover on the cable. Turbidity within the water column as a result of MFE in medium to coarse sand is comparable to that of jet trenching. Suspended sediment stays in the direct area of the operations and either re-settles into the created depression or in its direct vicinity. The seabed footprint of MFE may create a depression up to 10 m wide.

1.4.5.129 CFEs perform in a similar manner to that of MFE. Variable and more precise nozzles together with greater flow control allow a more precise operation than MFE.

1.4.5.130 Table 1.4.15 provides a summary of cable trenching activities. All lengths of the route for each trenching activity are indicative and will be confirmed after additional surveys in 2023 and once the final route has been established.

1.4.5.131 It is anticipated that the dominant protection method over the Offshore Scheme will be mechanical cutting using chain, in turn reducing the likelihood of extensive usage of cable ploughs.

Table 1.4.15: Summary of cable trenching activities

Method	Maximum equipment lateral footprint (m)	Indicative total footprint (m^2)	Indicative total footprint (km^2)
Displacement Plough	Width of disturbance per trench – 10 m–25 m. Length ~ 0.0 km.	-	-
Jet Plough/Jet Plough SLB	Width of disturbance per trench – 8 m–20 m. Length ~ 26.069 km.	521,380	0.521
Jet Trencher	Width of disturbance per trench – 6 m–12 m. Length ~ 6.275 km.	75,300	0.075
Mechanical Trencher (chain cutter)	Width of disturbance per trench – 5 m–15 m. Length ~ 58.92 km.	883,800	0.884

Method	Maximum equipment lateral footprint (m)	Indicative total footprint (m^2)	Indicative total footprint (km^2)
Mechanical trencher (Cutting Wheel – Bedrock)	Width of disturbance per trench – 5 m–15 m. Length ~ 15.00 km.	225,000	0.225
Mass Flow Excavator	Width of disturbance – up to 10 m. Length ~ 0.0 km.	-	-
Controlled Flow Excavator	Width of disturbance – up to 5 m. Length ~ To be confirmed after 2023 surveys.	To be confirmed after 2023 surveys.	To be confirmed after 2023 surveys.
Areas where multiple options can be deployed	Width of disturbance – up to 20 m. Length ~ 20.809 km.	416,180	0.416

1.4.5.132 The minimum DOL to the top of the cable is 0.5 m (in areas of bedrock), with a target DOL for the Proposed Project approximately 1.5 m–2.5 m, to be achieved where possible dependant on the seabed geology. The trench profile will be deep and narrow, to optimise protection by the trench walls and the in-situ soils characteristics. This is best achieved in cohesive clay soils, such as found along the majority of the route. Trench profiles from different installation equipment is presented in **Design Drawing S42_M/TDD/SS/1036.**

1.4.5.133 Where the sediments are sand-dominated and loose, the trench walls will slump and the trench profile will rapidly revert to virgin seabed level, or a wide depression will result, to be infilled by natural backfill.

External cable protection

1.4.5.134 Where burial cannot be achieved, external cable protection may be required where the soil or rock conditions are too hard to achieve effective burial, or third-party assets cross the route. Other locations may require additional protection to mitigate the effects of mobile sediments, such as at HDD exit points and to mitigate potential coastal erosion.

1.4.5.135 Options for external cable protection include:

- Rock Placement (planned berms) – installation of a pre-designed berm over the installed cables. Planned berms may comprise different grades of rock to provide a stable structure. Rock Placement (remedial berms) – installation of discontinuous single-grade rock berm in order to enhance the external protection due to insufficient achieved burial depth. Targeted placement will be undertaken using Fall Pipe ROV (FPROV) rock emplacement vessel, where water depths allow. Where water depths do not allow the use of an FPROV vessel, other methods may be used which are selected to minimise environmental disturbance, such as side dumping or open hopper dumping.
- Concrete Mattresses – frequently used to protect cables where external risks are lower, and as part of crossing constructions. The flexibility of the mattresses

allows them to follow the contours of the seabed or any exposed subsea asset. Several types of mattress are available for deployment in different environments, and appropriate types will be used for the local conditions.

