The Great Grid Upgrade

Eastern Green Link 5 (EGL 5)

Preliminary Environmental Information Report

Volume 1
Part 1
Chapter 4 Description of the Project

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nationalgrid

Contents

4. Description of the Project

4.1 Introduction

4.1.1 This chapter provides an overview of Eastern Green Link (EGL) 5 and presents a description of the main elements of the English Onshore Scheme and English Offshore Scheme (together referred to as 'the Project'), including details of design, construction, operation (and maintenance) and where known, decommissioning. It represents the current understanding of the key design parameters which have evolved in response to feedback received during pre-application consultation with stakeholders and non-statutory consultation, together with further ongoing environmental and design work. Following statutory consultation, a detailed description of the Project will be included in the Environmental Statement (ES) for which consent will be sought.

4.2 Eastern Green Link (EGL) 5

4.2.1 EGL 5 is a primarily offshore 2 Gigawatt (GW) High Voltage Direct Current (HVDC) electricity link, with associated onshore infrastructure, between Scotland and East Lindsey in England. EGL 5 comprises almost 600 kilometres (km) of subsea and underground HVDC cables between new converter stations at each end of the electricity transmission link, of which approximately 423 km of cable and one converter station is within the English EGL 5 Project. These in turn are connected to the existing National Electricity Transmission System (NETS) via High Voltage Alternating Current (HVAC) cables between the new converter stations and new substations.

4.2.2 The existing electricity transmission and distribution networks in England and Scotland both operate using predominantly HVAC. However, transmission projects such as EGL 5 use Direct Current (DC) technology because it is more efficient at transmitting large volumes of electricity over longer distances with lower losses than an equivalent Alternating Current (AC) system. A DC system also provides a greater degree of control over the magnitude and direction of flow. This flexibility brings operational benefits; however, to transmit electricity in DC form, specialist electrical equipment contained within converter stations at either end of EGL 5 is required to convert from AC to DC (or vice versa).

4.2.3 For the purposes of seeking the necessary consents EGL 5 has been split into different 'Schemes' i.e., Scottish Onshore Scheme, Scottish Offshore Scheme, English Offshore Scheme and English Onshore Scheme. These Schemes for EGL 5 are outlined in **Volume 1, Part 1, Chapter 1: Introduction**.

English Onshore Scheme

4.2.4 As outlined in **Part 1, Chapter 1: Introduction**, the English Onshore Scheme of EGL 5 extends from Mean Low Water Springs (MLWS) where the English Offshore Scheme makes landfall at Anderby Creek on the Lincolnshire coastline to the new EGL 5 converter station and proposed Lincolnshire Connection Substation (LCS) (B) - a new substation which is proposed in the Alford area, northeast of Bilsby as part of the Grimsby to Walpole Project. It is noted that the boundaries for the English Onshore Scheme and the English Offshore Scheme both overlap in the intertidal zone between MLWS and Mean High

Water Springs (MHWS). The English Onshore Scheme would comprise the construction of:

- A new converter station, in the vicinity of the proposed 400 kV LCS-B in East Lindsey;
- A Transition Joint Bay (TJB) connecting the offshore and onshore HVDC underground cables at the Anderby Creek Landfall;
- Up to approximately 8 km of new underground HVDC cable, from the landfall point at Anderby Creek to the EGL 5 converter station in the vicinity of the proposed 400 kV LCS-B in East Lindsey; and
- Up to approximately 1 km of new underground HVAC cable, between the EGL 5 converter station and the connection point at the proposed 400 kV LCS-B (the LCS-B substation is considered as part of the NGET Grimsby to Walpole Project).

4.2.5 To connect the Project into the NETS, a new 400 kV substation will be required i.e., the proposed 400 kV LCS-B. LCS-B is included as part of the Grimsby to Walpole Project and therefore will form part of its DCO and is not included as part of the EGL 5 Project.

English Offshore Scheme

4.2.6 As outlined in **Part 1, Chapter 1: Introduction**, the English Offshore Scheme of EGL 5 extends from MHWS where the English Offshore Scheme makes landfall at Anderby Creek on the Lincolnshire coastline to the border between English and Scottish adjacent waters. It is noted that the boundaries for the English Onshore Scheme and the English Offshore Scheme both overlap in the intertidal zone between MLWS and MHWS. The English Offshore Scheme would comprise the construction of up to 423 km of subsea HVDC cables from the Anderby Creek Landfall to the England – Scotland maritime border. The subsea cable system would consist of two bundled HVDC cables and a fibre optic cable (up to 140 km offshore) for control and monitoring purposes and associated external cable protection where burial of the subsea cable system in the seabed is not fully achieved i.e., due to ground conditions or the presence of existing infrastructure.

4.3 Design Parameters

4.3.1 The Project would be constructed within the draft Order Limits and such Limits of Deviation, or other parameters as may be specified for the individual works. All parameters will be confirmed in the ES and DCO application.

Draft Order Limits

4.3.2 **Volume 3, Part 1, Figures 1-2 to 1-4** illustrate the proposed draft Order Limits, which are presently the anticipated extent of land in which the construction and operation of the Project may take place. The draft Order Limits cover the area within which development could take place comprised of both temporary and permanent components of the Project. These include the proposed temporary access roads and easements for permanent access routes, widening works to existing highways, utility diversions, drainage and agricultural land drainage mitigation, construction compounds and laydown areas, a new converter station, the offshore and onshore HVDC cables and HVAC cables. The draft Order Limits also include for the expected proposed offshore construction and operations and include seabed preparation and maintenance works which would take place.

4.3.3 Areas of mitigation planting and reinstatement which will be identified as part of the Project design measures (and would typically include areas to mitigate potential landscape, visual and ecological effects) are still under development. Design measures in the form of mitigation areas for the English Onshore Scheme will be defined as further baseline data is collected and discussions take place with consultees and landowners. These areas will be developed and detailed in the ES and will include the planting proposals specific for each area and will include a range of native habitat types.

4.3.4 If approved, the DCO provides consent for the Project to take place within the Order Limits. The land within the draft Order Limits (and considered within this PEIR) is referred to as 'the Site' in some of the chapters in this PEIR. The extent of the draft Order Limits may be altered prior to the submission of the DCO application, based on detailed design matters and representations received during consultation. Final Order Limits will be presented within the DCO application and assessed within the ES.

Limits of Deviation

4.3.5 As recognised in guidance provided by Planning Inspectorate Advice Note Nine (Ref 4.1), a necessary and proportionate degree of flexibility often needs to be incorporated into the design of a proposed development so that unforeseen issues, that are encountered after a development has been consented, can be dealt with. For example, previously unidentified poor ground conditions may require proposed infrastructure to be re-sited slightly for geotechnical reasons. Therefore, to allow for this, works would be constructed within specified Limits of Deviation (LoD) which identify a maximum distance or measurement of variation within which the permanent works must be constructed.

4.3.6 At this stage of the design, the LoD has not yet been defined; however, flexibility has been retained within the draft Order Limits through the provision of several development zones. These include the following zones shown on **Volume 3, Part 1, Figures 4-1 to 4-3**:

- Indicative zone for construction compounds: identifies an area within which a temporary construction compound could be located. A preferred location within such area will be determined and reported in the ES.
- Indicative zone for underground cable assets: identifies the areas within which the permanent cable assets would be constructed, comprising the trench (or installation area) and the associated temporary working width which would be required for excavation of the cable trench. Note that further temporary works, e.g. access, drainage and compounds, will be required outside of this zone and within the draft Order Limits.
- Indicative zone for the new converter station: identifies the area within which the permanent converter station would be located.
- Indicative converter station siting zone: identifies the potential location of the converter station platform within the Indicative zone for the converter station.
- Indicative transition joint bay siting area: shows the indicative location proposed for siting of the Transition Joint Bay (TJB) connecting the offshore and onshore HVDC underground cables.
- Indicative zone for temporary construction works: identifies the areas within the draft Order Limits but outside of the Indicative zone for underground cable assets and Indicative zone for construction compounds required for other works including construction works, temporary drainage measures, diversionary works for utilities,

access and PRoW and areas for design measures such as landscape planting or ecological mitigation.

- Indicative zone for land drainage works: identifies additional areas, outside of the zone for temporary construction works, that are anticipated to be required for mitigation works to existing land drainage networks affected by the proposed cable installation.

4.3.7 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 excavation works would be unnecessarily restrictive. A standard below ground LoD is not therefore proposed. The Project would never go deeper than necessary for technical or environmental reasons as this would add engineering operational complexity and cost.

4.3.8 The LoD will be confirmed and reported in the ES, incorporating feedback and requirements from stakeholders.

Rochdale Envelope approach

4.3.9 At this stage of the Environmental Impact Assessment (EIA) and consenting process, the project description for the Project is indicative. It is often the case that, where consent is applied for and obtained before construction commences, there may be design elements that are unknown to an applicant at the time of application.

4.3.10 In such cases, a Rochdale Envelope approach may be used. The Rochdale Envelope approach defines a design envelope and parameters within which the final design would sit (Ref 4.1). It allows flexibility for elements that are likely to require more detailed design subsequent to submission of a PEIR or ES, such as the routeing and siting of infrastructure, foundation types and construction and installation methods. It also allows the findings of the consultation process and feedback from statutory and non-statutory stakeholders to be considered during the design process, where appropriate.

4.3.11 The adoption of this approach allows meaningful EIA to take place by defining a ‘maximum design scenario’ on which to base the identification of likely environmental effects. The maximum design scenario is the scenario that would give rise to the greatest impact (and subsequent effect), allowing for a realistic worst-case assessment to be undertaken. For example, where design options are under consideration, the assessment is based on the option predicted to have the largest magnitude of impact. This may be the option with the largest footprint, the greatest height or the largest area of disturbance during construction and installation, depending on the topic under consideration. By identifying the maximum design scenario, it can be concluded that the impact (and therefore the resulting effect) would be no greater for any other design scenario.

4.3.12 This approach is recognised in the Overarching National Policy Statement (NPS) for Energy (NPS EN-1) (Ref 4.2), the NPS for Renewable Energy Infrastructure (NPS EN-3) (Ref 4.3) and the NPS for Electricity Networks Infrastructure (NPS EN-5) (Ref 4.4).

4.3.13 This chapter describes the Rochdale Envelope for the Project, taking into account the policy set out in the NPSs and the advice in the Planning Inspectorate’s Advice Note Nine. The Rochdale Envelope described within this chapter has been designed to:

- Take into account site and route selection and design refinement work undertaken to date (see **Chapter 3: Reasonable Alternatives Considered**); and
- Include sufficient flexibility to accommodate future stages of design refinement.

4.3.14 It should be noted that the Rochdale Envelope presented in this chapter is generally considered to represent a realistic, reasonable worst-case design scenario and in most instances these design parameters form the basis of assessment for each of the aspect chapters presented in **Volume 1, Parts 2: English Onshore Scheme & 3: English Offshore Scheme** of this PEIR. However, there are instances where the reasonable worst-case scenario for a given design parameter might vary by environmental aspect, depending on how that particular parameter interacts with the receptor being considered. Therefore, each technical aspect chapter in **Volume 1, Parts 2: English Onshore Scheme & 3: English Offshore Scheme** of this PEIR sets out the assumptions made regarding the Rochdale Envelope specific to that particular environmental aspect. The methodology for assessment for the Projects is set out in more detail in **Chapter 5: PEIR Approach and Methodology**.

4.3.15 The design described within this chapter will continue to be refined, taking into account the findings of the ongoing EIA process and engagement with stakeholders. Refined design parameters will be presented in the ES and draft DCO that will accompany the application for development consent. The final design for the Project will be selected after development consent has been granted, from within the parameters set out in the project description chapter of the ES and the DCO application.

4.4 Development Proposals

English Onshore Scheme

4.4.1 As outlined in **Part 1, Chapter 1: Introduction**, the English Onshore Scheme would extend from MLWS where the English Offshore Scheme intends to make landfall at the Lincolnshire coastline before continuing to the proposed LCS-B Substation. It is noted that the boundaries for the English Onshore Scheme and the English Offshore Scheme would overlap in the intertidal zone between MLWS and MHWS. This area of overlap (i.e. the area from MLWS to MHWS) will be characterised and assessed within **Volume 1, Parts 2 and 3,** as necessary per topic chapter.

4.4.2 **Volume 3, Part 1, Figure 1-3** shows the extents of the English Onshore Scheme draft Order Limits, which is located within Lincolnshire. The English Onshore Scheme draft Order Limits extend into two local authority boundaries:

- East Lindsey District Council; and
- Lincolnshire County Council.

4.4.3 The temporary and permanent components of the English Onshore Scheme are illustrated in **Volume 3, Part 1, Figure 4-2**. The specific elements and planned works at each location of the English Onshore Scheme are described in the following sections. All dimensions in the sections below are approximate.

Converter Station

4.4.4 The converter station would house the main equipment indoors to facilitate the conversion of electricity between alternating current (AC) and direct current (DC), depending on direction of electricity transmission. The height of the converter station is determined by the size of the equipment required, the space required around the equipment, any permanently installed lifting equipment and any required roof structures.

4.4.5 The platform area for the converter station would be approximately 8.8 ha. It should be noted that this excludes related development including permanent access, peripheral landscaping, earthworks, drainage (i.e. attenuation basins) and other related works. The height of the platform above (or below) the existing ground level will vary according to existing ground levels, and will be designed to mitigate against flood risk.

4.4.6 The converter station would comprise the following main components within a secure fenced compound:

- DC Hall - the underground DC cables terminate here. The DC Hall would also contain indoor DC switchgear to connect to power electronics. This equipment would be enclosed in a building up to 30 m in height (not including aerials and lightning protection that may be required for safety).
- Valve Hall – contains high voltage power electronics equipment that would convert electricity from DC to AC and vice-versa. This equipment must be located indoors in buildings up to 30 m in height within a clean and controlled environment.
- Control Building – would contain control panels and associated operator stations, protection and communication equipment, offices and welfare facilities and other auxiliary systems all located within an enclosed building up to 15 m in height.
- Transformer bays – these change the AC voltage to an appropriate level for onward transmission via the AC system/or prior to conversion to DC. The transformers are normally sited outdoors and may be separated by concrete fire protection walls. Typical dimensions are 15 m long by 15 m wide by 16 m high. Cooling fans are also provided on transformers. Noise enclosures will be fitted around the transformers if required.
- AC Switchgear and filters (“switchyard”) – connects the converter station to the 400 kV AC transmission system. It includes a range of electrical equipment including harmonic filtration and reactive compensation equipment (if required), circuit breakers, transformers, busbars and insulators. The main function is to allow the effective integration of the DC system into the AC system. Commonly the AC switchyard and associated equipment is located outdoors although this equipment can be enclosed in a building or series of buildings to be determined through further detailed design, and will be confirmed within the ES.
- Diesel Backup Generator – the converter station requires its own power typically provided at 11 kV; up to two diesel back-up generators would be used to provide back-up electricity supply in the event of a failure of the low voltage electricity supply. Approximate dimensions are 15 m long, 3 m wide and 5 m high.
- Spares Building – a building to house spare parts and components; this would be supplemented by hardstanding areas provided for storage of a spare transformer and spare cable drums.

4.4.7 These components could be arranged differently, subject to the ongoing design process taking into account engineering, environmental and other requirements.

4.4.8 The converter station site would be within a fenced compound with restricted access. A palisade fence would be erected around the converter station site established at the start of construction and retained for operation. The site would also be monitored by CCTV and security gates would be in place for restricted/controlled access.

4.4.9 External lighting would be installed on the perimeter and within the converter station for safety and security purposes and to facilitate maintenance or repair works during the hours of darkness or low light. Additional temporary task lighting will also be used in any area in which maintenance or repair works are being undertaken. Internal amenity lighting would also be required for any necessary overnight works. All lighting would be designed in accordance with the appropriate design standards and would be designed to be environmentally sensitive. Further information regarding lighting design will be provided within the project description within the ES.

4.4.10 As described above, the converter station would require a new permanent access road, which would need to be suitable for operational works and would likely consist of a bituminous surface. The proposed permanent access route would exit the public highway from the A1111 Sutton Road, and traverse the north of the LCS-B substation, to provide access to the converter station. There may also be a need for an additional permanent access route for the replacement of the transformer unit which would be transported as an abnormal indivisible load (AIL). If the main access road is not suitable for this purpose, provision of another AIL permanent access route will be identified. This may involve having the permanent rights to build an access route to the converter site/s or installation of a new road (typically grasscrete or similar). Further definition of the access route and requirements will be provided as the design of the English Onshore Scheme progresses.

4.4.11 At this stage, the exact location and position of the converter station buildings (known as micro-siting) has not been determined, however, the indicative location for the converter station siting has been identified and is shown on **Volume 3, Part 1, Figure 4-1.**

4.4.12 The converter station would require a permanent access road, connecting to the A1111 Sutton Road. Where the permanent accesses connect to the public highway, a permanent bellmouth would also be required.

Plate 4-1 Indicative model for a converter station

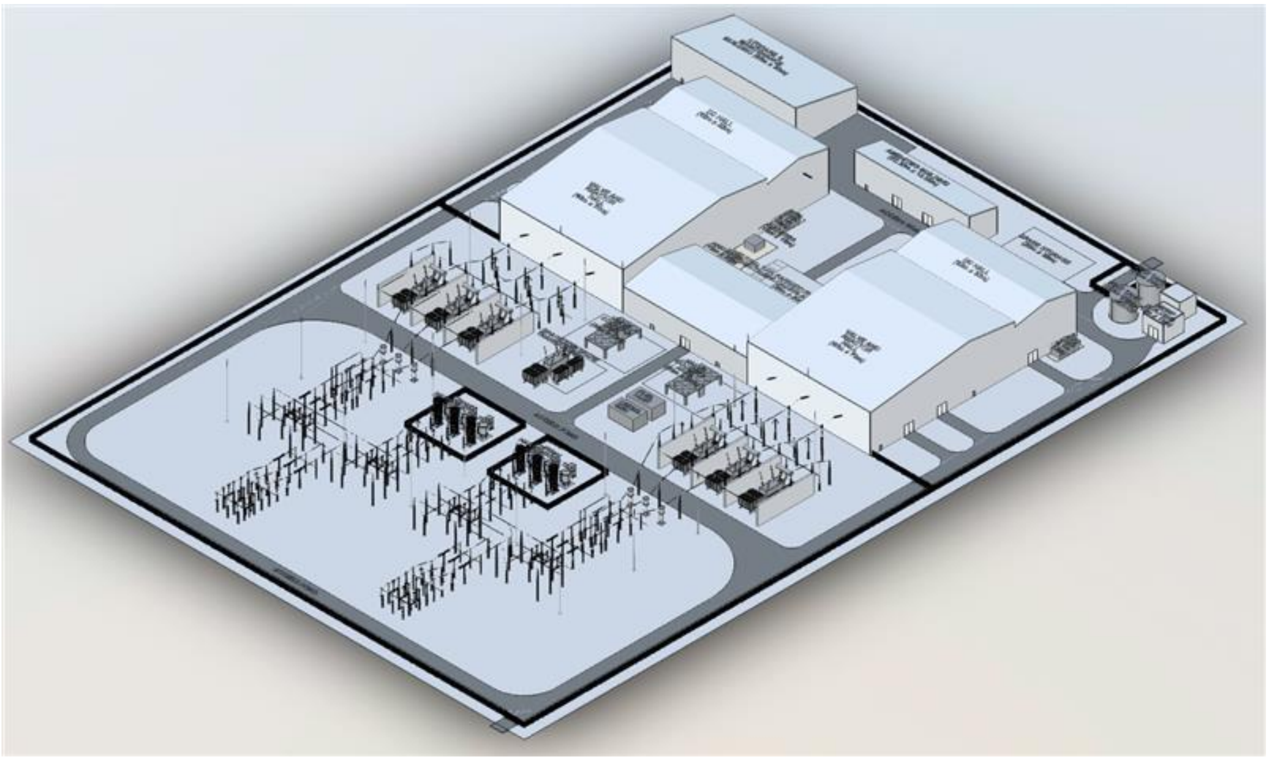


Table 4-1 Rochdale Envelope - Converter station

Parameter	Maximum design parameter
Indicative converter station platform footprint	8.8 ha. The footprint excludes any drainage (i.e. attenuation basins), permanent access roads or landscaping requirements
Converter station platform height	Preliminary calculations suggest a worst case range of up to 4.6 m to 7 m above sea level (above ordnance datum) across the platform, depending on existing variation. This is in addition to the converter station building heights.
Maximum height of structures	30 m (excluding lightning protection and aerials). Not including the platform height.
Height of lightning protection	To be established at detailed design, with a worst case to be presented at ES.

Underground HVDC Cables

4.4.13 The term Indicative Zone of Underground Cable Assets is used throughout this PEIR and refers to the areas within which the permanent cable assets would be constructed, comprising the trench (or installation area) and the associated temporary working width which would be required for excavation of the cable trench as described below. **Volume 3, Part 1, Figures 4-2 and 4-3** show the temporary and permanent elements and development zones of the English Onshore Scheme starting from Anderby Creek before continuing to the north west of Huttoft.

4.4.14 The exact configuration of the underground HVDC cables route would depend on a number of factors including the constraints (such as crossings of major rivers, roads and utilities) which are present, prevailing ground conditions, the length of each cable section, suitability of jointing positions and the number of bends and topography of the route.

Underground HVDC Cable Route Overview

4.4.15 At the landfall, where the English Onshore Scheme and English Offshore Scheme are expected to overlap, the DC cables would continue from the offshore to onshore environment. The English Onshore Schemes DC cables would begin at MLWS and extend across the intertidal zone (via a trenchless technique such as HDD) to connect into a buried TJB (where the subsea and onshore DC cables connect). From the TJB, the DC cables would route towards the new converter station.

Physical description of the DC Cables

4.4.16 The English Onshore Scheme would comprise two DC cables. Each DC cable is typically 15 cm in diameter and would be installed in plastic ducts; cable installation methods are outlined in detail in Section 4.5 below.

4.4.17 The type of underground cable proposed for this installation has not yet been determined. For example, the cable may comprise a single core copper conductor, insulated with cross linked polyethylene, shielded with a metallic screen and finished with a non-metallic outer sheath. Cable conductors are most often either aluminium or copper, depending on the electrical capacity required.

4.4.18 The English Onshore Scheme would require the construction of approximately 8 km of DC cables, connecting from the Anderby Creek Landfall to the proposed new converter station. The exact configuration of the DC cables is subject to detailed design following appointment of the Contractor; however, the general characteristics below have informed this PEIR, and a worst case will be assessed within the ES.

4.4.19 The DC cables would have a permanent easement. The exact width of the permanent easement is still to be determined; this would be established by the Contractor during the detailed design stage of the Project, however a worst case will be assessed within the ES.

4.4.20 The DC cables would be installed in sections, typically every 800 m to 1.5 km, although spacing would be subject to site conditions and the design. These sections would be connected at buried cable joint bays. The number, location and dimensions of cable joint bays required would be determined through consultation feedback, information from surveys and ongoing design studies.

4.4.21 There would be minimal permanent above ground infrastructure required along the new DC cables route. The exception to this is small marker posts and at least one link pit. Marker posts may be installed at field boundaries, crossings, and other locations as appropriate to highlight the presence of the DC cables to landowners, asset owners and those undertaking works within the vicinity. The link pit(s) would be required for monitoring the cables and would comprise a chamber lid on the surface. The link pit(s) may need to be fenced depending on land use.

4.4.22 The construction and cable installation methodology are detailed in Section 4.5 below.

4.4.23 A summary of the key characteristics of the underground DC cable route is outlined in **Table 4-2.**

Table 4-2 Rochdale Envelope - Underground DC Cables Route

Parameter	Maximum design parameter
Indicative Length of Route	Up to 8 km
Cable number	There would be up to one fibre optic cable on each DC cable for monitoring purposes.
Indicative cable dimensions	Each DC cable is approximately 15 cm in diameter. Each cable duct has an outer diameter of 250 mm.
Number of trenches	One trench
Number of cable joint bays	Required approximately every 800 m to 1.5 km
Permanent easement	The exact width of the permanent easement is still to be determined, this would be established by the Contractor during the detailed design stage, but a worst case will be presented within the DCO application and ES.

Parameter	Maximum design parameter
Permanent above ground infrastructure	Cable markers may be installed at field boundaries, crossings, and other locations as appropriate to highlight the presence of the DC cables to landowners, asset owners and those undertaking works within the vicinity.
Trench width at base	Approximately 1.4 m wide (subject to local ground conditions and obstacles).
Trench width at surface	Approximately 1.4 m wide (subject to local ground conditions and obstacles). The surface width of the trench would however be dependent on the Contractor's construction methodology. If the excavation is splayed (i.e. if the trench is battered (sloped) back) to reduce the risk of collapse, the surface width could extend to approximately 7.4 m, assuming a slope angle of 1:2.
Target depth of trench	The depth of the cables would vary, subject to the outcome of soil Agricultural Land Classification (ALC), agricultural land drainage, engineering and ground investigation surveys. The minimum depth coverage would be 900 mm to the cable protective tiles. Where justified, it may be laid deeper. The depth of installation would also be deeper at locations where trenchless methods e.g. HDD, are required.
Depth / thickness of specialised backfill	The cement bound sand (CBS) (or equivalent) would have an approximate depth of 600 mm; however, this is subject to further engineering studies, including the undertaking of a final cable system study. Above the CBS (or equivalent) would be a well compacted thermally suitable backfill (including the topsoil) to a minimum depth of approximately 900 mm from the ground surface level.
Working width (temporary)	Approximately 49 m where open-cut installation methods would be used. Working width includes provision for the cable trench, cable joint bays, temporary drainage, soil storage, materials and equipment laydown, and temporary haul road. For trenchless cable installation, the working width would be 60 m, assuming a 10 m separation between drills.
Number of haul roads	There would be one haul road which would typically be positioned adjacent to the cable trench. At certain locations, i.e. pinch points, or where physical constraints dictate, there may be a requirement for more than one haul road. Additional haul roads may also be required to access the working area.
Width of haul roads	7 m surface (excluding levelling material and widening at corners)

Underground HVAC Cables

4.4.24 The term Indicative Zone of Underground Cable Assets is used throughout this PEIR and refers to the areas within which the permanent cable assets would be constructed, comprising the trench (or installation area) and the associated temporary working width which would be required for cable installation as described below.

4.4.25 The underground HVAC cables would connect the converter station to the LCS-B Substation as shown on **Volume 3, Part 1, Figures 4-2 to 4-4**.

4.4.26 The exact configuration of the underground HVAC cable route would depend on several factors including the constraints which are present (such as crossings of major rivers, roads and utilities), prevailing ground conditions, the length of each cable section, suitability of jointing positions and the number of bends and topography of the route.

4.4.27 The following sections provide a high-level description of the design, construction and operation of the underground HVAC cables (described interchangeably as 'AC cables' in this PEIR).

Physical description of the Underground AC Cables

4.4.28 The English Onshore Scheme would require the construction of up to approximately 1 km of AC Cables, between the converter station and the LCS-B Substation. The exact configuration of the AC cables would be subject to detailed design following appointment of a Contractor; however, the general characteristics below have informed this PEIR, and a worst case will be assessed within the ES.

4.4.29 The connection from the proposed converter station to the LCS-B Substation would require two sets of three AC cables. These would be installed in two cable trenches. Each AC cable is typically 15 cm in diameter and would be installed in plastic ducts; cable installation methods are outlined in detail in Section 4.5 below. Each AC circuit would require both a distributed temperature sensing (DTS) cable for monitoring purposes, and a communications cable. The DTS cable and its carrier tube would be strapped to the middle of the three cable ducts in each trench. The communications cable would be installed in a separate duct, normally on one side of the trench.

4.4.30 The AC cables would have a permanent easement. The exact width of the permanent easement is still to be determined.

4.4.31 The AC cables would be installed in sections. Depending on the final length of the AC cables, these may either comprise a single cable section (with no intermediate joint bays) or three short cable sections with two intermediate joint bays. These sections would be connected at buried cable joint bays. The number, location and dimensions of cable joint bays required would be determined through consultation feedback, information from surveys and ongoing design studies.

4.4.32 There would be minimal above ground infrastructure required along the proposed AC cables route. The exception to this is at cable joint bays where link pillars and small marker posts would be required along the cable alignment. Link pillars would be required at buried cable joint bays (if used), where the AC cable sections would be joined. Link pillars are typically 0.5 m by 1.2 m and are at a height of 1.5 m and are typically enclosed within a timber fence, typically at a height of 1.4 m. Underground link boxes could also be used instead of link pillars at buried cable joint bays, however, from an operational perspective, these are less preferred and would typically only be considered at specific locations (e.g. roads). Marker posts may be installed at field boundaries, crossings, and other locations as appropriate to highlight the presence of the AC cables to landowners, asset owners and those undertaking works within the vicinity.

4.4.33 A summary of the key characteristics of the underground AC cable route are outlined in **Table 4-3**.

Table 4-3 Rochdale Envelope - Underground AC Cables Route

Parameter	Maximum design parameter
Indicative Length of Route	Up to 1 km
Cable number	Each trench would include a communications cable, installed in a separate duct, and a DTS (Distributed Temperature Sensing) cable, usually installed in a carrier tube that is strapped to the middle HVAC cable duct.
Indicative cable dimensions	Each AC cable is approximately 15 cm in diameter.
Number of trenches	Two trenches Each trench would contain three AC cables (subject to cable system design)
Number of cable joint bays	Dependant on the final length of the AC cables: these may either comprise a single cable section (with no intermediate joint bays) or three short cable sections with two intermediate joint bays.
Permanent easement	The exact width of the permanent easement is still to be determined, this would be established by the Contractor during the detailed design stage, and a worst case will be assessed within the ES.
Permanent above ground infrastructure	Cable markers may be installed at field boundaries, crossings, and other locations as appropriate to highlight the presence of the AC cables to landowners, asset owners and those undertaking works within the vicinity. Link pillars at buried cable joint bays which are typically 0.5 m by 1.2 m and are at a height of 1.3 m. Link pillars are typically enclosed within a timber fence typically at a height of 1.4 m.
Trench width at base	Approximately 2.85 m wide (subject to local ground conditions and obstacles).
Trench width at surface	Approximately 2.85 m wide (subject to local ground conditions and obstacles). The surface width of the trench would however be dependent on the Contractor's construction methodology. If the excavation is splayed (i.e. if the trench is battered (sloped) back) to eliminate the risk of collapse, the surface width could extend to approximately 9 m, assuming a slope angle of 1:2.

Parameter	Maximum design parameter
Target depth of trench	The depth of the cables would vary, subject to the outcome of soil ALC, agricultural land drainage, engineering and ground investigation surveys. The minimum depth coverage would be 900 mm to the cable protective tiles. Where justified, it may be laid deeper. The worst case assumed for the purposes of this PEIR, where no crossings of utilities or watercourses are required, is 1.8 m trench depth. Where crossings are required, greater depths may be required locally.
Depth / thickness of specialised backfill	The cement bound sand (CBS) (or equivalent) would have an approximate depth of 550 mm; however, this is subject to further engineering studies, including the undertaking of a final cable system study. Above the CBS (or equivalent) would be a well compacted thermally suitable backfill (including the topsoil) to a depth of approximately 900 mm from the ground surface level.
Working width (temporary)	Approximately 84 m where open-cut installation methods would be used. Working width includes provision for both cable trenches, cable joint bays, temporary drainage, soil storage, materials and equipment laydown, and temporary haul road.
Number of haul roads	Should the HVAC cable trenches be located next to each other, there would be one haul road which would typically be positioned in the centre of the two sets of trenches. If it is not possible to locate the HVAC cables alongside each other, then two separate haul roads may be required to facilitate the transport and delivery of materials to the site. Additional haul roads may be required to provide access to the HVAC cable alignments.
Width of haul roads excluding passing bays	7 m surface (excluding levelling material), increasing at bends to a maximum of 15 m to suit vehicle tracking.

Construction Traffic Routes

Highway Modifications and AIL delivery

4.4.34 At this preliminary stage in the project, EGL 5 is continuing to explore methods of transporting abnormal indivisible loads to the proposed converter station site. This includes the possibility of utilising a beach landing, in line with the Department for Transport Water Preferred Policy Guidelines (Ref 4.5) for the movement of AILs. This guidance sets out a “water-preferred” policy which encourages using water transport where it is practical, economically viable, and environmentally desirable. NGET will set out within the ES why waterborne transport is or is not appropriate for the Project in line with these considerations. At this time there is insufficient information available to inform a decision or assessment as to which transport method will be taken forward (by road/by port/by beach) for the Project, however, this process will continue alongside the evolving design development, with appropriate consultation and engagement with key stakeholders to inform the final decision and assessment as part of the environmental statement and DCO application.

4.4.35 Although further assessment and consultation is required to determine the route to site for AIL delivery during construction, the current assumed route to Site on the existing highway departs from the A16, and traverses south east via the A157, the B1373 and the A1104. A number of permanent modifications to the existing highway (one location on the A157, seven locations on the B1373, and three locations on the A1104) will be required to widen the highway along this route to enable the delivery. The current assumed construction routes to Site for AIL delivery and other construction traffic can be seen on **Figure 4-2**, and these will be confirmed within the ES.

Temporary Access from Public Highway

4.4.36 A temporary means of accessing the English Onshore Scheme from the public road network will be required during construction. Two options have been identified and are under consideration and further assessment at this stage, and are therefore both included within the draft Order Limits:

- The Alford Construction Route; and
- The Shared Grimsby to Walpole Haul Route.

4.4.37 It is proposed that one or other of the Alford Construction Route or Shared Grimsby to Walpole Haul Route will be used to access the English Onshore Scheme, once leaving the public highway.

4.4.38 The Alford Construction Route would consist of enabling works required to facilitate the construction and installation of the permanent assets of EGL 5. Its requirement was identified due to a potential constraint for AIL to reach the Anderby Creek Landfall and the potential converter station site. It would depart the A1104 Station Road south west of Alford, traversing north and east of Alford, crossing the A1104 East Street and A1111 Sutton Road before continuing to the north east of LCS-B substation. The Alford Construction Route would be temporarily required during construction and land would be reinstated on completion of construction.

4.4.39 The Shared Grimsby to Walpole Haul Route would consist of a temporary construction traffic route departing from the road network, using the same haul route proposed as part of the Grimsby to Walpole project to the LCS-B substation. The route would depart the public highway from the A1104 East Street, and continue south east, crossing over the A1111 Sutton Road and to the north of LCS-B substation. The Shared Grimsby to Walpole Haul Route would be temporarily required during construction and land would be reinstated on completion of construction (or retained where necessary for mitigation planting or permanent access). The Shared Grimsby to Walpole Haul Route would be installed by the Grimsby to Walpole project, and would therefore also be included in their DCO application. The assessment assumes the haul route will be already installed prior to construction of the English Onshore Scheme. The assessment includes the continued use of this route during construction of the English Onshore Scheme, and reinstatement (or retention) of the land on completion of construction. Assumptions for temporary and permanent land requirements will be confirmed within the ES, following confirmation of the Order Limits for the Grimsby to Walpole project.

4.4.40 The parameters for these haul roads are as presented within **Table 4-3.** Further details on the dimensions of bellmouths will be confirmed within the ES and DCO application.

Anderby Creek Landfall

4.4.41 The landfall is the interface between the English Onshore Scheme and the English Offshore Scheme and would be located at Anderby Creek, East Lindsey, Lincolnshire.

4.4.42 This is the location where subsea cables (which are commonly of a greater diameter compared to the onshore cables due to increased protection), would connect to the onshore underground cables at a buried transition joint bay (TJB) located above MHWS illustrated on **Volume 3, Part 1, Figure 4-3**. More specifically, the landfall is considered to extend from the trenchless solution exit point below MLWS (where it overlaps with the English Offshore Scheme components) beneath the intertidal zone to terminate at a buried TJB located a short distance inland. A TJB is a permanent underground chamber constructed of reinforced concrete that houses the cable joints and a fibre chamber/link pit. It is currently anticipated that a single TJB would be required for the Project with a maximum footprint of 15 m by 4 m (60 m^2), and a raised platform area of up to 50 m by 50 m plus slopes on surrounding sides..

4.4.43 No permanent above ground infrastructure would be required for the TJBs; however, there may be a requirement to permanently raise the platform for the TJBs. The height of the platform is not yet known; this will be confirmed by the Contractor, and a worst case assessed within the ES. There will also be an access manhole present at the ground level marking the cable connection point. Once installation has been completed, the land would be reinstated to pre-existing conditions (but at a higher elevation due to the raised platform) if required; the only infrastructure visible on the surface (on otherwise fully reinstated land) would be the cover of the link box pit and marker posts. Fencing surrounding the link box pit may be required depending on land use.

4.4.44 The landfall would be constructed using a trenchless technique and in this location only for the purposes of this PEIR, an open cut technique will be ruled out. Two bores will be drilled and then ducted. Each cable duct would be installed from the TJB to a point below 3 m lowest astronomical tide (LAT). Within each cable duct a HVDC power cable would be pulled through to make the transition from the subsea environment to the TJB. A fibre optic cable (for control and monitoring purposes) would be installed with one of the power cables. The exact exit points for the trenchless technique and the cable ducts would depend on further technical studies and design. The trenchless technique would ‘punch out’ (exit the seabed) between the 3 m and 6 m LAT water depth contours.

4.4.45 It is proposed that although only two cable ducts are required for the Project at the Anderby Creek Landfall, allowance will be included within the ES and DCO application for an additional trenchless technique bore, should one fail during construction.

4.4.46 It should be noted that EGL 3 and EGL 4 will also be making landfall at Anderby Creek, in the vicinity of EGL 5. Co-ordination between the projects is ongoing and further details of the interactions at the Anderby Creek Landfall between the projects will be confirmed within the ES. Cumulative effects that arise as a result of the projects will be assessed within the Cumulative Effects chapter of the ES for the Project.

4.4.47 A summary of the key characteristics of the landfall is outlined in **Table 4-4.**

Table 4-4 Rochdale Envelope - Anderby Creek Landfall and transition joint bay

Parameter	Maximum design parameter
Transition Joint Bays	
Number of TJBs	It is currently anticipated that one single TJB would be required for the English Onshore Scheme. This would be confirmed within the ES.
Maximum permanent area of above ground transition joint bay covers (m^2)	TJB is typically buried in a concrete chamber with no above ground infrastructure; however, there may be a requirement to permanently raise the platform for the TJB. There will also be an access manhole present at the ground level marking the cable connection point. TJB dimensions are approximately 15 m by 4 m (60 m^2). It is to be noted that this area would increase if a raised TJB platform is required.
Permanent raised platform area	50 m x 50 m plus slopes on surrounding sides.
Landfall	
	Potential trenchless construction techniques include Horizontal Directional Drilling (HDD), microtunnelling and using a direct pipe. These are techniques commonly used to install cable duct(s) underneath sensitive environmental features (such as sea defences, dune system, etc) or technical constraints (cliffs, shallow bedrock etc.). It is expected that up to two permanent cable ducts would be installed at the landfall.
Number of cable ducts	Two permanent ducts would be installed between the onshore TJB and the offshore exit location. Assessment of three trenchless technique drill attempts, in the instance that one fails during construction.
Indicative length of ducts (m)	It is currently assumed that the length of each duct would likely extend from a compound location above MHWS to a punch-out point below MLWS, indicatively between 650 m to 1600 m from the TJB.
Number of exit pits (below MHWS)	Two
Volume of excavated material per exit pit (below MHWS)	1,875 m^3

English Offshore Scheme

Subsea cables

4.4.48 The English Offshore Scheme would comprise two HVDC cables and up to 140 km of fibre optic cable for control and monitoring purposes. The cable system would be buried with the exception of infrastructure crossing points and areas where sufficient depth of burial cannot be achieved where external cable protection would be used.