- Rock/gravel/sand/grout bags – a range of pre-filled bags of different sediment grades, or grout, which can be used to provide local protection, or structural support, in areas where access is restricted for conventional protection systems.
- Protection Sleeves/Cast-Iron Shells – additional, flexible, protection systems for the cable, which are installed around the cable during installation and/or post installation. Protective sleeves usually comprise of polyurethane with steel banding.

1.4.5.136 Rock berms provide a strong protective cover to protect the cables from external threats, such as potential interactions with other marine activities including anchoring and fishing and ensures stability of the cables, by shielding the cable from the currents. The size of the berm and grade (size) of rock required will depend on the current and wave loading conditions at the location where rock placement is required, but it currently anticipated to be between 2.54 cm–12.7 cm (5.08 cm–20.32 cm in areas where hydrodynamics may determine coarser material required, or capping layer).

1.4.5.137 Where rock placement is required to protect an exposed or shallow buried cable, the height and width of these berms will be kept to a practical and safe minimum, typically a height of up to 1 m, with a width of up to 7 m for post-lay berms, and a height of 0.5 m, with a width of 4 m for pre-lay berms. The berms will be designed to reduce snagging risk in so far as is practicable, with 1:3 slopes and flat crests in line with industry guidance. Representative images of rock berms are shown in **Design Drawing S42_M/TDD/SS/1021, S42_M/TDD/SS/1022, S42_M/TDD/SS/1023, S42_M/TDD/SS/1024, S42_M/TDD/SS/1025, S42_M/TDD/SS/1034** and **S42_M/TDD/SS/1035**.

Up to approximately 13.207 km of planned rock berm and areas of potential remedial rock berm is anticipated to be required for the protection of the bundled cables.

1.4.5.138 Indicative rock placement locations along the Offshore Scheme draft Order Limits are presented in **Figure 1.4.22 Indicative Rock Placement.**

Cable and pipeline crossings

1.4.5.139 There are 10 in-service power and fibre optic crossings as summarised in Table 1.4.16 below.

Table 1.4.16: Summary of in-service crossings

Aspect	Description	Easting	Northing
Pan European Crossing (PEC)	Fibre optic cable	398569.3961	5690372.027
Tangerine	Fibre optic cable	397342.3731	5688764.014
Farland (North)	Fibre optic cable	408940.8781	5774914.392
BT North Sea Mercator	Fibre optic cable	399882.2104	5703766.93
Thanet Wind Farm Export Cable	Power cable	396994.6818	5687825.789

Aspect	Description	Easting	Northing
East Anglia One Export Cable	Power cable	408473.8399	5769937.727
BritNed	Power cable	399839.3704	5707086.475
NEMO (GB-Belgium Interconnector)	Power cable	393179.3566	5685122.909
East Anglia One Export Cable	Power cable	408461.4251	5769450.261
Thanet Wind Farm Export Cable	Power cable	396990.2423	5687882.089

1.4.5.140 In addition to the above in-service power and fibre optic cables, Table 1.4.17 below also lists the nine known developments also likely to cross the Offshore Scheme but at this stage, specific locations are unknown.

Table 1.4.17: Summary of future developments

Planned development	Description	Number of cables	Planned installation
East Anglia 3	HVAC	2	TBC
NeuConnect Interconnector	HVDC	2	2023 commences
Five Estuary Export Cables	HVAC	Up to 4	TBC
North Falls	HVAC	Up to 4	TBC
GridLink	HVDC	2	TBC
ExA Infrastructure	Fibre optic telecoms	1	TBC
Mercator	Fibre optic telecoms	1	2022/3
Kemsley (East Kent) – Zeebrugge (Belgium)	HVDC	TBC	TBC
East Anglia Connection Hub – Niederlangen, (Germany)	HVDC	TBC	TBC

1.4.5.141 The Offshore Scheme would enter into crossing agreements and/or proximity agreements with the third-party asset owners of any subsea infrastructure installed and/or planned along the corridor. Power, telecom and fibre optic cables will be crossed by the HVDC cables; these cables will be both In-Service (IS) and OOS. Crossings of IS cables will be undertaken using agreed crossing designs in accordance with the crossing agreements with the third-party owners and will ensure separation between the assets and protection over the installed HVDC cables. The separation and protection structures may comprise concrete mattresses, protective sleeves on the HVDC cables and/or pre- and post-lay rock placement. OOS cables may be cleared prior to installation of the cables, thus removing the need for a crossing structure.