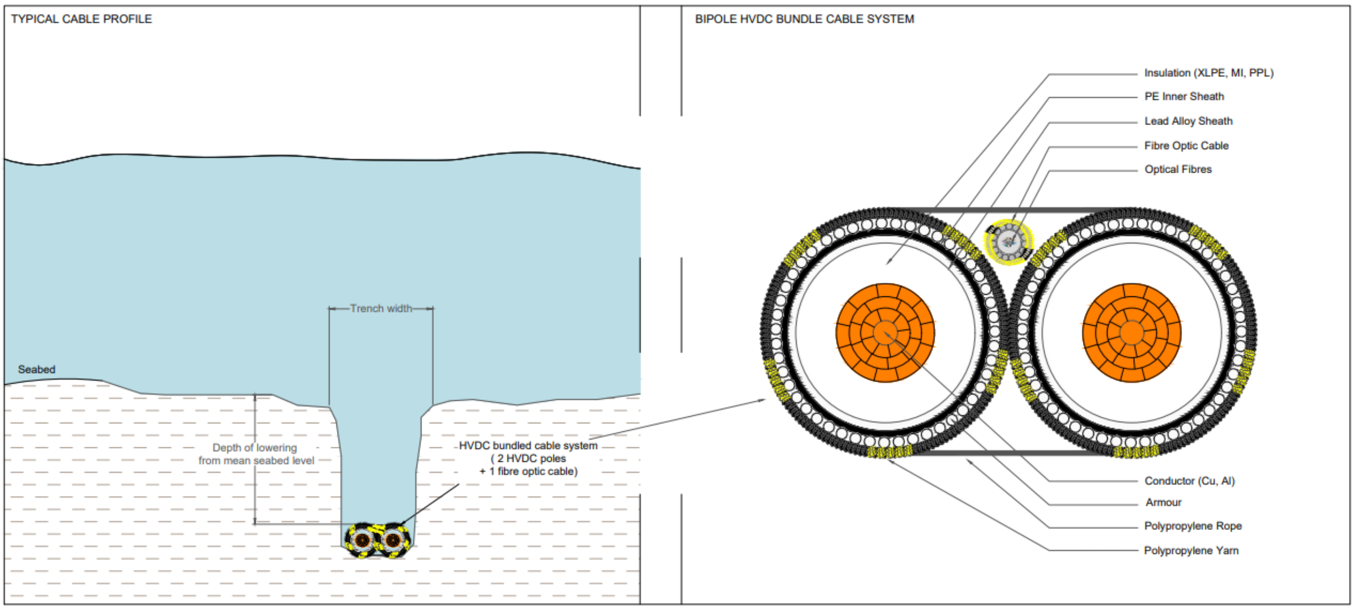
4.4.49 The draft Order Limits encompass the English Offshore Scheme as shown in **Volume 3, Part 1, Figure 1-3**.

Cable configuration

4.4.50 The HVDC cables would comprise two single core metallic conductors (one positive, one negative). The cables would be installed as a single bundle of two conductors with a single fibre optic cable laid in a single trench. The configuration is shown in **Plate 4-2**. As the cables approach the landfall, they would be unbundled and each core passed through its own duct. Two ducts in total would be installed at the landfall. The fibre optic cable would be installed with one of the HVDC cables in one of the two ducts.

4.4.51 The cable system will be installed in a minimum of four sections (offshore campaigns), with each section connected by a joint. However, there could be up to eight in-field joints.

Plate 4-2 Offshore illustrative drawing of HVDC Bundled Cable System Profile / Configuration



HVDC cable design

4.4.52 The cables would likely be cross linked polyethylene (XLPE). As illustrated in **Plate 4-2**, the cables would have a central core (comprising of aluminium or copper), protected by insulation and a lead sheath. Heavy steel wire is wound in a helical form around the cable as armour to protect the cable from external damage during construction and operation.

4.4.53 The cables would have a nominal voltage of 525 kV and typically have an outer diameter of 175 mm. The cables would be non-draining, containing no free liquid or gases that could be released into the marine environment even in the event of severe mechanical damage to the cables.

Fibre optic cable design

4.4.54 One fibre optic cable would be required and would not run through the entire length of the cables offshore, typically up to the first joint offshore from the landfall (approximately 140 km offshore). The cable would comprise a core of optical fibres, armoured with layers of steel wires, and sheathed with either a polypropylene or polyethylene material for outer protection. The outer diameter of the fibre optic cable would be expected to be between 20 mm and 30 mm.

4.4.55 The fibre optic cable would not include any repeaters and would not have an electrical current running through it.

Summary of the offshore draft Order Limits and cable parameters

4.4.56 Key aspects of the proposed English Offshore Scheme and parameters are summarised below in **Table 4-5.**

Table 4-5 Rochdale Envelope - Cable Corridor and Cable Configuration

Aspect	Parameter	Maximum Design Parameter
Offshore draft Order Limits	Minimum Width in English Waters	1 km
	Maximum Width in English Waters	1.5 km
	Maximum Length in English Waters	423 km
HVDC Cables	Configuration	Bi-pole One cable per pole
	Number	2
	Maximum Number of Joints	8
	Outer Diameter	175 mm
Fibre Optic Cable	Number	1
	Joints	1
	Outer Diameter	20 – 30 mm
Cable Trench	Number	2 (from trenchless technique exit pit before being bundled into 1 trench for majority of route)
	Maximum Depth of Burial	3.5 m (1.5 m average)
	Maximum Width of Trench	1.5 m
	Maximum Width of Disturbed Area (From footprint of burial equipment)	25 m

4.5 Construction

Construction Programme

English Onshore Scheme

4.5.1 Subject to gaining development consent in 2028, it is anticipated that access and enabling works would commence in 2029 once pre-commencement DCO requirements are discharged, including site clearance activities, the installation of construction compounds and access roads. It is expected the main construction and works would continue through to 2035 (approximately 6 years).

4.5.2 Reinstatement, comprising removal of construction haul roads, construction compounds, reinstatement of subsoil and topsoil and replacement of planting, would be required following construction. However, for specific components of the Project and at specific locations along the cable route, reinstatement would overlap with the wider construction programme. It is currently envisaged that some reinstatement of temporary trackways could commence in 2031 once trenchless crossings had been installed. Reinstatement of land around the TJBs could also commence in 2031. Reinstatements works would be expected to continue through to 2035. Based on the currently available design information, the earliest in service date when EGL 5 would be operational is Q1 2035.

4.5.3 The construction programme would be developed as the Project progress and would take account of seasonal constraints such as protected species breeding or hibernation seasons.

4.5.4 The exact phasing of some activities would depend on the Contractor and detailed design, but the main construction activities for the English Onshore Scheme would typically include:

- Preliminary works, including diversion of electricity distribution network overhead lines;
- Access road construction;
- Site establishment;
- Earthworks;
- Civil engineering works;
- Building works (converter station only);
- Cable installation;
- Provision / installation of permanent services (converter station only);
- Mechanical and electrical works;
- Testing and commissioning; and
- Site reinstatement and landscape works.

4.5.5 The current indicative construction programme for the English Onshore Scheme is provided in **Plate 4-3.** Further details on the phasing of the Project will be set out within the ES.

English Offshore Scheme

4.5.6 The construction programme for the English Offshore Scheme is expected to commence in 2030. It is anticipated that construction would take approximately 5 years with the English Offshore Scheme becoming operational in 2035.

4.5.7 Works at the Landfall may commence in 2031 with installation of the ducts ahead of the main construction works.

4.5.8 The construction programme would be developed as the Project progresses and would take account of environmental conditions (e.g., weather, tides, currents), operational downtime, variable lead times for vessels and equipment, supply chain bottlenecks as well as implementation of any required mitigation measures for environmental sensitivities or sensitive receptors.

4.5.9 Preparation activities that would be required for the cable installation are listed below, along with indicative durations. Cable route preparation may be undertaken in one single campaign along the entire length of the cable within the English Offshore Scheme, or may be split and undertaken separately. For the purposes of assessment, it has been assumed that the English Offshore Scheme will involve up to eight cable lay and burial campaigns. The final number of cable lay and burial campaigns and the exact phasing of some activities would depend on the Contractor and detailed design, but the main construction activities, along with indicative durations for the English Offshore Scheme would include:

- Pre-installation surveys – 10 months.
- Cable route / seabed preparation: 12 months – 14 months.
- Cable lay and burial: 20 months.
- Remedial external cable protection: 8 months.
- Post lay survey: 1 month – 2 months.

4.5.10 Due to the length of the English Offshore Scheme, activities will occur at the same time with different works taking place in different areas (for example, seabed preparation in one area and cable lay and burial in another).

4.5.11 The current indicative construction programme for the English Offshore Scheme is provided in **Plate 4-3.** Further details on the phasing of the Project will be set out within the ES.

Plate 4-3 Summary of indicative construction programme

Year	2029	2030	2031	2032	2033	2034	2035
English Onshore Scheme							
Converter Station							
Access and enabling works	■	■					
Construction		■	■	■	■		
Underground Cables							
Access and enabling works	■	■	■				
Construction	■	■	■	■	■		
Testing and commissioning							
Final testing and commissioning					■	■	
Earliest in service date							
EGL 5 would be in service (operational)						■	■
Reinstatement works			■	■	■	■	■
English Offshore Scheme							
Anderby Creek Landfall							
Trenchless technique and duct installation			■				
Seabed preparation							
Pre-lay survey		■					
UXO target investigation		■	■				
Pre-lay grapnel run		■	■				
Boulder clearance		■	■				
Crossing of third-party infrastructure preparation		■	■				
Sandwave clearance		■	■				
Cable burial trial trenching (TBC)							
Offshore Construction							
Cable pull-in, cable lay and burial and crossings			■	■	■	■	
Jointing				■	■	■	
Remedial – external cable protection				■	■	■	■
Post-lay survey				■	■	■	■
Post-burial survey							■

Construction workforce

4.5.12 It is anticipated that the peak workforce for the English Onshore Scheme would be up to 500 workers. The peak workforce for the English Offshore Scheme workforce will be confirmed within the ES.

Construction working hours

English Onshore Scheme

4.5.13 The proposed construction working hours for the English Onshore Scheme would be:

- Monday – Friday: 07:00 – 19:00; and
- Saturdays, Sundays and Bank Holidays: 08:00 – 17:00.

4.5.14 Exceptions to the above include but are 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. 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 converter station;
- Delivery 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, or property, or an obstruction to the delivery of electricity; and
- Survey works.

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

English Offshore Scheme

4.5.16 The English Offshore Scheme, including the trenchless technique at the Anderby Creek Landfall would be a 24-hour operation to minimise overall installation time, maximise the use of suitable weather and current windows and take advantage of vessel and equipment availability.

English Onshore Scheme Enabling Works

4.5.17 The following construction methods relate to temporary components of the installation process which would be required to facilitate the construction and installation of the permanent assets. Termed ‘enabling works’, these would be removed upon completion of construction and commissioning of the system. The activities outlined below apply to all of the permanent assets, i.e. the landfall, underground cables and the converter station. Where enabling works are specific to the landfall, these are outlined within the relevant sub-section under English Onshore Scheme Construction Activities below.

Haul Road

4.5.18 Primary access to the construction sites (including the cable working width) would be from the existing road network. New, purpose-built temporary bellmouths are typically required to support safe site access, due to the size and number of the construction vehicles. These bellmouths would connect to temporary new access tracks (including culverts and bridges) which would be connected to the haul roads that are located adjacent to the construction areas. Further details on access from the public highway during construction are outlined in Paragraph 4.4.42 to 4.4.45.

4.5.19 Construction haul roads are required to facilitate access and construction of the cable route, given the nature of works required and plant to be used. There are a number of different options available including temporary track way, stone roads and soil stabilisation. The Contractor would choose which option is preferred based on which solution is most suited for the particular works being undertaken. Track way is often more efficient where limited access is required, whereas stone roads or soil stabilisation typically provide a more effective solution for heavily trafficked areas.

4.5.20 Track way consists of metal or plastic panels that interlink and or overlap to create a running surface, they are quick to install and remove but are expensive and can suffer from settlement if trafficked over a longer period or with very heavy vehicles.

4.5.21 Stone haul roads would be constructed of an unbound stone material bedded on a separation membrane and often including a polymer-based geogrid reinforcement. The separation membrane would serve to minimise ingress into the underlying ground (subgrade) and to aid removal upon completion of the works. The reinforcement layer would provide additional mechanical stability, significantly reducing the overall road (pavement) thickness and the associated volume of imported material required. These are overlain by a layer of stone, placed, and compacted in layers, up to the required thickness and/or finished surface level. Two layers of different stone types may be used if the design dictates (capping and subbase design).

4.5.22 Soil stabilisation may be used to give a similar performance to a stone road, by chemically strengthening the existing soils. The chemical admixtures are site specific and depend on the chemical composition of the existing ground. Following topsoil removal, the subsoil is mixed with the chemical admixtures and compacted to create the haul road. Soil stabilisation can be combined with a stone layer or be used in isolation, depending on the traffic requirements and ground conditions. Soil that has been chemically stabilised is returned to its former use by the addition of further admixtures subject to the specific properties of the soil in each location where soil stabilisation is used.

4.5.23 In most scenarios, the topsoil is first stripped from the working width, exposing the underlying ground (subgrade), and is stored adjacent to the works. The exposed ground is then excavated to the required formation level and tested for strength. Where soft grounds are encountered, further excavation would be undertaken until a stable subgrade is reached.

4.5.24 The ultimate thickness of the haul road is determined by the subgrade strength, vehicle type and vehicle numbers. A soft subgrade would dictate a thicker construction than a stronger subgrade. The haul road working width is envisaged to be 7 m, to allow for passing vehicles and topography, although this may extend in limited areas to provide turning for Heavy Goods Vehicles (HGVs) and construction plant.

4.5.25 The haul road may be installed above existing ground level to aid drainage, however subject to the Flood Risk Assessment (FRA) to mitigate against potential flooding, perpendicular cross drains may be installed beneath the haul road to allow water to flow across the road. Alternatively, the road could be installed at or near grade to prevent it acting as a barrier to surface water runoff.

4.5.26 To prevent overland greenfield flows from crossing the haul road, header drains would be installed along the working width to intercept clean surface water runoff and prevent the haul road from becoming silty. The header drains would run parallel to the haul roads and discharge into the nearest watercourse or dispersion point along the route with intermittent check dams and other appropriate measures to control the quality and flow rate of the runoff.

4.5.27 It is likely that filter drains or swales would be used alongside the haul road. They collect runoff from the haul road and discharge into various ponds. The design would include pollution control measures such as check dams, and the Contractor would implement suitable mitigation measures to manage the risk along the route. Ponds are sized to suit appropriate rainfall levels and discharge rates in agreement with the relevant drainage/flooding authorities.

4.5.28 Following construction the access tracks and working areas along the cable route would be removed and the ground reinstated by removing stone and trackways. All topsoil stripped within the construction areas would be retained and used during reinstatement. Where suitable, sub soil would be retained and used to backfill the trenches. It is recognised that there may be excess sub soil following reinstatement. Any excess sub soil would either be retained for use on site, such as for landscaping or removed from site. Other surfaces would be reinstated and widened accesses would be restored to the condition they were in at the commencement of the works.

4.5.29 An Outline Code of Construction Practice (Outline CoCP) and an Outline Construction Traffic Management Plan (Outline CTMP) will be developed for the English Onshore Scheme for DCO submission which will outline the modes of transport proposed for the delivery of construction materials, plant, the construction workforce and the removal of waste materials. The aim of the Outline CTMP will be to reduce and manage HGV and road traffic movements generated by the English Onshore Scheme where practical and possible. An Outline Public Rights of Way management plan (Outline PRoWMP) will also be developed for DCO submission, setting out any temporary and permanent diversions of PRoW.

Bellmouth junctions

4.5.30 Sizing of the bellmouths would be in accordance with the relevant design guidance (Design Manual for Roads and Bridges (DMRB)) and the vehicles required to access/egress the Site. Visibility requirements would dictate where the bellmouths can be positioned. 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 would need to be maintained throughout the duration of construction.

4.5.31 Normally, traffic management measures and/or a reduced speed limit would be required to safely manage the interaction between works traffic and the public highway at bellmouths, particularly where visibility may be limited. It is sometimes necessary to alter or upgrade elements of the public highway for similar reasons.

4.5.32 Following top-soil stripping, the subbase would be compacted in layers prior to the running surface being laid. To provide better longevity from turning vehicles, particularly articulated HGVs, the finished surface would normally be constructed of a bituminous material or concrete. Existing pavement material may be removed at the interface between the existing highway in order to join the two constructions and prevent degradation during use. Road signs, site demarcation and linework would be installed in accordance with the relevant highway design to provide a safe environment for road users and construction traffic. Finally, fencing is erected surrounding the site and gates installed, usually setback approximately 15 – 20 m from the highway to allow vehicles to stop clear of passing traffic.

4.5.33 Subject to ground conditions, runoff from bellmouths would typically be attenuated via attenuation basins at the adjoining section of the haul road with a controlled discharge to the nearest watercourse or drainage ditch. Attenuation may take the form of linear ditches with check dams.

Temporary Culverts

4.5.34 Temporary culverts would be required where the construction haul road crosses existing watercourses, i.e., ditches, field drains, dykes and small rivers. Culverts would be in place for the duration of the works and removed upon completion, and watercourses will be reinstated to no worse condition than they were prior to construction of the English Onshore Scheme. The type and size of culvert is dependent upon the size and the ecological and hydrological properties of the ditch. Typical culvert types include concrete pipes, plastic (twin wall) pipes and pre-cast concrete modular units (box or portal culverts). Each culvert type has slightly varying and specific methods of installation, but the key stages are described below.

4.5.35 Following ecological surveys (and watching briefs, subject to requirements), the crossing location would firstly be cleared of vegetation and any bankside furniture removed. Bunds would then be installed upstream and downstream of the crossing location to prevent the ingress of water to the excavation. A series of pumps and pipes would then be installed to transfer the flow of water from the upstream side to the downstream side, bypassing the worksite.

4.5.36 Once the worksite is sufficiently dewatered, the bed of the watercourse would be excavated to the required depth. Generally, this is to a depth such that the pipe or culvert invert is at bed level once placed on the required thickness of bedding. A geotextile separation membrane would be placed into the excavated trench followed by bedding material, placed, and compacted to the required depth and gradient. The pipe or culvert sections would then be lifted into the trench and jointed. Further material would be placed around and above the pipe/culvert and compacted to a level required to provide adequate protection from traffic. A prefabricated concrete or concrete bag headwall and temporary fencing would be installed around the culvert followed by the haul road construction. Upon completion, the temporary bunds and pumps would be removed, allowing water to flow freely through the newly laid culvert sections.

4.5.37 With the aim of preventing any mud and debris entering the water course from the haul road, straw bales or sandbags should be placed along the haul road. This would reduce the risk of silty water running off and contaminating the water course below.

Bridges

4.5.38 Bridges would be required in locations where the watercourses are large and a culvert solution is not reasonably practicable, or where specified by the relevant stakeholder. These would be temporary or permanent depending on whether they would be on the temporary haul road network or along one of the permanent accesses. Access to both sides of the bridge location would be required using mobilisation accesses to undertake vegetation clearance and foundation and abutment construction, the primary access would then be used to bring in elements of the bridge deck which would be lifted into place using a mobile crane.

Utility Diversions

4.5.39 Overhead Line (OHL) interactions have been identified in the following locations, for which proposed diversions have been identified. These will require further investigation and assessment, and the appropriate diversions or alternative design measures will be confirmed within the ES. From east to west:

- Existing overhead lines are to be diverted in the vicinity of the A52 and Nothings Lane to accommodate installation of the proposed underground cables. The area allocated allows for raising of the existing overhead lines (should this be required) to safely accommodate construction traffic. Alternatively, the design allows for underground diversion of the affected overhead line sections. Note that additional spans of existing overhead lines are included within the draft Order Limits to allow for effective electrical isolation during any diversion works that may be required for the Project;
- Existing overhead lines are to be diverted in the vicinity of the B1449 Thurlby Road and the A1111 Sutton Road to accommodate works in the vicinity of LCS-B Substation.
- Existing overhead lines south of Mill Lane, Thoresthorpe, Alford and Ailby are to be diverted as a result of vehicle movements along the Shared Grimsby to Walpole haul route.
- Existing overhead lines intersecting / in the vicinity of both the A1111 Bilsby / Alford Road and the A1104 East Street (north east of Alford), and also north of Tothby Lane, to accommodate the Alford Construction Route.

Construction compounds

4.5.40 Temporary construction compounds and laydown areas would be set up at strategic locations along the alignment, with associated access points from the existing road network where practical. These compounds store all materials necessary for the works, including plant, waste, cable ducts, cable drums and accessories. In addition to storage, compounds also provide a location for site offices and welfare facilities for construction operatives. For the English Onshore Scheme, it is assumed for the purposes of this PEIR that construction compounds would be required at the following locations within the draft Order Limits:

- Along the HVDC / HVAC cables route;

- Along the construction traffic route used to access site, once departed from the public highway;
- Landfall; and
- The converter station.

4.5.41 It is assumed that laydown areas and welfare areas will be required within the Indicative zone for temporary construction works for the duration of the construction works.

4.5.42 **Volume 3, Part 1, Figures 4-1 and 4-2** show the field boundaries within which temporary construction compounds are anticipated to be located. The exact location where the construction compounds may be located within these fields is not known at this stage; this decision will be subject to further environmental and engineering studies and will be confirmed within the ES.

4.5.43 Compound locations have been identified considering a number of constraints and opportunities. These include the existing environmental sensitive features and receptors, and technical opportunities such as accessibility for HGVs and access to existing services. It is recognised that the importation of material would be required to provide hardstanding if suitable material is not already in place.

4.5.44 Construction would begin by securely fencing the site. The specification and construction of fences would depend on factors such as the level of security required and the degree of visual impact. Lighting of construction compounds would be designed to limit light pollution to the surrounding area.

4.5.45 Topsoil would be removed (stripped) and stored in bunds adjacent to the site. Once soil stripping has been completed, the compound area would be excavated to the required formation level and the associated material stored in the same manner. The formation level would be determined by the pavement thickness applicable to the individual ground conditions at each location. Where existing ground conditions are poor, the pavement layer would be thicker, and consequently a greater volume of excavation would be required. Laydown of material and welfare facilities are expected to be required elsewhere within the draft Order Limits to support construction activities.

4.5.46 Once excavation has been completed, a geotextile layer would be laid followed by compacted layers of stone in the same manner as the haul road construction. The majority of the compound would be left as natural stone, however, car parks may be surfaced with a bituminous surface layer to prevent damage to road-going vehicles, such as cars and vans. Alternatively, soil stabilisation may be employed, where the existing ground is chemically strengthened, allowing the volume of imported stone to be reduced. Soil stabilisation would normally be undertaken by specialist contractors, with the stabilisation reversed following completion of the works.

4.5.47 The construction compounds would generally comprise of temporary cabins or modular style units that would be positioned to maximise construction space and limit the area of land take required. Such units would be used for the purposes of site management activities and also provide welfare accommodation for the construction workforce. As well as this, the construction compounds would provide distinct laydown areas for the storage of construction plant and the delivery and removal of materials. Compounds may also be used for the stockpiling of materials to facilitate their transfer to and from the construction working area. Storage areas within a construction compound should sit away from sensitive receptors, at least 10 m from a watercourse or a drain. Defined areas for staff parking would also be provided as part of the construction compound. Details of the drainage measures which would be employed at the construction compounds are provided in Paragraph 4.5.53.

4.5.48 Compounds would comprise a mix of satellite and main compounds for the underground cable installations and main compounds for the converter station; approximate dimensions are provided in **Table 4-6** below. Satellite compounds are smaller compounds with storage and laydown areas and may include offices/welfare cabins. Indicative locations for up to seven compounds have been identified within the PEIR and will be refined within the ES and DCO application, and are as follows:

1. Alford construction route (west): Haul road compound and potential materials storage, sized as per main cable compound (approximately 150 m x 150 m);
2. Alford construction route (east): Haul road compound, sized as satellite cable compound (approximately 75 m x 75 m);
3. Shared Grimsby to Walpole haul route: Haul road compound, sized as satellite cable compound (approximately 75 m x 75 m);
4. Converter station (west): Converter station main compound (approximately 200 m x 200 m);
5. Converter station (east): Main cable compound (approximately 150 m x 150 m);
6. Eastern cable compound (two options):
   a) West of A52: Satellite cable compound. Sized as satellite cable compound (approximately 75 m x 75 m);
   b) East of A52: Primary cable compound. Sized as per main cable compound (approximately 150 m x 150 m);
7. Landfall (two options) (approximately 105 m x 115 m).

4.5.49 All compound areas would be reinstated as soon as reasonably practicable after completion of the construction works and demobilisation.

4.5.50 A typical construction compound, which the cable and converter station would likely to resemble, is shown on **Plate 4-4.**

Plate 4-4 Typical construction compound

Table 4-6 Rochdale Envelope - Construction compounds

Parameter	Maximum Design Parameter
Typical construction compound element heights	
Single storey site cabin (height)	2.6 m
Two storey site cabin (height)	5.2 m
Small crane (height)	54 m
Medium crane (height)	76 m
Large crane (height)	120 m
Concrete batching plant (height)	10 m
Lighting mast (height)	8 to 10 m
Soil bund (height)	2.5 m
Fencing (height)	2 to 3 m
Underground cable installation (AC/DC)	
Typical footprint of construction compound for cables (main cable compound)	Construction compounds and other working areas for installation of DC and AC cables would be required at various locations along the length of route. Approximately 150 m by 150 m (2.25 ha).

Parameter	Maximum Design Parameter
Typical footprint of construction compound for cables or haul road (satellite cable compound)	Approximately 75 m by 75 m (0.56 ha)
HVDC typical trenchless crossing (terrestrial) construction compound	Approximately 35 m by 60 m (0.21 ha).
HVAC typical trenchless crossing (terrestrial) construction compound	Approximately 35 m by 60 m (0.21 ha).
Converter station main compound	
Footprint	Approximately 200 m by 200 m (4 ha)
Anderby Creek Landfall main compound	
Footprint	Approximately 105 m by 115 m (1.2 ha)

*All element heights are approximate and subject to Contractor requirements

Temporary Land Access for Land Owners and Occupiers

4.5.51 Temporary land access for land owners and occupiers, and for access to the English Onshore Scheme during construction had been identified in the following locations, from east to west, to enable continued access to land during the construction period:

- Along Green Lane;
- Along Northing Lane;
- East of the A52 Sutton Road;
- Along Mill Lane, west of the A52 Sutton Road;
- Along an existing lane perpendicular to the Alford Road, traversing north;
- Along an existing lane traversing west and north west from Huttoft Road;
- Two existing lanes, south of Asserby;
- A number of access options in the vicinity of Asserby Turn, accessed via the A1111 Sutton Road;
- Access to enable works for overhead line diversion, north of the B1449 Thurlby Road; and
- Along an existing lane south of Mill Lane.

English Onshore Scheme Construction Activities

Enabling works and earthworks

4.5.52 Construction of the converter station would commence with site establishment, involving demarcation of the site, stripping of topsoil, establishment of the construction compounds (see Paragraph 4.5.40 to 4.5.50) and erection of temporary facilities, i.e., site offices, storage areas and hardstands. Bellmouths (see Paragraphs 4.5.30 to 4.5.33) and access roads would also be constructed at this stage to ensure prior access from the highway network for construction traffic.

4.5.53 Earthworks would begin upon completion of site establishment, involving levelling of the site and creation of the necessary levels or benching according to the topography and to prevent flooding. Due to the ground conditions being poor in the site area, ground improvement would likely be required as part of these works. The type of ground improvement works that would be required is subject to a ground investigation and a ground improvement design but could involve rigid inclusions (Controlled Modulus Columns) / Prefabricated Vertical Drains. Landscaping involving earth bunds may also be completed at this stage to improve the visual impact of the converter station once built. Once initial earthworks have been completed, all drainage should be installed to prevent any flooding during the construction stage before the formation levels of the converter station site would be created, by importing and compacting sub-base materials.

Utilities and drainage

4.5.54 Drainage works would be undertaken on the site, including diversions of existing watercourses, installation of new stormwater and foul water drainage, and construction of any interceptor tanks and/or attenuation/infiltration ponds.

4.5.55 Third party utility connections to the site would be established, including, water, foul, communications, and power, as required. Specific easements would be utilised for each of the assets within the converter station boundary. Requirements for each asset would need to be agreed with each of the third-party utility providers.

4.5.56 All drainage for the proposed converter station and construction compounds would be installed at the initial stage of the construction phase to avoid any flooding during construction. Where groundwater is elevated, lining of the attenuation ponds with an impermeable liner may be necessary to mitigate groundwater ingress, and anchoring of the liner may be required to manage buoyancy. Some of the attenuation basins may need to be formed above the ground level and pumped into this due to the anticipated high-water table and flat topography.

4.5.57 The site earth mat would be installed at an early stage, with requirements set out based on the high voltage arrangement, electrical requirements, and local ground conditions of each site. The main earth grid is typically installed 500 mm below ground and is therefore installed at an early stage with earthworks and utility installation. Final earth mat connections would be completed once equipment has been installed on site.

Foundations

4.5.58 Foundation requirements would be location specific and dependent on the geology of the area and function of the foundation. The use of piling could be required due to the settlement criteria of the electrical equipment within the high voltage converter station.

4.5.59 The installation of foundations would typically be completed in parallel to the utilities and drainage works due to the interfaces. Foundations supporting high voltage equipment may require significant ducting and fixings to be suitable for the function of the high voltage equipment.

4.5.60 Early studies suggest a likely combination of ground improvement works and piling would be required, with the majority of structures requiring piled foundations. Ground improvement may provide a suitable solution across wider areas of the platform.

Construction and installation of the converter station

4.5.61 Once the above works have been fully completed, erection of the converter halls and supporting buildings could begin. Buildings typically comprise of steel frames, craned into place, fixed and clad with composite materials.

4.5.62 The materials and cladding used in converter station environments are typically simplistic, utilising greys and greens to blend into the surroundings. Exact specifications vary depending on location and stakeholder engagement. The infrastructure that would be required for the converter station is outlined in Section 4.4 above. To summarise, the platform dimension for each converter station would comprise an area of approximately 8.8 ha and housing specialised electrical equipment. The height of the tallest buildings would be up to 30 m, not including the need for additional platform raising to allow for flood risk protection and surface water drainage. Additional space would be required for landscaping, drainage and access requirements.

Underground HVDC Cables

Construction sequence

4.5.63 The cable installation would likely be following a construction sequence comprising:

1. Site surveys – including ecological, archaeological, UXO, highways, topographical, utilities, detailed ground investigation;
2. Initial enabling works:
   a) Installation of demarcation fencing and diversion of Public Rights of Way;
   b) Vegetation clearance/topsoil strip;
   c) Construction of access junctions (bellmouths);
3. Establishment of construction compounds including site facilities;
4. Haul road installation, including temporary culverts, bridges, and diversions;
5. Ducted and trenchless crossings in advance of main works;
6. Cable trench installation, including ducts where used, and construction of joint bays;
7. Cable pulling (installation);
8. Cable jointing and terminations;
9. Testing and commissioning; and
10. Decommissioning of all site works. Restoration of the site to the original condition.

4.5.64 Subject to agreement, the Contractor may make the decision to reinstate certain areas of the English Onshore Scheme early. These areas could potentially be handed back to the landowner at this stage.

Construction and Installation of the HVDC Cables

4.5.65 The typical DC working width required for the construction and installation of the DC cables, including for temporary haul roads, soil storage and drainage, would be approximately 49 m in total. This is described in this PEIR as the ‘working width’. The working width may widen at crossing locations, particularly where trenchless crossings (see Paragraphs 4.5.87 and Paragraph 4.5.95 - 4.5.101 for further details) would be required. The working width is demarcated by a post and rail fence and would typically comprise:

- Storage areas for topsoil and subsoil stripped from the working width;
- Drainage measures, such as:
  - Installation of drainage filter drains for the capture of water within the working width;
- Installation of filter drains/swales to intercept the runoff entering the site from the adjacent ground, as this creates additional polluted waste;
- Temporary haul road, typically 7 m in width, for the movement of installation traffic;
- Excavation of the cable trench / trenches to a minimum depth of 900 mm (to the cable protective tiles) and approximate width of 1.4 m;
- Storage areas for excavated material in preparation for its return, if suitable;
- Security fencing;
- Additional space requirements at joint bays and sites of potential engineering difficulty;
- Tolerance to adjust the positional location of the cable route corridor and its components to practicably accommodate the unexpected; and
- Other mitigation measures as necessary.

4.5.66 In addition to the working width, cable construction and installation would require temporary construction facilities to be established at various locations along the route. This includes temporary access to the working width, drainage and temporary compounds for storage, lay-down and site offices.

4.5.67 The exact methods for cable installation would depend on the final cable route and constraints which are present. The general types of physical constraint identified along the cable route are:

- Main rivers, water courses, and ditches;
- Major road crossings;
- Crossings of existing underground utilities (gas/water pipes, telecommunication, electrical cables, etc.); and
- Areas of important environmental significance i.e. Internationally designated ecological sites.

4.5.68 An overview of typical cable installation techniques and the activities they would involve is outlined below. Further explanation of the cable installation techniques most likely to be utilised by the English Onshore Scheme are also provided under the relevant headings below.

- Open cut/direct buried: this is where a trench is excavated, and the underground cables laid directly into a single trench typically 1.4 m wide unless ground conditions or constraints dictate otherwise, as described above. The trench would then be backfilled using a combination of excavated soils and thermally suitable material (such as CBS) and the land reinstated. Further information regarding the measures that would be undertaken to reinstate land and soils is provided in **Volume 1, Part 2, Chapter 11: Agriculture and Soils**. One trench is required for the English Onshore Scheme.

- Open cut/ducted - This installation method is largely the same as per the process for open cut/direct buried. The main difference is that ducts are laid in the trench, and the underground cables are then pulled through the ducts. This installation method allows for the ducts to be laid, and the majority of the trench reinstated without the underground cables being present. Cable joint bays would need to remain open as they would be utilised to pull the underground cable through the preinstalled ducts and join the sections of underground cables together. Following underground cable installation, the land would be reinstated. Open cut ducted methods will be employed for the majority of the cable route; further details are provided below.
- Trenchless methods such as HDD or micro tunnelling/pipejacking: these are used where specific features are encountered, such as main rivers, sensitive habitats, major roads, flood defences or other significant infrastructure, need to be crossed. Where HDD is not technically viable, then a tunnelled (micro tunnelling/pipejacking) solution can be considered. In determining the most appropriate trenchless technique for installing DC cables, NGET would need to assess the existing ground conditions for trenchless installation and ensure the electrical performance of the DC cables is not compromised.
  - HDD involves the use of a drill to bore a route below the ground through which ducts would be pulled and cables installed. For the English Onshore Scheme, HDD is the preferred trenchless installation method and as such further details are provided in Paragraph 4.5.77 - 4.5.82, respectively.
  - Micro tunnelling/Pipejacking is a technique for installing underground ducts and uses hydraulic jacks to push specially designed pipes through the ground behind a shield at the same time as excavation is taking place within the shield, cables are then installed in the pipes.
  - Direct Pipe is a more recent method of installing pipelines which combines pipe jacking and HDD technology. A slurry supported micro tunnelling machine is used to drill the hole while installing a steel pipe. From the launch pit, a pipe thruster pushes the pipe and the tunnelling machine into the ground. Pipe sections are welded to previous sections on the surface while being pushed in, therefore the size of the construction site can be kept as small as the length of the pipe sections. A carrier pipe or pipes may be inserted within the steel pipe.
  - E-Power Pipe is an emerging trenchless crossing technology which takes on some of the best aspects of HDD, Direct Pipe and pipe jacking. The method relies on a two-stage process. From a shallow launch shaft, a pilot hole is drilled. This hole is drilled using an Automated Slurry Boring micro-tunnelling machine, which is a closed, full face excavation machine using a hydraulic slurry circuit. This machine is pushed through the ground using temporary steel jacking pipes, which carry the slurry circuit, power supply and data transmission system. Once the pilot hole is drilled, the Tunnel Boring Machine (TBM) is removed, and a pull-head is attached to the drill string. A prefabricated pipe that will form the permanent pipeline is attached and pulled back through the borehole. As the pipe is pulled back, the overcut between the pipe and the borehole is backfilled with material. The material

injection is pressure and volume controlled, maintaining mechanical support of the borehole during the entire process.

Cable joint bays

4.5.69 Limitations on the maximum length of cable that can be manufactured and delivered to site mean that cable joints would be required at regular intervals along the length of the route, approximately every 800 m to 1.5 km. At these locations, the individual cable lengths would be mechanically joined in oversized trenches known as 'joint bays'. Joint bay sizes would be determined by the cable joint accessories, the area required for jointing works and the environment in which they are installed. Sizes may vary throughout the route, though typically, this would be approximately 12 m in length and approximately 3 m in width.

4.5.70 Cable joint bays must be clean and dry so temporary covers would be erected at jointing locations, as shown in **Plate 4-5**. Due to the precise nature of engineering employed, cable joint bays could remain open for several weeks to allow for trench and joint bay excavation, cable pulling, jointing and reinstatement.

Plate 4-5 Cable joint bay

Open cut ducted

4.5.71 Where conditions allow DC cables are typically installed using open cut methods. Open cut methods are generally preferred as they enable DC cables to be installed at more technically efficient depths. Open cut methods are also generally more economical and often require a smaller construction footprint than trenchless methods.

4.5.72 Where technically feasible, and unless other environmental and infrastructure features and considerations determine otherwise, the underground cable system would be predominantly open-cut ducted. The cables would be pulled through plastic ducts preinstalled at the required depth below ground. Where direct burial of cables is required, the excavated trench would be left open until the cables are pulled in, this has a greater impact on land owners and exposes the open trench to a greater risk due to bad weather given the extended nature of the open excavation. Due to these risks, a ducted installation would be used with the exception of specific locations on the cable route where direct buried cables may be required (e.g. in close proximity to the converter station or entry to Trenchless Crossings).

4.5.73 For a ducted installation, the cable trench would first be excavated to a minimum depth of 1500 mm (below the surface of the ground to the top of the cable protective tiles).

4.5.74 However, the depth of the cables would vary, subject to the outcome of soil ALC, agricultural land drainage, engineering and ground investigation surveys. Where justified, cables may be laid deeper.

4.5.75 The width of the cable trench would be approximately 1.4 m at its base (unless physical constraints dictate otherwise). To provide protection to the operatives, trench supports would be installed, or the trench would be battered (sloped) back to reduce the risk of collapse and the risk of injury. The plastic ducts would be laid within the trench and surrounded by CBS or similar thermally suitable material surround. The CBS or equivalent material would be covered with protection tiles and the remainder of the excavation would be backfilled with indigenous, previously excavated soil where this is thermally suitable, installed 100 mm above the protective tiles. The ground surface would be reinstated to the original condition and level or as agreed with the landowner.