1.4.5.142 Indicative diagrams of typical methods of asset crossings are presented in **Design Drawing S42_M/TDD/SS/1034 and S42_M/TDD/SS/1035.** It should be noted in these diagrams, that in some instances, mattresses can be replaced by pre-lay rock berms. Detailed conceptual crossing design schematics are presented in **Design Drawing S42_M/TDD/SS/1021, S42_M/TDD/SS/1022, S42_M/TDD/SS/1023, S42_M/TDD/SS/1024,** and **S42_M/TDD/SS/1025.**

1.4.5.143 No pipelines currently cross the Offshore Scheme. However, the same principal would be applied to any future pipelines that may cross the HVDC cables, where the pipeline owner will be responsible for crossing installation.

1.4.5.144 Table 1.4.18 provides an indicative summary of rock placement parameters. These estimates are based on a worst-case scenario of a 10 m wide pre-and post-lay rock berm being used and will be finalised once the final design has been established.

Table 1.4.18: Summary of rock placement parameters

Aspect	Description
Height, width and slope of rock berm (pre- and post-lay berms)	*1.5 m (H) x 1.0 m (top) 10 m (base) with 1:3 slope.
Grade of material	2.54 cm–12.7 cm (5.08 cm – 20.32 cm in areas where hydrodynamics may determine coarser material required, or capping layer).
Total length of rock berms (1 bundled cable solution)	13.207 km
Total area of rock berms	0.13207 km^2 (based on basal 10 m width).
Total volume of rock berms	65420 m^3 (**includes factor of failure).
Total Tonnage	146110 tonnes (**includes factor of failure).
Height, width and length of Mattresses	0.45 m x 3 m x 6 m One mattress = 18 m^2
Total number of mattresses	80 (assumes eight mattresses per cable crossing, and ten in-service crossings as per Cable Burial Risk Assessment (CBRA)).
Total length of mattresses	480 m (based on the ten current in-service crossings).
Total area of mattresses	1,440 m^2 (based on the ten current in-service crossings).
Total Number of Rock bags	To be confirmed (assumes ten per HDD exit, both landfall points).

* Assumes a worst-case scenario of both pre-and post-lay rock berms.

** The Factor of Failure considers a % chainage failure factor, even in areas of high confidence.

Post installation survey and reporting

1.4.5.145 Following the various phases of route preparation and cable installation, there will be an as-built survey of the route. This will be combined with the installation contractors' records to produce an as built report. The report will include all data relating to the protection status of the installed cables, between the TJBs at each landfall and the marine corridor: i.e. as-built drawings, engineering alignment sheets, imagery and video data, which together will provide a record of the safe installation of the cable. In effect this will be the baseline (reference) report for future OMR (Operations, Maintenance and Repair) activities, as well as input into the eventual decommissioning operations.

1.4.5.146 Central to the report will be the as-trenched and as-installed geophysical reports from the post-burial surveys, rock emplacement campaigns and as-built trenchless solution construction drawings at the landfalls. Together, the reports will provide DOL (depth the cable is found below the mean seabed level) and Depth of Cover (DOC) (depth of material above the buried cable – may be less than DOL) achieved immediately after installation, as well as the location of the cables.

1.4.5.147 Subsequent routine inspection surveys will be compared to the baseline report to assess any changes to the DOL and DOC of the cables and inform the engineering of any remediation or repair activities during the lifetime of the cables.

1.4.5.148 The 'as-built' RPL data will be supplied to relevant stakeholders, third-party asset owners and the United Kingdom Hydrographic Office (UKHO), for inclusion in the relevant Charts. Other national hydrographic agencies may also be supplied with the data, as per best practice.

1.4.6 Operation

Proposed Friston and Minster 400kV Substations

1.4.6.1 The substations will be continuously monitored remotely by National Grid, it is therefore anticipated that the substations would not be staffed. There would be regular monthly visits to inspect site.

1.4.6.2 External lighting would be installed on the perimeter and within the substations for safety and security purposes and to facilitate maintenance or repair works during the hours of darkness or low light, although the substation would not normally be lit. Additional temporary task lighting will also be used in any area in which maintenance or repair works are being undertaken.