4.5.76 Where specific environmental or infrastructure features preclude the use of open cut methods, use of trenchless methods such as HDD would be used. The depth of installation would be deeper at locations where trenchless installation methods are used.

Trenchless Crossings

4.5.77 Trenchless crossings (such as HDD) 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.

4.5.78 Where a constraint is required to be crossed using a trenchless method, there are a number of methods that could be employed depending on the ground conditions and detailed design. For the English Onshore Scheme, HDD would be the preferred trenchless installation method. However, the final decision on the implemented technology will be subject to detailed ground investigation and the encountered on-site conditions. The parameters outlined within this PEIR are considered to accommodate all trenchless techniques outlined within paragraph 4.5.68, so as to present a worst case assessment.

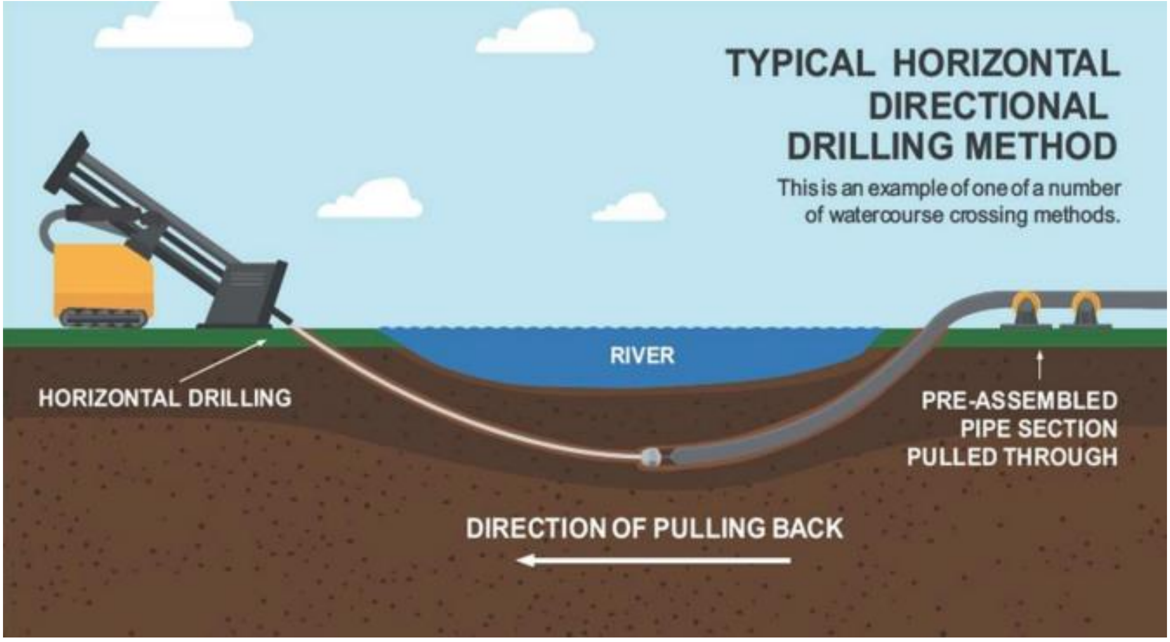
4.5.79 The process of HDD comprises of three main stages: the pilot bore, reaming and finished pipe installation. See **Plate 4-6** for illustration. Firstly, temporary construction compounds would be established at either end of the desired crossing, termed launch and reception areas, to locate the drilling equipment, store materials and undertake pipe stringing.

4.5.80 At both sites, a pit would be excavated to provide a smooth entry and exit (approximately 12 degrees) and to aid the collection of fluid returns from the drilling works. Drilling would commence by pushing a cutting head connected to sections of rigid drill pipe on a defined path towards the reception pit. A mechanism of tracking the drill head and controlling the angle at which it progresses would allow the direction to be determined by the operator. A mixture of water and bentonite clay would be continually pumped through the cutting head to assist the removal of cuttings and stabilise the bore. The pilot bore process is complete when the cutting head surfaces at the reception pit location.

4.5.81 A larger diameter cutting tool would then be affixed to the nose of the pilot bore cutting head and pulled in reverse back through the newly excavated pilot bore. The process would be repeated with successively larger reaming tools as required until the desired diameter is achieved. A final pass, known as a 'swab pass', would be undertaken using a reamer of larger diameter than the final pipe installation. Throughout the process of reaming, drilling fluid would be continually pumped through, entraining the soil and aiding removal.

4.5.82 The final stage concerns the installation of the finished pipe. In a process known as pipe stringing, sections of pipe, corresponding to the full length of the crossing, are laid out at the reception pit location and welded together. A draw string would be installed within the ducts to later aid the process of cable pulling. Pressure testing and inspection of welds may be undertaken on the final string to ensure watertightness. The pipe string would then be pulled into the bore towards the drill rig to achieve the finished cable duct. Further testing would then be undertaken and finally the bores would either be joined to the remainder of the ducting works or be capped, buried, and re-excavated with future works. Once the above process has been repeated for each of the cables, the drilling sites would be demobilised, and the ground returned to pre-existing conditions.

Plate 4-6 Typical HDD methodology



Frac-out

4.5.83 Frac-out is the term for an unintentional or inadvertent loss of drilling fluid during the drilling of the boreholes. This occurs when a fracture in the underlying geology is encountered and drilling fluid finds an alternative path to the intended route, returning to the drill entry point for re-use and recycling. Drilling fluid can either be lost in the geological formation or can emerge at the surface.

4.5.84 Bentonite is a non-toxic, inert, natural clay mineral (mainly montmorillonite) with ability to absorb water and increase its own volume by several times, forming a gelatinous and viscous fluid. With addition of water, it forms drilling fluid, used in HDD. Although non-toxic, in the event of 'breakout' of bentonite to the ground surface (the risk of which is discussed in more detail below), bentonite presents a potential risk of temporary smothering of aquatic or emergent plant species, before it disperses or is removed, temporarily impacting on aquatic or emergent plant species and those species which they support. The amount of drilling fluid used in a drill is closely monitored and therefore most frac-outs are of small quantities. Control measures will be included in an Outline HDD Method Statement and Contingency Plan within the ES.

Underground HVAC Cables

Construction and Installation of the HVAC Cables

4.5.85 The typical AC working width required for the construction and installation of the AC cables, including for access routes, soil storage and drainage, would be approximately 84 m in total where open-cut installation methods are used. The working width would be demarcated by a post and rail fence and would typically comprise the same measures and activities as required for HVDC cables. Unlike the HVDC cable trench, however, the HVAC cable trench would be approximately 2.85 m wide, comprising three cables per trench.

4.5.86 In addition to the working width, cable construction and installation would require temporary construction facilities to be established at various locations along the route. This includes temporary access to the working width, drainage and temporary compounds for storage, lay-down and site offices.

4.5.87 As with DC cables, there are several different installation methods available for the installation of AC cables. These methods are the open-cut and trenchless methods described in Paragraph 4.5.68 with AC cables installed in sections and connected at buried cable joint bays. The number of sections and the number, location and dimensions of cable joint bays required, would be determined through consultation feedback, information from surveys and ongoing design studies.

4.5.88 Where technically feasible, and unless other environmental and infrastructure features and considerations determine otherwise, all underground cable installation would be by open-cut ducted methods. However, as with DC cables, where specific environmental or infrastructure features preclude the use of open cut methods, use of trenchless methods such as HDD would be used.

4.5.89 Where open-cut installation methods are used for the AC cables, two trenches would be required for the English Onshore Scheme AC cables. Each trench would contain three AC cables and (subject to cable system design) would be approximately 2.85 m wide. Each trench would also accommodate a DTS carrier tube and communications fibre cable.

4.5.90 As with DC cables, the minimum depth coverage would be 900 mm to the cable protective tiles. However, the depth of the cables would vary, subject to the outcome of soil Agricultural Land Classification (ALC), agricultural land drainage, engineering and ground investigation surveys. Where justified, cables may be laid deeper.

4.5.91 An optical fibre link would be provided along the alignment of the cable installation. This would require regular chambers to be installed along the route for installation, monitoring, and repair. Inspection chambers are installed at regular intervals, usually at approximately 450 m intervals. Made of precast concrete, these chambers would be buried with chamber covers suitable for the anticipated loading for the area.

Anderby Creek Landfall

Construction and Installation at the landfall

4.5.92 An area larger than that required for the permanent area of the TJB would be required temporarily during its construction and installation to accommodate temporary construction equipment and storage areas. A description of the offshore elements of the landfall is provided below in Paragraphs 4.5.156 to 4.5.170.

4.5.93 A temporary construction compound, which would extend approximately 105 m by 115 m (1.2 ha), would be required to construct the landfall and the TJB. The temporary compound would contain all necessary plant and equipment, plus parking and welfare facilities required. Once installation of the TJB and all construction works is completed the land would be reinstated to pre-existing conditions (but at a higher elevation due to the raised platform); the only infrastructure visible on the surface (on otherwise fully reinstated land), refer to **Plate 4-7** as an example of a TJB raised platform at Triton Knoll) would be the cover of the link box pit.

Plate 4-7 Illustration of a TJB raised platform

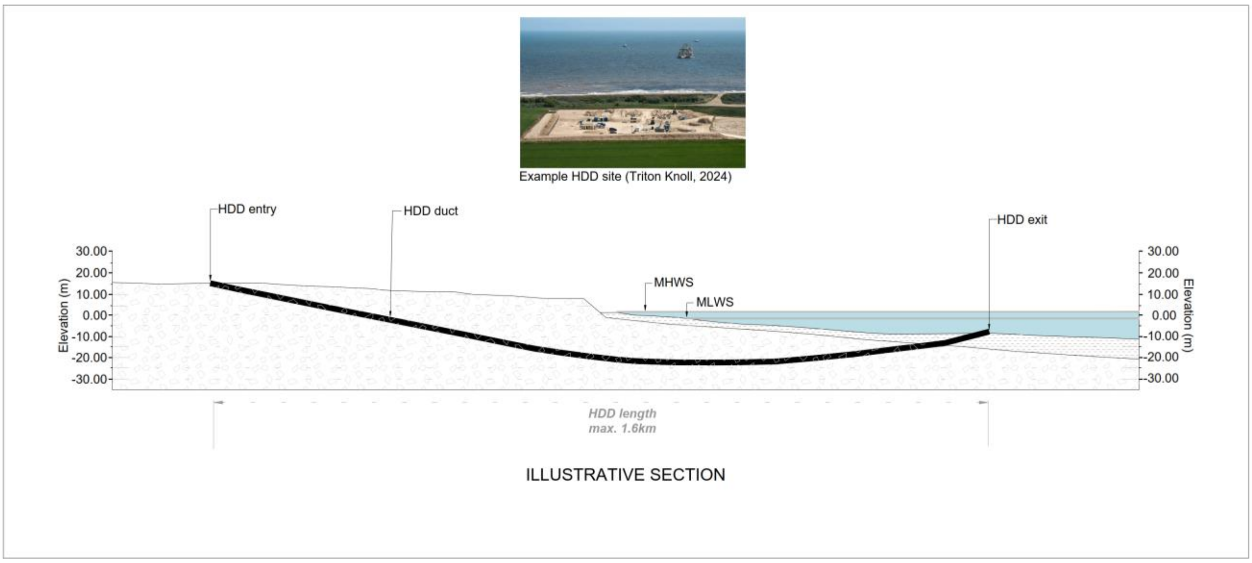
4.5.94 Installation of the DC cables at the landfall between onshore and offshore environments would be achieved utilising trenchless methods to minimise disruption and avoid direct impacts to the intertidal zone. The exact trenchless method is subject to further detailed design considering the results of ground investigation; however, the most likely installation technique would be HDD whereby a bore is drilled under a constraint (such as a watercourse, environmentally sensitive area or other infrastructure) and a pipe or duct is pulled back through the bore. The HVDC cables can then be pulled through the duct at a later date. Further details of trenchless techniques, including HDD, are provided within the Underground HVDC Cables section above, Paragraphs 4.5.63 to 4.5.68, respectively.

4.5.95 At the landfall, a trenchless technique (such as HDD) would be utilised to install a duct for each subsea cable between the TJB, passing beneath the sea defences and the punchout point in the offshore environment beyond the MLWS. Two ducts would be installed for the Project between the TJB, which is located behind the dune system above the MHWS mark to a point below 3 m Lowest Astronomical Tide (LAT). A detailed description of the Anderby Creek Landfall HDD (the preferred technique) operation is provided in Paragraphs 4.5.156 to 4.5.170.

4.5.96 The subsea cables would be pulled through the installed ducts and joined to the underground onshore DC cables at the TJB. An indicative cross section of the HDD at the Anderby Creek Landfall is provided in **Plate 4-8**.

4.5.97 Onshore access to the Anderby Creek Landfall would likely to be via a temporary access track from the existing road network. Onshore construction activities within the Anderby Creek Landfall would include trenchless installation works, compound construction, site mobilisation, site operations, materials deliveries, cable pull-in, site demobilisation and site reinstatement. Anticipated construction vehicles would include HGVs, light goods vehicles (LGVs), vans and cars. AIL movements would be required to allow cable delivery to the Anderby Creek Landfall.

Plate 4-8 Indicative landfall cross section



English Offshore Scheme Construction Activities

Pre-installation Activities

4.5.98 Prior to the installation of the subsea cables, certain activities would be undertaken to prepare the route for cable lay.

Pre-installation Survey

4.5.99 Although detailed marine surveys have been undertaken, further surveys may be carried out prior to the start of cable installation. The objectives of these surveys would be:

- To confirm that no new obstructions have appeared on the seabed since the original marine surveys were undertaken;
- To establish the final position for infrastructure crossings;
- To establish a reference seabed level against which the depth of burial of cables can be compared;

- To determine the position of any potential Unexploded Ordnance (UXO) (note clearance is subject to a separate licence process);
- To support the micro-routeing of the cables around any mobile bedforms, archaeological features or sensitive habitats; and
- To provide a pre-installation baseline should it be required for post-construction monitoring purposes.

4.5.100 The pre-installation surveys could involve a range of marine survey techniques including:

- Multi-Beam Echo Sounder (MBES) and backscatter data are used to record water depth, prepare a three dimensional (3D) digital terrain model of the seabed, and to identify relevant bedforms and bathymetry.
- Side Scan Sonar (SSS): maps the seabed surface and is used for identification of sediment types, environmental features, obstacles lying on the seabed, such as wrecks, debris, UXO, and surface-laid or exposed pipelines and cables that might affect cable installation.
- Sub-Bottom Profiling (SBP): directs a pulse of acoustic energy into the seabed. By analysing reflections from the sub-surface geological layers, it can determine sediment thickness, stratification, and the acoustic properties of the underlying materials.
- Magnetometer: passively detects magnetic anomalies compared to the earth's magnetic field. Such anomalies can be caused by geological faults and buried metallic objects such as UXO, pipelines, cables and archaeological features.
- Geotechnical surveys: consisting of cone penetration tests (CPTs) and vibrocores (VCs) to take measurements and core samples to assess the geotechnical properties of the seabed.
- Drop Down Video or remotely operated vehicle video: (DDV) is a piece of marine survey equipment that typically comprises an underwater camera and lighting on a robust sled or frame which is able to stream live footage to the surface. It has built in depth sensors and lasers to provide a scale to estimate the field of view.
- Grab sampling: Is a technique of grabbing a sample of the seabed for testing e.g., to look at sediment composition and properties or to identify marine flora and fauna or eDNA. Types of grabs include hamon grab, dual van veen grab and shipek.

4.5.101 The pre-installation survey would typically be split into two elements: nearshore (< 10 m depth of water) and offshore (>10 m depth of water), each requiring a survey vessel suitable for the different water depths.

4.5.102 An offshore vessel is generally larger and can conduct 24-hour operations.

4.5.103 A nearshore vessel is generally smaller and due to its reduction in size can be used in shallower water depths. Operations are usually kept to 12 hours (or daylight hours), however if the size of the vessel allows night working or 24-hour working, operations would still be possible.

4.5.104 The use of Autonomous Surface Vessels (ASV) and Remotely Operated Vehicles (ROV) may also be considered as a platform for survey equipment.

Unexploded Ordnance (UXO) Identification and Clearance

4.5.105 A separate Marine Licence application under the Marine and Coastal Access Act 2009 (Ref 4.6) would be submitted to the Marine Management Organisation (MMO) to permit the UXO clearance activities. UXO clearance activities are excluded from this DCO application, however a high-level impact assessment has been provided within relevant chapters of the PEIR at the request of Statutory Nature Conservation Bodies (SNCBs).

4.5.106 A desk-based study and risk assessment for potential UXO across the English Offshore Scheme will be undertaken by the appointed UXO Consultant, which will inform the position and development of the English Offshore Scheme.

4.5.107 Publicly available data, historic maps, aerial photographs and records, internet research and research documents will be used to characterise the types of ordnance likely to be present within the English Offshore Scheme. **Table 4-7** lists the types of ordnance that could be present, within the English Offshore Scheme.

Table 4-7 Potential UXO types typically found in the southern North Sea

UXO	Net Explosive Quantity (NEQ)
Small arms ammunition	< 50 kg
Land service ammunition	101 kg
High explosive bombs	260 kg
Sea mines	697 kg
Torpedoes	365 kg
Depth charges	272 kg
Missiles / rockets	< 50 kg

4.5.108 The offshore geophysical survey completed in 2025 was designed to detect any significant seabed features and obstacles within the offshore draft Order Limits and will be analysed as part of the initial assessment being carried out by the appointed UXO Consultant.

4.5.109 A more detailed UXO specific pre-construction survey would be conducted using a magnetometer array and side scan sonar array prior to seabed clearance and cable lay, to characterise and investigate any anomalies, that may be UXO, in more detail. These surveys will also be designed to capture archaeological features.

4.5.110 The extent of the UXO survey would be nominally 40 m either side of the proposed cable centreline (80 m total); the route along which the cable would be laid and buried within the offshore draft Order Limits. It would be undertaken using a geophysical survey vessel(s).

4.5.111 The data acquired during the survey would be used to map potential UXO (pUXO) and undertake further micro-routeing of the cable centreline to avoid as many pUXO as possible.

4.5.112 Any pUXO detected during the survey that cannot be avoided by the cable centreline would be further investigated to confirm whether it is UXO, an archaeological feature or debris.

4.5.113 Archaeological pUXO identified as a target for investigation would be surveyed in one of two ways:

- Diver survey using a circular search pattern with handheld magnetometer to identify the position of the target and using a low-pressure water jet and dredge system; and/or
- Remotely Operated Vehicle (ROV) equipped with magnetometer, dredge pump and sonar.

4.5.114 A minimum 5 x 5 m grid would be investigated around each target. Should scrap/debris be identified during the survey e.g., objects with ferrous content, this would be removed to the surface to be disposed of according to the Waste Hierarchy and Waste Regulations (2011) (Ref 4.7). Targets covered by sediment would be exposed. A small pit would generally be excavated, until the target is sufficiently exposed to confirm whether it is UXO. Where debris has been identified and removed, investigations would continue until the entire search grid is complete, in case debris had masked the presence of UXOs.

4.5.115 Any non-explosive debris that cannot be removed to the surface (e.g., for health and safety reasons) would be relocated on the seabed within the offshore draft Order Limits.

4.5.116 A Written Scheme of Investigation (WSI) and Protocol for Archaeological Discoveries (PAD) would be followed throughout the UXO identification campaign, and a marine archaeologist would be on hand in case any targets have archaeological potential. A UXO As Low as reasonably Practicable (ALARP) certificate would be issued for the English Offshore Scheme installation corridor.

4.5.117 UXO clearance would be undertaken following completion of the initial UXO identification survey and once all potential targets have been identified and where avoidance of targets, through micro routing, is not possible.