Proposed Converter Stations

1.4.6.3 Following a period of commissioning and testing the proposed converter stations would operate continuously throughout the year.

1.4.6.4 The converter stations are likely to be operated by staff on site. It is anticipated that two staff will be on site or on call at all times.

Proposed Overhead HVAC Connection

1.4.6.5 During operation the overhead line would transmit electricity from the proposed Minster 400 kV substation onto the existing network in the South East of England.

Proposed Underground HVAC and HVDC Cables

1.4.6.6 During operation the HVDC link would transmit electricity from the proposed Friston Substation to the existing network in Kent and vice versa depending on the supply and demand at the time.

Proposed Marine Cable

1.4.6.7 During operation the HVDC link would transmit electricity from the proposed Friston Substation to the existing network in Kent and vice versa depending on the supply and demand at the time.

1.4.6.8 Post-installation, it is critical that developers ensure that contractors have installed cable systems as per the project specification. They must ensure that contractual obligations have been satisfied and this validation process also forms a major part of the technical due diligence.

- Electrical testing
- Depth of Burial (DOB) Assessment

1.4.6.9 A preliminary Inspection, Maintenance and Repair (IMR) inspection programme as the basis for preventive maintenance may comprise of the following:

- Base-line as-built DOB survey (ideally a continuous survey after installation and protection completed)
- Initial DOB Monitoring survey 12 months after commissioning and handover to operations (may also be linked to the duration of warranty of the cable after installation)
- Regular monitoring surveys at 12-24 months duration to establish any areas where DOB hot spots may develop and where integrity of cable is critical (eg. Shipping channels, crossings), and inform the maintenance programme.
- Establish that the seabed conditions and DOB have reverted to equilibrium and reduce the frequency of inspections
- Reduced interval surveys to ensure DOB is maintained (may be as much as 5-year interval)
- Potential near real-time DTS and Distributed Acoustic Sensing (DAS) HVDC cable monitoring during the life of the cables
- Automatic Identification System (AIS) monitoring of the marine and fishing traffic over the installed cable in case of accidental damage to cables by vessel anchors/towed equipment snagging on the cables.

1.4.6.10 Ideally the first monitoring survey should take place annually after the as-built survey until a trend is established (or no major changes observed) after which this interval may be relaxed to 2-5 years. It might be the case that only certain areas require more frequent assessment, but this can only be determined after several surveys have been undertaken to establish any trends.

1.4.7 Maintenance

Proposed Friston and Minster 400kV Substations

1.4.7.1 Maintenance visits would be carried out at least annually. Maintenance could include visual and physical inspections plus testing, repairing and replacing substation equipment as necessary. In the majority of cases inspection would require access to the substation using light goods vehicles (LGVs) and the delivery/removal of a Mobile Elevating Works Platform (MEWP). On the rare occasions where equipment needs to be replaced additional deliveries, vehicles and staff would be required including HGV movements.

1.4.7.2 External lighting would be installed on the perimeter and within the substations for safety and security purposes and to facilitate maintenance or repair works during the hours of darkness or low light, although the substation would not normally be lit. Additional temporary task lighting will also be used in any area in which maintenance or repair works are being undertaken

Proposed Converter Stations

1.4.7.3 There would be regular maintenance visits as part of an annual maintenance campaign. Maintenance could include visual and physical inspections plus testing, repairing and replacing equipment as necessary. In the majority of cases maintenance would require access to the converter station using LGVs and the delivery/removal of a MEWP. On the rare occasions where equipment needs to be replaced additional deliveries, vehicles and staff would be required including HGV movements.

1.4.7.4 External lighting would be installed on the perimeter and within the converter stations for safety and security purposes and to facilitate maintenance or repair works during the hours of darkness or low light, although the converter station would not normally be lit. Additional temporary task lighting will also be used in any area in which maintenance or repair works are being undertaken.

Proposed Overhead HVAC Connection

1.4.7.5 The overhead line would be subject to an annual inspection from the ground or by helicopter. The inspection would identify if there are any visible faults or signs of wear and would also indicate if changes in plant or tree growth or development had occurred that could risk infringing safety clearances. Inspections would provide input as to when refurbishment was required.

1.4.7.6 The overhead line could support telecommunication equipment such as small mobile telephone antennae and would contain optical fibres within the earthwire. If this were to be the case, independent companies would require access for maintenance purposes using pickup trucks and vans. Access for the optical fibres will usually be at the joint box positions located just above the anticlimbing devices on certain pylons. Position and frequency of joint boxes is subject to design by the successful contractor.

1.4.7.7 Access for vegetation management, telecommunications and fibre optic maintenance would be along routes agreed with the landowners and may require interlocking track mat panels.

1.4.7.8 The overhead line would be made up of a variety of materials, including concrete and steel for the foundations, steelwork for the pylon and aluminium for the conductors. All these materials have an expected lifespan, which would vary depending on how the overhead line was used and where it is located. Typically, pylon steelwork and foundations have a life expectancy of approximately 80 years, the conductors have a life expectancy of approximately 40 to 60 years and the insulators and fittings have a life expectancy of approximately 25 to 40 years. The lifespan of the overhead line may be longer than the anticipated 80 years, depending on its condition, the environment to which it is exposed, refurbishments and transmission network requirements.

1.4.7.9 Minor repairs or modifications may be required from time to time for local earthwire damage, addition of jumper weights, local conductor damage, broken insulator units, damaged or broken spacers, broken or damaged vibration dampers, damaged or broken anti climbing guards. Minor repairs would be programmed locally by a maintenance team using pickup trucks and vans to access site along routes agreed with landowners. Access may require interlocking track mat panels.

1.4.7.10 Refurbishment work would be undertaken typically on one side of the pylon at a time, so that the other side could be kept 'live' or in use.

1.4.7.11 Refurbishment work could involve:

- the replacement of conductors and earth wires;
- the replacement of insulators and steelwork that holds the
- conductors and insulators in place, insulator fittings and
- conductor fittings;
- painting or replacement of the pylon steelwork and
- replacement of telecommunication equipment (by separate companies).

1.4.7.12 During refurbishment there would be activity along the overhead line, especially at tension pylons when a new conductor is installed, and an old conductor taken down.

1.4.7.13 Vans would be used to carry workers in and out of the site and trucks would be used to bring new materials and equipment to site and remove old equipment. Temporary works including access tracks and scaffolding to protect roads may be required as for construction.

Proposed Underground HVAC and HVDC Cables

1.4.7.14 Maintenance activity along the proposed cable routes would generally be limited to non-intrusive inspections and cable repairs. The latter would only be required in the unlikely event of a cable fault. Where a fault does occur the location of the fault would be identified, and the faulty section of cable replaced. The activities involved in cable repair would be similar to those outlined above for installation albeit over a much smaller area and scale.

Proposed Marine Cable

1.4.7.15 Maintenance activity along the marine cable route would generally be limited to non-intrusive inspections and cable repairs.

1.4.7.16 Periodic surveys would be undertaken to assess the protection levels afforded the cable, particularly important in areas of mobile seabed. The survey results would be used to inform the necessity of any remedial works to maintain depth of cover to the cables. A schedule of surveys would be prepared to monitor the stability of the seabed after installation and identify any critical areas where the seabed does not stabilise, necessitating additional monitoring and a maintenance/mitigation plan.

1.4.7.17 Cable repairs may be required at any time, however good design and installation will mitigate this. A repair preparedness plan (RPP) may be prepared in association with any cable repairs which details the actions to be taken, from detecting a fault to re-commissioning. Stakeholder contact information would be included in this plan.

1.4.7.18 The activities involved in cable repair would be similar to those outlined above for installation albeit over a much smaller area and scale. In areas of mobile seabed periodic surveys may identify areas where the cable has become exposed or is in free span, in these areas remedial burial may be needed using similar techniques to those described above for installation, particularly jetting and rock placement, albeit over a much smaller section.

1.4.8 Decommissioning

Proposed Friston and Minster 400kV Substations

1.4.8.1 The lifespan of substation equipment is approximately 40 years. It is likely that during this period refurbishment and equipment replacement would extend the life of the substation rather than decommissioning. If the elements of the proposed Friston or Minster 400 kV Substation, that form part the Proposed Project were no longer required, the equipment would be safely disconnected from the transmission system and carefully dismantled. Much of the material would be taken for recycling. Similar methods and equipment would be required for dismantling as for construction.