Route Preparation

4.5.118 Prior to the construction of the English Offshore Scheme, preparation of the seabed would be required to ensure installation equipment can operate efficiently and safely. The following activities may be undertaken within the draft Order Limits.

Boulder Clearance

4.5.119 Geophysical data would be used to inform the requirement for boulder clearance within the offshore cable corridor. Where possible micro-routing around boulders would be undertaken, however, where there are large volumes of boulders present micro-routing may not be feasible and therefore clearance of boulders from the route of the cables would be required to allow the use of burial equipment.

4.5.120 There are a number of methods that may be used for the clearance of boulders. Where there are few boulders to be cleared, a grab could be used to individually target and move boulders away from the centreline of the cables. Boulders would be repositioned within the draft Order Limits away from the final route of the cable.

4.5.121 Where there are high volumes of boulders, a plough or similar would be used. The plough would push boulders to either side of the centreline, clearing a swathe of up to 25 m wide. Multiple passes may be required to achieve the required clearance.

4.5.122 All clearance activities would be undertaken from a Construction Support Vessel (CSV) or similar.

4.5.123 The intention is for all boulders to be relocated using the grab method, as this will reduce the impact footprint. However, the worst-case scenario in terms of boulder clearance is assumed to be the use of the plough as this results in the greatest footprint on the seabed. Boulders are present along the entirety of the English Offshore Scheme.

4.5.124 The boulder clearance parameters are shown in **Table 4-8**.

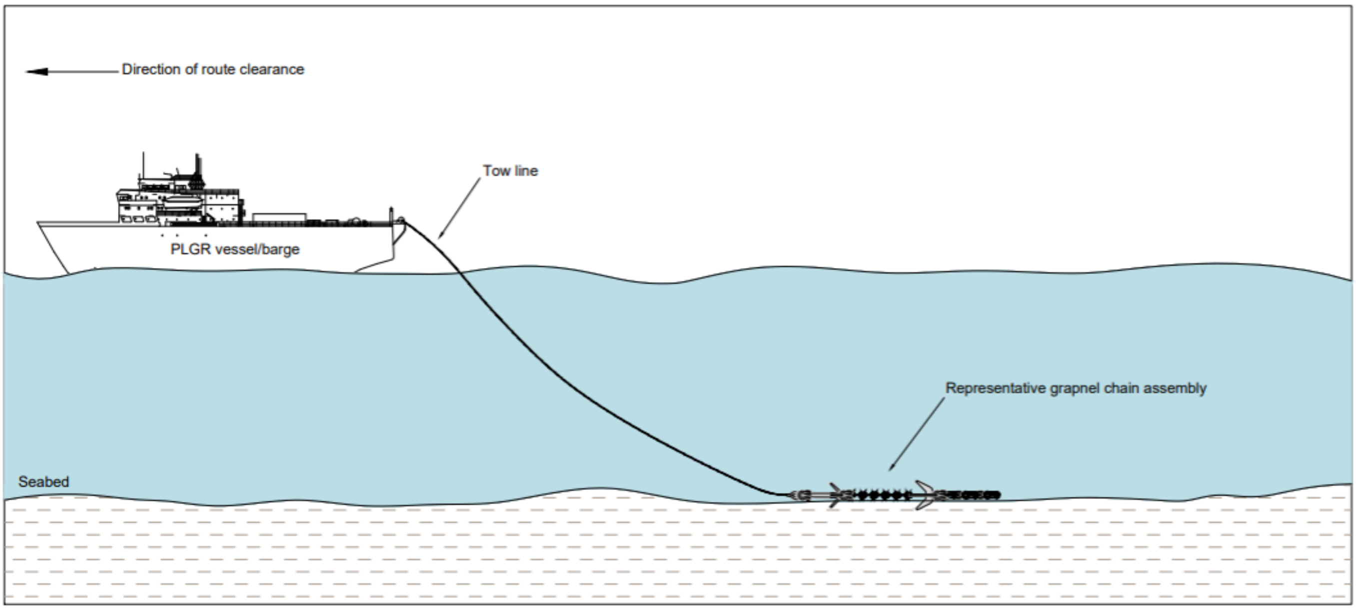
Table 4-8 Boulder Clearance Parameters

Aspect	Parameter
Length of cable requiring boulder clearance using plough (km)	423 km
Width of plough / cleared swathe (m)	25 m
Total area of seabed disturbed by boulder plough (km^2)	10.56 km^2
Depth of seabed disturbed by clearance plough	~10 cm

Pre-Lay Grapnel Run (PLGR)

4.5.125 A PLGR would be required to clear any debris from the seabed prior to cable installation to ensure the cable route is clear of snagging risks. The PLGR is a wire with specially designed hooks or grapnels at intervals along its length that is towed behind a vessel, typically a CSV. A typical PLGR arrangement can be seen in **Plate 4-9**.

Plate 4-9 Typical PLGR Arrangement



4.5.126 The PLGR is designed to capture all types of debris at or just below the surface of the seabed, up to approximately 1 m depth. Debris, such as scrap trawler warps, old cable, ghost fishing gear, caught with the grapnel would be recovered to the vessel for appropriate licenced disposal onshore.

4.5.127 Due to the length of the cable as described above, installation may be undertaken over a number of campaigns. The PLGR may therefore be undertaken in one single phase prior to the first installation campaign or in separate phases prior to each installation campaign to ensure the route is clear of debris. Typically, the PLGR is undertaken a few days prior to cable installation but may be undertaken up to a month prior to cable installation.

4.5.128 The PLGR parameters are listed in **Table 4-9**.

Table 4-9 PLGR Parameters

Aspect	Parameter
Percentage of cable requiring PLGR (%)	100 %
Length of cable requiring PLGR (km)	423 km
Width of PLGR clearance (m)	30 m
Total area of seabed disturbed by PLGR (km^2)	12.69 km^2
Depth of seabed disturbed by PLGR	1 m

Cable Burial Trial Trenching

4.5.129 Trial trenching would be performed without a cable, if required to test the capabilities of the trenching tool to meet depth of burial requirements and would be undertaken within the draft Order Limits. The trial trenching would use the same methodology as that proposed for the installation of the cables. During the trial trenching, if cables were to be laid and buried, these would be subsequently removed following the trial. The total length of trial trenching would be up to 1 km. The total area of seabed disturbed by trial trenching would be 15,000 m^2 (0.015 km^2) assuming the maximum width of a burial tool would be 15 m.

4.5.130 Cable burial trial trenching will not be conducted within the Holderness Offshore Marine Conservation Zone.

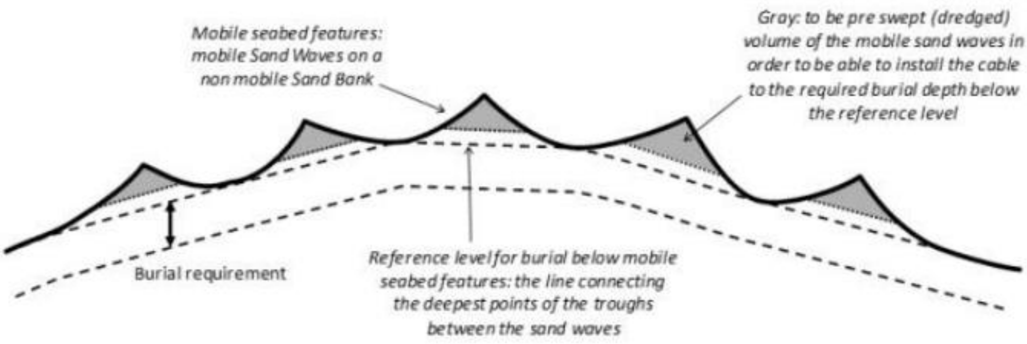
Sand Wave Clearance and Disposal of Dredged Material

4.5.131 In areas where mega ripples (wave heights 1.5 m or greater) are present along the English Offshore Scheme cable corridor, sand wave clearance may be required prior to cable installation to:

- Ensure the burial equipment can operate safely along the cable centreline (i.e., avoiding step slopes); and
- Ensure that the burial equipment reaches the required depth of burial, therefore preventing future exposures.

4.5.132 Sand waves can present a major technical challenge for both towed and self-propelled burial equipment. Burial equipment commonly works on long inclines of up to 8-12°. For commonly available machines, the practical limit for burial depth is 3 m. By removing a proportion of the sand wave prior to installation, the burial machine can reach further down and place the cables below the level at which they may be affected by the mobility of the bedform feature (the non-mobile reference level) and can reduce the slope angle, ensuring the burial machine does not topple or tilt over as illustrated in **Plate 4-10**.

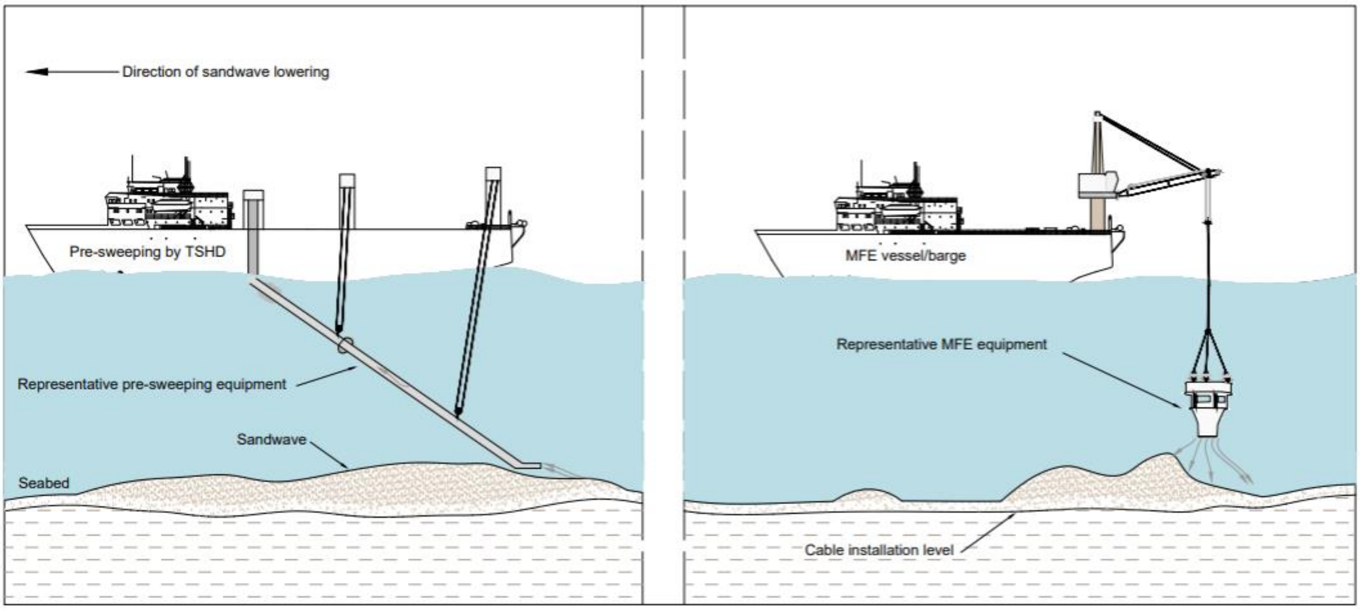
Plate 4-10 Sand wave pre-sweeping process



4.5.133 Sand wave clearance can be undertaken using two different techniques:

- Controlled Flow Excavator (CFE) - A technique that uses highly pressurised water directed at the seabed to push sediment to either side of a trench, also commonly referred to as a mass flow excavator (MFE). An example is shown in **Plate 4-11**. This equipment works best where the sand waves are < 3 m, it also creates a wide footprint and uneven ground, where the sand is pushed aside.
- Trailing Suction Hopper Dredger (TSHD) - A dredging vessel that uses a suction pipe (the trailing drag head) to suck up sediment off the seabed. The sediment is discharged into a compartment (the hopper) on the vessel. An example is shown in **Plate 4-11.** The sand can either be retained in the hopper for deposition onshore or deposited back on the seabed by opening the hopper doors. Alternatively, it can be side cast as the dredging occurs to allow the sand to settle away from the trench or deposited back to the seabed using the suction pipe in a reverse process to dredging. Compared to the CFE, the TSHD can create a defined trench with a stable flat bottom, typically seabed disturbance is narrower using this technique. However, TSHDs are typically restricted to water depths of 30 – 40 m. Some larger vessels can reach 100 – 160m although there are limited vessels internationally that can achieve this.

Plate 4-11 Illustrations of Controlled Flow Excavator and Trailing Suction Hopper Dredger



4.5.134 The area to be cleared would be wide enough for the passage of the burial equipment at the base of the sand wave. Where sand wave clearance is required this would be undertaken up to a few weeks in advance of the cable lay and burial to ensure a cleared path for burial.

4.5.135 If seabed material is recovered to the TSHD and not returned to the seabed it would be disposed of within the English Offshore Scheme draft Order Limits. The preference would be for the dredged material to be returned to the seabed in the vicinity of the dredged area where practical. Proposed disposal locations would be licensed through the DML, however are not currently known. This detail will be provided and considered as part of the ES.

4.5.136 The requirements for sand wave clearance would vary along the English Offshore Scheme. The final determination of depths and locations would be made post consent and would be informed by the CBRA and pre-installation surveys, which can be compared to the marine characterisation survey data to determine seabed mobility. However, the maximum design scenario for sand wave clearance is presented in **Table 4-10.** These parameters will continue to be refined for the ES.

Table 4-10 Maximum sand wave clearance parameters

Aspect	Parameter
Length of cable requiring sand wave clearance (km)	20.04 km
Maximum sand wave clearance width (m)	60 m
Total area of seabed disturbed by sand wave clearance (km^2)	1.2 km^2
Maximum volume of sediment disturbed by sand wave clearance (m^3)	629,965 m^3

Preparation for Infrastructure Crossings

4.5.137 The proposed cable route would cross over several types of third-party infrastructure which have been identified through desktop studies, the marine characterisation survey and direct engagement with the operators and asset owners. A formal crossing agreement will be agreed with each of the infrastructure asset owners prior to making the crossing. This agreement will include the design of the crossing, describing aspects such as crossing angle and vertical separation distance between the third-party asset and the English Offshore Scheme. Where out of service infrastructure is present, agreements will be made to cut and remove sections of this infrastructure to allow unimpeded burial.

4.5.138 At the time of writing, the English Offshore Scheme will cross 45 other assets. These are a combination of:

- Operational or under construction interconnector or grid reinforcement cables;
- Operational windfarm export cables;
- Active telecommunications and fibre optic cables; and
- Active and not in use or abandoned pipelines.

4.5.139 For the purposes of assessment, it has been assumed that the Project would require up to 58 infrastructure crossings to account for existing and planned infrastructure that may be constructed prior to the English Offshore Scheme.

4.5.140 **Volume 3, Part 1, Figure 4-4: Known Infrastructure Crossing Locations** shows the locations of all existing infrastructure crossings.

Active Telecommunications Cables

4.5.141 The crossing of active telecommunications cables (telecoms cables) by the English Offshore Scheme would comprise a crossing over the assets made of either aggregate (rock) or concrete mattresses. This would provide a protective layer and separation between the English Offshore Scheme and the telecoms cable.

4.5.142 Separation could also be achieved by installing a protective material around the English Offshore Scheme (such as Uraduct® or TekDuct). This protective material would be installed on the cable as it is laid over the crossing and positioned during route preparation by a pre-construction vessel using either a crane or a fall pipe. A secondary layer of rock or mattressing would then be laid over the crossing once the cable is installed. This is described further in paragraphs 4.5.201 to 4.5.207.

4.5.143 A list of the telecoms cables identified from spatially mapped data sources (e.g., KIS-ORCA and Admiralty charts), as crossing the English Offshore Scheme, is provided in **Volume 1, Part 3, Chapter 24: Other Marine Users**. It is assumed that infrastructure crossings would be required for all active third-party fibre optic cables.

Offshore Wind Farm Export Cables

4.5.144 The crossings of offshore wind farm export cables would be undertaken in the same manner as the crossing of telecoms cables although, as there may be multiple cables in close proximity, the required length of rock protection or mattresses may be greater.

4.5.145 There are several operational or under construction offshore wind farm export cables that would need to be crossed by the English Offshore Scheme. **Volume 1, Part 3, Chapter 24: Other Marine Users** provides an overview of the offshore wind farm export cables that would require crossing, the number of cables to be crossed and the anticipated position of the crossings. For the purposes of assessment, it has been assumed that all these crossings would be required.

In-Service Pipelines

4.5.146 The English Offshore Scheme would need to cross several active or planned pipelines, some are buried, and some are surface laid. Where the pipeline is buried, it would use the same methodology as described above for telecoms cables and offshore wind farm export cables, comprising a crossing of rock or concrete mattresses.

4.5.147 Where the pipeline is surface laid a crossing bridge would be created using supporting structures to ensure the cable is supported as it crosses the pipeline. These supporting structures are typically concrete bridges which are designed according to the asset being crossed but would have a maximum dimension of 5 m width, 20 m length and 2.5 m height.

4.5.148 **Volume 1, Part 3, Chapter 24: Other Marine Users** lists all of the in-service pipelines that cross the English Offshore Scheme.

Abandoned or Out of Service Pipelines

4.5.149 There are several abandoned or out of service pipelines that have been identified that would need to be crossed by the proposed English Offshore Scheme identified from spatially mapped data and the geophysical surveys.

4.5.150 These pipelines are a combination of surface laid and buried. As they have been decommissioned, a crossing structure would be needed for the pipelines. Where these are buried, the construction methodology would be similar to that proposed for In Service cables. Where the pipeline is surface laid, methodology would be the same as that for surface laid in service pipelines.

Out of Service (OOS) Telecommunications Cables

4.5.151 There are several out of service telecoms cable that would need to be crossed by the English Offshore Scheme.

4.5.152 Agreement would be sought from the cable owners to cut the OOS cables where owners can be identified. At the known location of the cable a grapnel would be used to try and retrieve the cable. Should this be unsuccessful, then a de-trenching grapnel would be deployed, which can penetrate the seabed up to 2 m, to retrieve the cable.

4.5.153 Once the OOS cable is retrieved to the vessel, the cable would be cut, and the ends secured with clump weights and returned to the seabed in accordance with guidelines from the International Cable Protection Committee (ICPC) recommendation No 1 (Ref 4.8). The use of clump weights should ensure the risk of fishing gear snagging the cut cable ends is reduced.

4.5.154 The length of cable to be removed would be agreed with the asset owner in advance, but typically a section 100 m long, 50 m either side of the centre line would be removed.

4.5.155 The clearance of OOS cables would be undertaken by a construction support vessel during the seabed clearance campaign.

Anderby Creek Landfall Enabling Works and Cable Pull-in

4.5.156 The trenchless technique (such as HDD, mircotunneling or direct pipe) for drilling cable ducts from the site compound to the offshore exit point is described below. There would be up to two ducts installed, exiting in the nearshore (between 3 m and 6 m LAT).

4.5.157 During drilling, if the bore fails, then the hole will be redrilled a short distance (up to 10 m) from the original entry point. The failed bore would not punch out or be ducted. The entry hole for the failed bore would be made safe either by collapsing the hole or filling it with grout.