Proposed Converter Stations

1.4.8.2 The anticipated operational life of the proposed Saxmundham and Minster Converter Stations is approximately 40 years. It is likely that during this period refurbishment and plant replacement would extend the life of the converter station rather than decommissioning. In the event that the Proposed Project ceases operation the proposed converter stations would be decommissioned in accordance with a decommissioning plan that is expected to include but not limited to as follows:

- Dismantling and removal of equipment;
- Removal of cabling from site;
- Removal of any building services equipment;
- Demolition of the buildings and removal of fences; and
- Landscaping and reinstatement of the site.

1.4.8.3 The main components would be dismantled and removed for recycling wherever possible. It will also be evaluated whether the buried cables systems could be used for another purpose. Where this is not possible disposal would be undertaken in accordance with the relevant waste disposal regulations at the time of decommissioning. It is anticipated that the permanent access road would be left in-situ whereas the above ground features would be removed to a sufficient depth to allow other practices/construction to occur unhindered.

Proposed Overhead HVAC Connection

1.4.8.4 If the Project is required to be decommissioned the section of overhead line between the proposed converter station site and the existing Richborough to Canterbury 400kV overhead line would be removed. Fittings such as dampers and spacers would be removed from the conductors. The conductors would be cut into manageable lengths or would be winched onto drums in a reverse process to that described for construction. the fittings would be removed from the pylons and lowered to the ground.

1.4.8.5 Each pylon would most likely be dismantled by crane, with sections cut and lowered to the ground for further dismantling and removal from site. Depending on the access and space available, it may be possible to cut the pylon legs and then pull the pylon to the ground using a tractor. The pylon could be cut into sections on the ground. Unless there was a compelling need for removal of all the foundations, these would be removed to approximately 1.5 m deep, sufficient for safe agricultural use of the land and subsoil and topsoil reinstated.

Proposed Underground HVAC and HVDC Cables

1.4.8.6 If the Project is required to be decommissioned, the proposed underground cables would be decommissioned. Dependent on specific requirements the redundant cables could either be left in-situ, or all or parts of the cable could be removed for recycling. Where this is not possible, removed cables would be disposed of in accordance with the relevant waste disposal regulations at the time of decommissioning.

Proposed Marine Cable

1.4.8.7 An initial decommissioning plan will be written once the final route and installation methodology is chosen. This will be in accordance with all applicable legislation and best practice guidance at the time of compilation, however as decommissioning of the cable will be many decades into the future, regulatory requirements and industry best practice will change. The decommissioning plan will be updated throughout the life of the project in preparation for decommissioning occurring.

1.4.8.8 In the event that the Proposed Project is required to be decommissioned the proposed marine HVDC cable could be decommissioned. Dependent on specific requirements the redundant cables could either be left in-situ, or all or parts of the cable could be removed for recycling. Where this is not possible removed cables would be disposed of in accordance with the relevant waste disposal regulations at the time of decommissioning.

1.4.8.9 Due consideration of the effects of removal of the cables to the benthic ecology and relevant protected areas, these should be incorporated into the assessment for the best method of cable removal, or the value of the decommissioned cables remaining in situ.

1.4.8.10 Operations to undertake decommissioning of the cable will be dependent on the burial depth of the cable and the mobility of the seabed, which may have significantly changed the design depth of lowering and the depth of sediment over the cable at the end of life. The techniques for decommissioning are often simpler than for installation prioritising minimising seabed disturbance over cable integrity.

1.4.8.11 In areas where the cable is shallow buried it may be possible to pull the cable out of the seabed without the use of other equipment. In slightly deeper areas, under running the cable to help free it from the seabed may be a possibility. These aforementioned techniques have a low environmental impact and are only suitable where the cable is not deeply buried. In areas of deeper burial, or mobile seabed, the use of jetting or MFE to release the cable from the seabed may be considered. It then becomes a matter of weighing up the environmental benefit of removing the cable against the damage caused by doing so.

1.4.8.12 Any active crossings, at the time of decommissioning, will normally be left in place. Similarly, where the cables are in close proximity to other in-service assets, removal of the decommissioned Proposed Project cables may not be possible until the other assets are decommissioned.

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