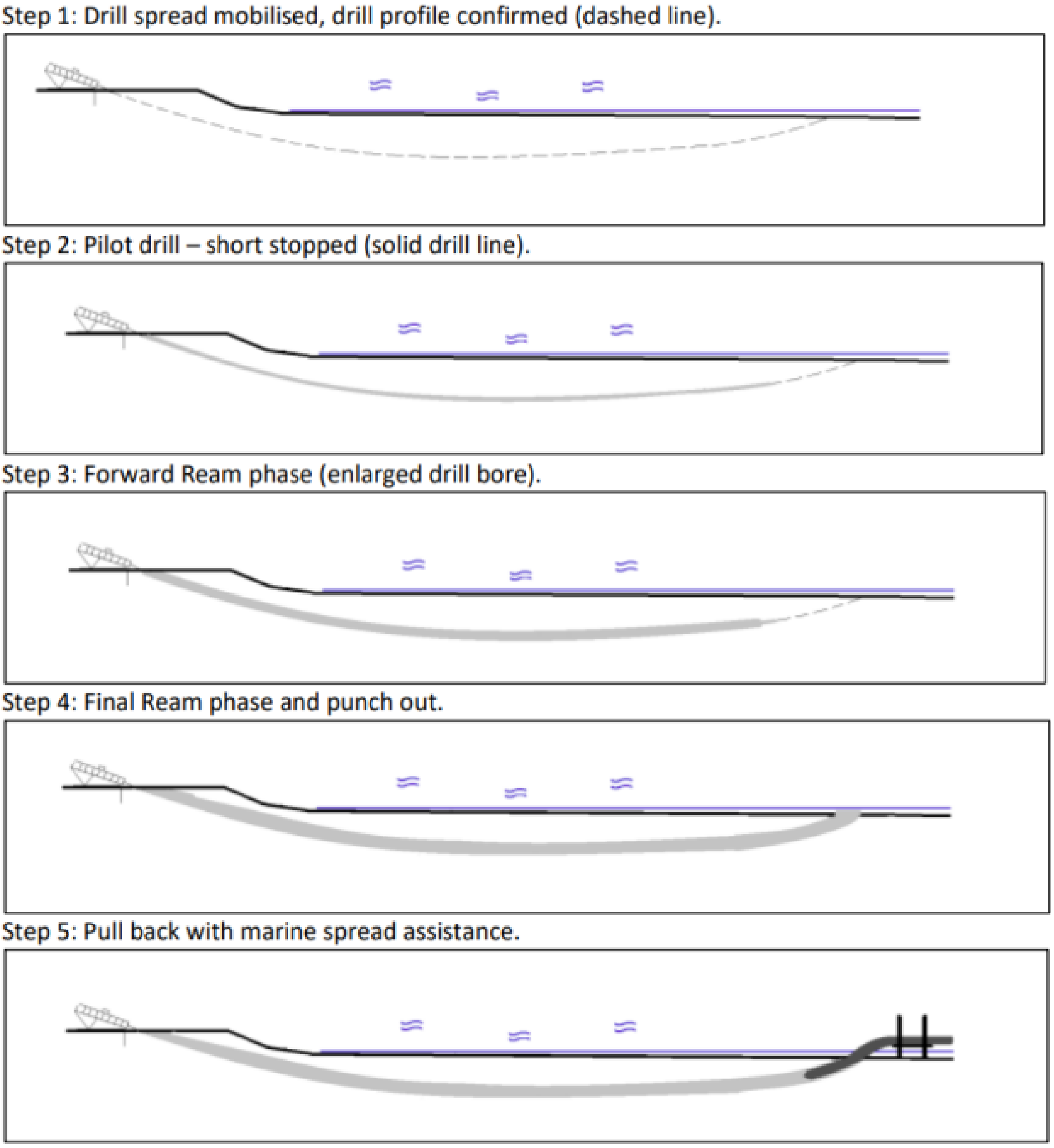
4.5.158 The trenchless technique entry point would be located onshore and directed out to sea, to avoid disturbance of the coastal flood defence, dunes and beach. The trenchless technique would reach 40 m at its maximum depth. For each borehole, a pilot hole would be drilled and then widened to the full diameter required. The primary activity that interacts with the offshore environment is where the trenchless technique breaks through the sediment (or punches out) onto the seabed. During the trenchless technique punch out, drilling fluid and cuttings would be released from the bore on to the seabed. Should HDD be the selected technique, works would broadly involve the following activities:

- Mobilisation and aligning the HDD Rig;

- Pilot hole drilling;
- Forward Reaming;
- Excavation of HDD pits (if required)
- Punch Out;
- Installation of ducts;
- Demobilisation;
- Re-excavating the HDD pits (if required); and
- Pulling of cables.

4.5.159 An illustration of an indicative HDD process is presented in **Plate 4-12**.

Plate 4-12 Illustration of a typical HDD process



Note: Alternatively step 5 may involve push through from onshore

4.5.160 The drilling fluids that would be used for the trenchless technique are likely to be a modified bentonite, a biodegradable drilling fluid additive, a modified natural cellulosic polymer, soda ash (sodium carbonate) and a natural biodegradable polymer which does not contain synthetic polymers, and a solidification reagent (or similar). All products used would be certified as being environmentally friendly. Bentonite is classified by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) (scientific advisors to DESNZ) as posing little or no risk to the marine environment.

4.5.161 The volume of drilling fluid and cuttings lost during punch out would be minimised by several factors, including the boreholes having been drilled to their maximum diameter prior to punch out and the continuous removal of drilling fluid and cuttings prior to punch out. Lower drilling fluid pumping rates would also be used during punch out to minimise the loss of drilling fluid. It is estimated that approximately 3,800 m^3 of drilling fluid would be released into the marine environment per duct (7,600 m^3 total).

4.5.162 An excavated exit pit may be required at the trenchless technique exit points to clear unconsolidated sediment layers that may jam equipment during punch out or prevent duct installation once the boreholes have been drilled. This excavation would be undertaken by either a backhoe excavator (barge mounted) or a controlled flow excavator. Up to two exit pits may be required measuring up to 750 m^2 each. Sediments would be side cast next to the pits for later backfilling. Exit pits would then be refilled with a combination of manual infilling (backhoe excavator) and natural backfilling. Exit pits would remain open until the cable pull in. Ducts laid in the bottom of the exit pits may be weighted to the seabed using clump weights, up to five concrete mattresses or up to 10 rock bags per duct. Temporary deposits would be within the excavated area and are unlikely to protrude above the original level of the seabed. If the pits naturally re-fill between punch out and cable pull-in additional excavation would take place, within the original footprint.

4.5.163 Should an exit pit not be required, the drill and duct would exit directly onto the seabed. Once installed, the ducts may still require to be weighted using clump weights, concrete mattresses, rock bags or temporarily buried.

4.5.164 Upon completion of borehole drilling, two HDPE ducts would be installed in each borehole. These may be pulled through from either onshore or offshore or pushed through from onshore. The method requiring the most offshore activity is a pulled installation from onshore. This would require a completed HDPE duct to be floated to the trenchless technique exit point and pulled through the borehole to the trenchless technique entry point in the onshore TJB. Floating the HDPE ducts would involve several vessels and tugs.

4.5.165 A jack-up barge, spud barge or multi-cat would be on site at the exit for a period of 2-4 months. This is to support the installation of the HDPE ducts as they are pushed or pulled through the boreholes. The vessels would be equipped with cranes, winches and dive support facilities. Other vessels used at this time may include a guard vessel, crew transfer vessels, a diver support vessel and tugs. A maximum of five vessels would be used.

4.5.166 Depending on the construction programme and any seasonal sensitivities at the Anderby Creek Landfall, there may be a break in works between the duct installation and the cable pull-in. The offshore end of the cable ducts would be “wet stored” for this period by fitting a temporary flange to stop water ingress. This would be either a blanking plate (flat plate) or marine bell mouth (not to be confused with onshore bellmouth junction relating to highways infrastructure) with blanking plate to cover. A bell mouth in this context, is a cone type structure, as illustrated in **Plate 4-13**. It would support the cable as it is pulled into the duct to ensure that the cable does not snag on sharp duct edges or bend too far. The duct ends would then be stabilised as described above.

4.5.167 To prepare for the cable pull-in, any deposits would be fitted with lifting rings, which divers would fit a chain from the surface deck crane. If the ducts have been buried into the seabed, they would be exposed using a barge mounted excavator, hydraulic dredge pump or controlled flow excavator. Once the bell mouth or flange is exposed, temporary bags of sand, rock or grout could be placed underneath the bell mouth to keep it raised off the seabed and prevent egress of sediment into the bell mouth during works.

Plate 4-13 Example of a marine bell mouth

4.5.168 At the start of cable pull-in, a pigging run will be performed to ensure the duct is clean, unobstructed and suitable for cable installation. During the pigging run, a messenger wire would be fed through each duct from the site compound. The messenger wire would be attached to a winch within the site compound. The cable lay vessel or shallow water barge would approach the Anderby Creek Landfall and position at approximately the 10 m water depth contour. The cable end would be transferred to a multi-cat or construction support vessel and the cable end sailed to the messenger wire at the duct exit. Floats would be installed along the cables to keep them from sinking to the seabed. Workboats would be positioned along the length of the floating cable, always ensuring the steady positioning of the cable.

4.5.169 The onshore winch would start to pull the cable through the duct. Floats would be removed by personnel on a workboat / pontoon or divers as the cable approaches the duct, allowing the cable to sink into and be pulled through the duct. Floats may either be allowed to wash to the beach in a controlled manner for retrieval or would be picked up by a support boat. A maximum nine vessels will be present for cable pull-in at any one time.

4.5.170 A cofferdam will not be used for the Anderby Creek Landfall enabling works.

Frac-out

4.5.171 Frac-out is the term for an unintentional or inadvertent loss of drilling fluid during the drilling of the boreholes. This occurs when a fracture in the underlying geology is encountered and drilling fluid finds an alternative path to the intended route, returning to the drill entry point for re-use and recycling. Drilling fluid can either be lost in the geological formation or can emerge at the surface. When released on an intertidal or subtidal surface, drilling fluid is rapidly diluted, dispersed and breaks down in the marine environment.

4.5.172 Due to the geology in this area, glacial till overlaying chalk, the trenchless technique would likely avoid the chalk layer, therefore minimising the likelihood of a frac-out. The components of the drilling fluid, including bentonite, are not hazardous to the marine environment (i.e., it is biodegradable, does not bioaccumulate and is non-toxic) and if released at the surface in the intertidal or sub-tidal area would not have any adverse effect on water quality or the environment. Construction Contractors would be required to ensure that chemicals used in the marine environment are selected from the CEFAS Offshore Chemical Notification Scheme (Ref 4.9).

4.5.173 The amount of drilling fluid used in a drill is closely monitored and therefore most frac-outs are of small quantities. However, if there were to be a large release, this could be visible as a plume in the marine environment for a short period (typically the length of the tidal cycle over which the release is occurring). Once drilling fluid is in contact with sea water, Sodium Chloride molecules (which are present in salt sea water) would react with the clay particles and polymers of the bentonite. The particulates in bentonite flocculate on contact with seawater. Immediately after this flocculation, the bentonite particle shrinks and becomes a flat platelet (de-flocculation). The seawater would discolour at the outbreak, but the particles would be mixed by tidal and wave driven currents and dilute over time and with distance from the outbreak so that any discolouration would be localised. Once the drilling fluid is diluted, the clay and polymer molecules would be separated from the freshwater component of the drilling fluid and would be broken down into such small particles they would no longer be visible by human eye. Dilution would continue during the following 1 to 2 tidal cycles until the discolouration disappears.

4.5.174 Measures to manage any such spills will be detailed in the Outline Marine Pollution Contingency Plan.

Cable Installation

Cable Laying

4.5.175 Following completion of the preparation activities, the cable would then be transported to the site ready for cable laying. When the cable lay vessel (CLV) arrives on site the cable would be transported via cable engines from the carousels on the deck to the over-boarding point at the back of the ship. Under tension, the cable would be guided over the back into the water. It would either be laid directly on the seabed for later burial or would be directed into a burial tool for burial into the seabed.

4.5.176 There are three possible configurations for cable installation:

- Pre-cut trenching – A pre-cut trenching vessel would tow a plough along the seabed creating a V-shaped trench. A separate CLV would follow, laying the cables directly into the trench. It would generally be followed by another construction support vessel towing a back-fill plough which would push the spoil heaps into the trench, covering the cables. Alternatively, the trench would be left to naturally backfill or be filled using external cable protection.

- Simultaneous lay and burial – This technique would simultaneously create a trench excavation and lay the cable into the trench at the same time. The CLV may tow the burial equipment, or it would be deployed by another vessel following close behind, creating effectively a single large spread. The cables would be fed into the burial equipment directly from above and the cables would be buried as the spread progresses along the route.
- Post-lay burial – The CLV would lay the cables on the seabed and a post-lay burial vessel would follow later to bury the cables. As the post-lay burial is a stand-alone operation, the post-lay burial vessel may operate with a longer separation distance from the CLV, so there would be two operations separated physically by distance and in time.

4.5.177 During cable installation a safety zone would be in place around construction vessels; typically 500 m in radius to allow safe manoeuvring of the installation vessel. This would be extended to cover an anchor spread if one is used. Depending on the burial tool used, the vessels would be moving at speeds of 25 to 300 m per hour during cable lay and burial. The cable laying operations can generally continue in weather conditions up to force 7 winds and wave heights of up to 3 m. Operations would continue until the total cable length within that cable section has been installed.

4.5.178 If the weather is more severe, and the vessels can no longer remain on station, there would be two options:

- The cable lay vessel would continue to slowly lay the cable onto the seabed, allowing the vessel to turn to face into the wind. After riding out the storm, the length of the cable laid during the storm (within the draft Order Limits) would be retrieved from the seabed and cable lay operations started again from the point of suspension.
- If the weather is too severe, it might be necessary for the cable lay vessel to cut the cable and leave the site until it is safe to return (appropriately marked and position recorded). This would be considered as a last resort. On return, the vessel would retrieve the end of the cable, make a joint and then continue the laying operation.

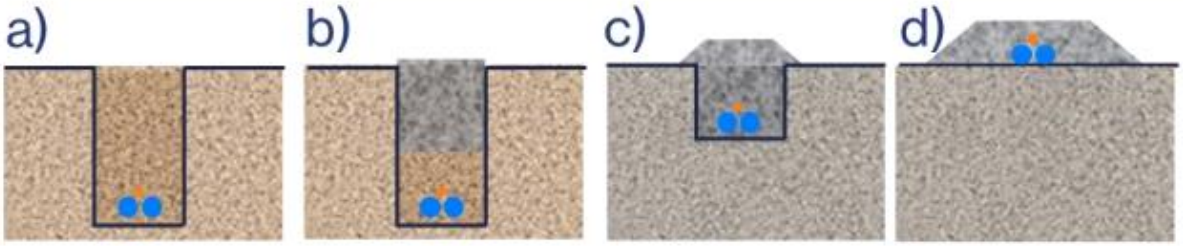
4.5.179 Cable lay and burial operations typically operate 24-hours a day to maximise the vessel and equipment time, and minimise disruption to shipping channels, fishing grounds or any other sensitive areas.

Burial Depths

4.5.180 Burial in the seabed is recognised as the best protection method for marine HVDC cables. However, ground conditions may not always allow full cable burial to the depth necessary to protect from external risks. The cable would be buried below the seabed wherever possible, with a target burial depth defined post-consent in a pre-construction CBRA and Burial Assessment Study undertaken by the cable installation contractor. The minimum and maximum cable burial depth would vary along the offshore scheme, depending on numerous factors such as soil type, presence/absence of sub-cropping or outcropping rock, shipping and fishing activity and the type of burial tool utilised.

4.5.181 Information on seabed conditions and water depth has been gathered through the 2025 geophysical survey. **Plate 4-14** presents the various cable burial and protection scenarios that may be encountered along the proposed English Offshore Scheme.

Plate 4-14 Typical Cable Burial and Protection Scenarios



a) Target depth of burial achieved - full burial in sediment.
b) Target depth of burial achieved - insufficient natural backfill, cable protection required to seabed level.
c) Target depth of burial not achieved - additional cable protection required above seabed level to achieve adequate protection.
d) Cables surface laid - protection provided fully by external measures.

4.5.182 The design envelope of the English Offshore Scheme is provided in **Table 4-11** below and is based on preliminary calculations from marine characterisation surveys. At this stage, no cable burial tools, as outlined in the section below, can be ruled out.

Table 4-11 Maximum design envelope for cable burial for the English Offshore Scheme

Aspect	Parameter
Length of cable	423 km
Maximum target burial depth	3.5 m
Indicative average target burial depth	1.5 m
Maximum width of trench	1.5 m
Maximum width of cable burial tool on seabed	25 m
Indicative area of seabed disturbed by cable installation	10.56 km^2

Burial Tools

4.5.183 There are a range of burial tools and techniques that could be used to bury the English Offshore Scheme. The selection of the tool would be based on numerous factors including the seabed geology and mobility, burial depth to be achieved, the installation contractor selected, proximity to existing infrastructure and environmental sensitivities and mitigation defined during the assessment process.

4.5.184 For all burial techniques, machine function would be controlled from the surface vessel via an umbilical cable. In shallow water, divers may be used to assist e.g., load cable into the machine.

4.5.185 The nature of the seabed, the target burial depth and the tool selection would influence how successful the first attempt at burying the cable is. Additional passes (i.e., where the burial equipment makes a number of attempts at burying the cable to get it deeper each time) would be made where the target burial depth is not achieved on the first attempt.

4.5.186 The following sub-sections describe the burial tools that could be used.

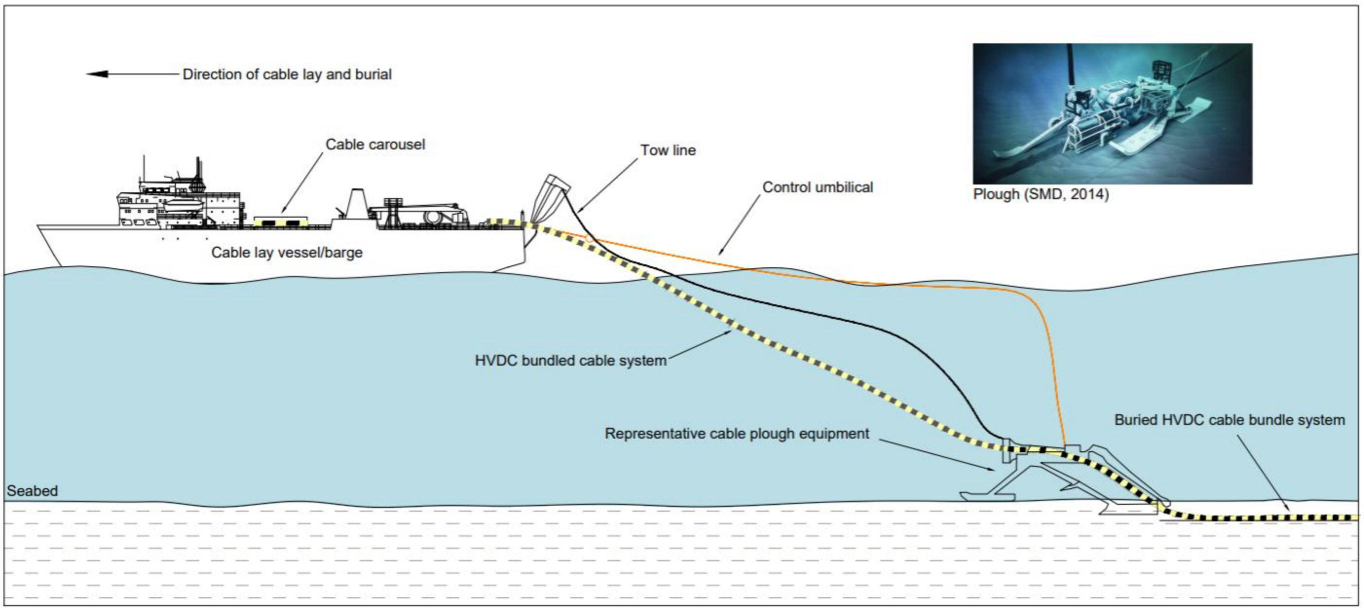
Cable Plough

4.5.187 Cable ploughs are used in non-cohesive soils such as loose coarse sand to fine dense sand and cohesive soils such as clay through to rock. They are either towed behind the cable lay vessel to simultaneously lay and bury the cables or towed by a separate vessel to bury the cables post-lay. A typical cable plough is shown in **Plate 4-15.**

4.5.188 The cable plough would be positioned on the seabed with the cable fed into the front of the burial machine. The cable would be guided through the machine to a plough 'share' to emerge in the trench the share leaves as it passes through the seabed. Soil displaced by the share is pushed to either side of the trench. The displaced soil may be simultaneously pushed by the plough back into the trench to cover the cables; pushed into the trench by a separate back-fill plough; or left in place to naturally back-fill the trench via natural seabed sediment movement.

4.5.189 The action of the plough has a greater seabed footprint of disturbance (in comparison to other techniques such as jet trenching).

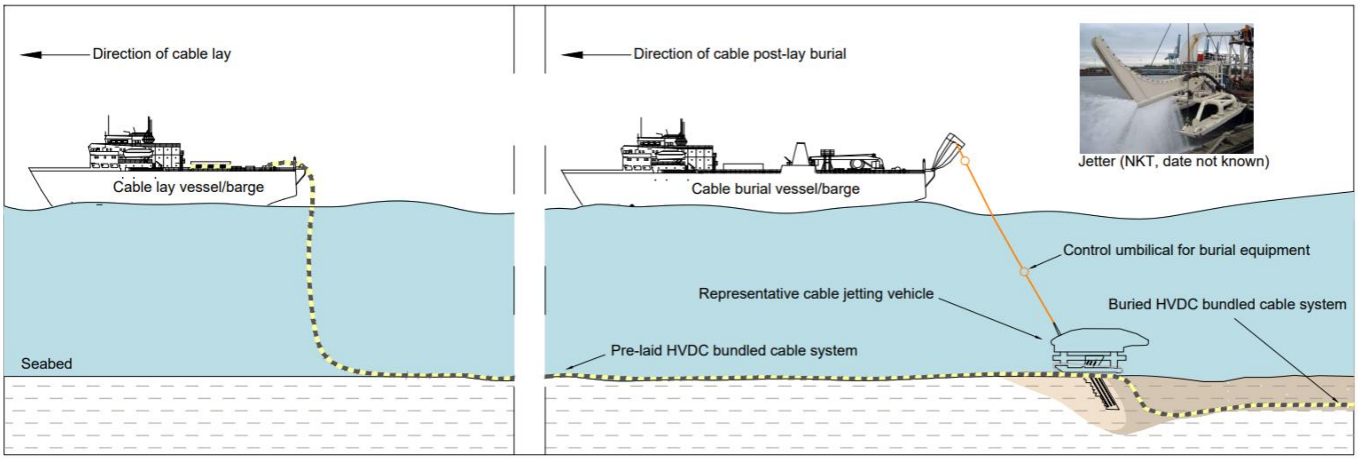
Plate 4-15 Example of a Typical Cable Plough



Jet Trenching and / or Vertical Injector

4.5.190 These burial tools are tracked or Remotely Operated Vehicle (ROV) fitted with jetting swords. Most jet trenchers are self-propelled ROVs, although some can be towed from the cable lay vessel. The trencher would be lowered to the seabed above pre-laid cables. High pressure water is pushed through jetting swords into the seabed on either side of the cable, to fluidise the sediment. Lowering mechanisms allow the swords to be lowered into the seabed to the required burial depth, usually with a transition to the target depth of burial. The pre-laid cables sink through the fluidised soil to the bottom of the trench. The seabed sediments naturally re-form and back-fill the trench covering the cables. If the required depth of burial is not achieved, several passes can be made. A schematic of the typical jet trenching process is shown in **Plate 4-16**.

Plate 4-16 Schematic of Typical Jet Trenching Method



4.5.191 Jet trenchers operate in unconsolidated sediments (sand, silt) and can achieve burial depths of up to 3 m. Vertical injectors operate using a similar principle to jet trenchers, but can achieve greater burial depths down to 10 m.

Backhoe Excavator

4.5.192 A backhoe excavator is used for digging, trenching, lifting and handling of material and is likely to be mounted on a jack-up platform, then fixed for stability against waves, tides and currents. The backhoe excavator features a backhoe arm which uses hydraulics to dig trenches in the seabed where cables can be later laid.

Cutting

4.5.193 Cutting is used on hard clay, cemented sand, sandstone and other types of rock. It would be used to either create a pre-cut trench into which the cables would be laid, or post-lay. The burial machine is usually a tracked vehicle that uses chain saws or wheels armed with tungsten carbon steel to cut a defined trench. Soil from the trench is ejected by the cutting action to either side of the trench. This action may be augmented by eductors that suck cut spoil out of the trench and deposit it on either side. The open trench would be backfilled or left to refill naturally.

4.5.194 The operation is slower than other burial methods and typically requires more frequent maintenance stops.

Controlled Flow Excavation (CFE)

4.5.195 CFE is a technique that uses highly pressurised water directed at the seabed to push sediment to either side of a trench. Also commonly referred to as MFE, this technique can also be used for the pre-sweeping of sand waves.

4.5.196 The CFE is operated and directly connected to the installation vessel and is suspended over the seabed unlike the previous methods noted above which are on the seabed.

External Cable Protection

4.5.197 External cable protection such as rock placement and concrete mattressing may be required in various areas along the English Offshore Scheme. These are discussed further below. Areas that require protection would include:

- Infrastructure crossings; and
- Areas where depth of burial cannot be achieved.

4.5.198 A preliminary review of the 2025 geophysical data has provided an indication of potential areas along the offshore draft Order Limits where external cable protection may be required. This will be reviewed and refined as the Project geotechnical data becomes available and detailed design is undertaken in advance of submission of the DCO and by the Contractor prior to construction.

4.5.199 Cable protection would be required at up to 58 infrastructure crossings, this cannot be avoided and is discussed in the following sections.

4.5.200 The design parameters for cable protection are listed in **Table 4-12**.

Table 4-12 Maximum Design Parameters for Remedial Cable Protection (excluding Infrastructure Crossings)

Aspect	Parameter
Maximum height of remedial external cable protection	1.5 m
Indicative length of remedial external cable protection	92 km
Maximum width of remedial external cable protection	16 m
Total indicative area of seabed affected by remedial external cable protection	1.472 km^2
Total indicative volume of remedial cable protection	2,208,000 m^3

Rock Placement

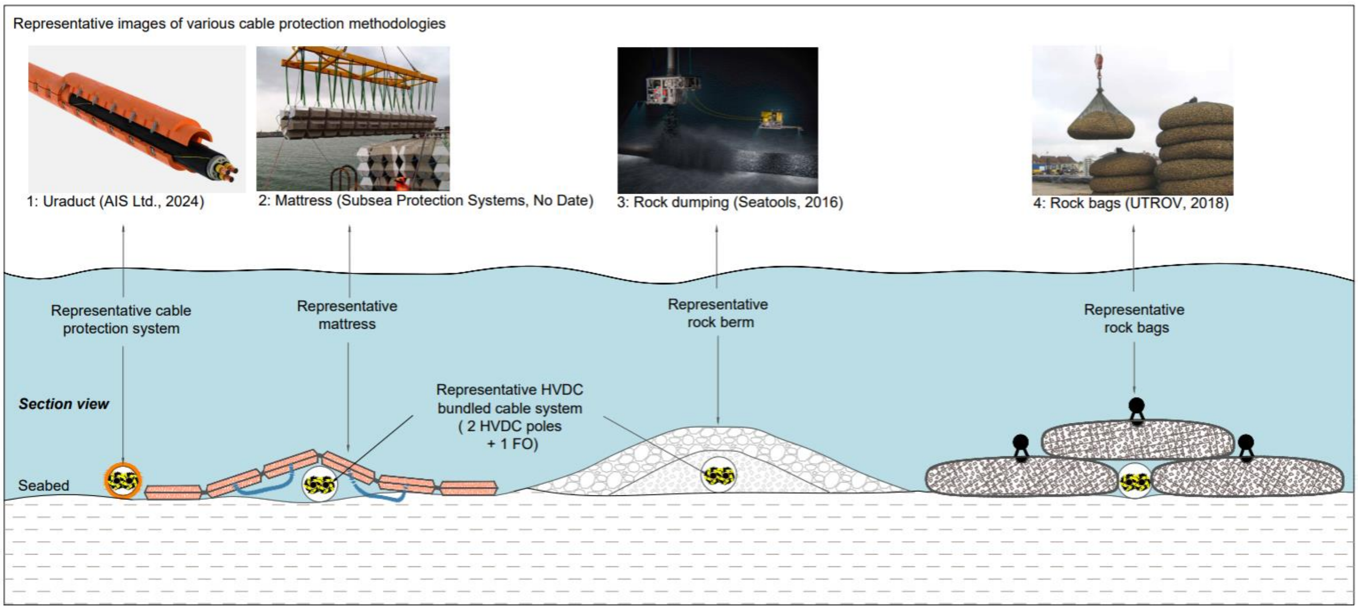
4.5.201 Rock placement is used to protect subsea cables by covering the cable with a continuous berm of graded rock which would be profiled. The berm is typically made up of two layers, a filter layer and then a layer of armour.

4.5.202 The filter layer is made of smaller particle size rock which is laid first to provide a stable layer for the armour layer, which comprises larger sized rock. The outer armour layer is designed to provide protection from external threats such as fishing gear or anchors as well as withstanding the metocean conditions.

4.5.203 Typically, the rock used would be an inert material such as granite to prevent the chances of non-native species being introduced to the area. The size of the berms would depend on the location of the berm and seabed conditions and would be individually designed as indicatively shown in **Plate 4-17**.

4.5.204 The berm is typically constructed using a fall pipe vessel which would place rock over the cable in a targeted manner.

Plate 4-17 Example Schematic of a Rock Berm



Concrete Mattresses

4.5.205 A concrete mattress comprises of matrices of interlinked concrete which are connected with rope and wire. They are installed using a crane from a construction support or diving vessel, which would lower the mattress into position over the cable.

4.5.206 Concrete mattresses are typically 6 m in length and 3 m wide and provide a strong protective cover to prevent potential snagging of fishing gear or anchors. They are not as protective as rock berms and it is possible for the mats to be caught and dragged by anchors or moved by strong currents, so they cannot be used in all locations. Multiple mattresses can be laid to provide larger area of coverage. For infrastructure crossings, mattresses are used in combination with rock protection.

4.5.207 There are various companies in the market that are investigating alternative designs for concrete mattresses to make them more nature inclusive. Concrete blocks are designed with complex surface structures and textures to encourage marine life to colonise them once installed. The concrete may also include chemical additives which promote the growth of encrusting organisms such as oysters and barnacles.

Flow Dissipation Devices

4.5.208 The purpose of a flow dissipation device is to reduce the velocity of water passing over, encouraging sediment to drop out of suspension and accrete. They are often used to protect structures from erosion. The most commonly used device is a fronded system/mat which can be either used on its own or attached to a concrete mattress. The system comprises of UV polypropylene fronds secured to a polyester webbing. Once laid, they resemble seaweed which interrupts and reduces the velocity of the local currents. The drop in velocity allows the sediment to drop out of suspension and build up on the mats to form a natural embankment on and around the mat.

4.5.209 Fronded mats are suitable to be used in areas where the seabed is primarily sand, as they are designed to capture sediment as it moved over the mattress, they would not be appropriate on a rocky seabed environment. The mats can be custom made but are typically 5 m in length and 2.5 m wide, with the fronds being up to 1.25 m in length.

4.5.210 As technologies develop, there are opportunities for fronded mats to be made of non-plastic products.

Protective Coverings, Claddings or Pipes

4.5.211 There are several varieties of protective coverings for subsea cables currently on the market such as Uraduct® or TekDuct, which are polyurethane half tubes and used to enclose the cable bundle. They can include a ballast should the cable system need to be weighted down further.

4.5.212 There are also cast iron and concrete versions of the half pipe which can also be used. This type of protection is typically used in combination with another type of protection such as rock placement. However, it can be used as a standalone method for short lengths of cables.

Rock, Gravel and Sand Bags

4.5.213 Rock bags consist of various sized rocks (or sand and/or gravel) within a rope or wire netting bag, although there are new products coming on to the market whereby the bags are made from specially developed basalt fabric. They would be installed using a crane from a construction vessel placing them over the cable in the correct position.

Sand Backfill

4.5.214 Sand sourced from the seabed adjacent to the cable trench may also be used to backfill the trench. A fall pipe vessel would be used to gather and place the sand within the trench. The fall pipe system enables the controlled installation of backfill materials without excessive misplacement, which is crucial for maintaining the integrity of the cable installation.

Nature Inclusive Design

4.5.215 Wherever possible and appropriate, opportunities to incorporate nature inclusive design solutions into the cable protection will be considered. Nature inclusive design incorporates measures that are integrated into or added to the design of cable protection to increase suitable habitat for native species (or communities). This could include designing the cable protection to encourage growth of benthic fauna to increase biodiversity.

Cable Jointing

4.5.216 Cable lay vessels are limited in the length of cable they can carry in a single load (typically 5,000 to 10,000 tonnes). For the cable system design, this equates to cable lengths in a bundled configuration of 80 – 100 km. Sections of offshore cables would be connected by a cable joint. The cable system would therefore require four joints and up to eight joints within the English Offshore Scheme due to its length.

4.5.217 At the cable joint position, the end of the installed cable would be temporarily left on the seabed whilst the cable lay vessel returns to port to pick up a new cable length. A ground wire would be attached to the cable end to enable retrieval when the cable lay vessel returns. The cable end may be temporarily buried into the seabed, marked with a buoy and/or guarded by a guard vessel whilst the cable lay vessel is offsite.

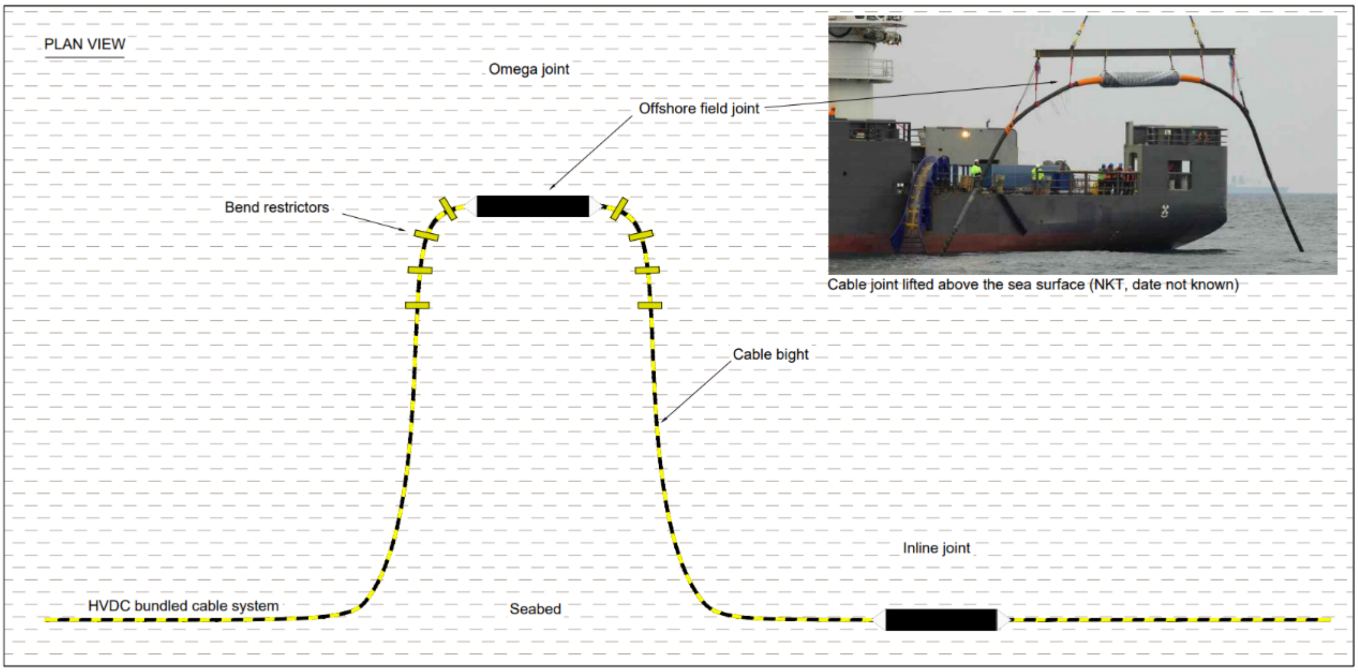
4.5.218 The cable joint would be made on board the cable lay vessel and would take up to two weeks per joint location. During this time, the cable lay vessel would likely anchor to maintain position. Once the cable joint has been made, the cable lay vessel would continue to lay the new cable section.

4.5.219 In-line joints would be made where cable laying can be continued after the cable end has been picked up. Where the cable is laid towards the cable end, or where a repair is required in an existing cable, an omega joint is made, as illustrated in **Plate 4-18**. In this scenario, both cable ends would be bought on board the cable lay vessel to make the joint. The process requires extra cable, approximately equal to three times the depth of water to allow for the transition of each cable from the seabed to the surface to make the joint. When the cable is returned to the seabed the additional cable would be laid on the seabed to one side of the centreline in a loop.

4.5.220 For both types of joint, the joint and cables would be buried (as the preference) or protected by external cable protection.

4.5.221 It is assumed that the seabed footprint for cable jointing is within the design envelope for seabed preparation and cable installation described in Paragraphs 4.5.98 to 4.5.136 and Paragraphs 4.5.175 to 4.5.196 respectively. Cable operations and maintenance requirements are described in **P**aragraphs 4.6.1to 4.6.17.

Plate 4-18 Indicative Illustration of Subsea Cable Joints



Infrastructure Crossings

4.5.222 The works that would be undertaken to prepare the seabed for infrastructure crossings are described in Paragraphs 4.5.197 to 4.5.215. This would involve installing a protective layer between the existing infrastructure and the HVDC cables as part of the English Offshore Scheme.

4.5.223 An exclusion zone either side of the existing infrastructure would be agreed as part of the crossing agreement. The burial tool would transition out of the soil before reaching the exclusion boundary, and the English Offshore Scheme would be surface laid over the infrastructure 'bridge' created during the seabed preparation works. A protective layer may also be installed on the cables to create a barrier between the infrastructure bridge and HVDC cables for the English Offshore Scheme. A minimum vertical separation between the existing infrastructure and the HVDC cables for the English Offshore Scheme, typically 300 mm, would be agreed with the asset owners, and the crossing engineered to achieve the agreed vertical separation. Burial (as applicable) would continue after cable lay progresses outside of the burial exclusion zone on the opposite side of the crossed infrastructure.

4.5.224 External cable protection would then be laid over the the surface laid HVDC cables for the English Offshore Scheme (including the zones where the HVDC cables transited out and into the soil). **Plate 4-17** illustrates a typical crossing berm.

4.5.225 The physical crossing designs for each infrastructure crossing would vary according to, among other things, the size, type, location and burial state of the crossed asset, and the exclusion zone. However, the crossings would not exceed the maximum design parameters presented in **Table 4-13**.

4.5.226 If the HVDC cables for the English Offshore Scheme are exposed for any period e.g., between cable lay and deposition of external cable protection, a guard vessel would be deployed.

Table 4-13 Maximum Design Parameters for Infrastructure Crossings

Aspect	Parameter
No. of infrastructure crossings	58
Typical length of external cable protection per infrastructure crossing	500 m
Total length of cable crossings	29,000 m
Maximum width of infrastructure crossings	16 m
Maximum height of infrastructure crossings	2.5 m (where pipeline bridges are required)
Maximum number of concrete mattresses	290
Maximum number of pipeline bridges	10
Total area of seabed affected by infrastructure crossings external cable protection	0.464 km^2

Cable Wet Storage

4.5.227 It may be necessary to temporarily store sections of the cable on the seabed prior to installation. Sections would be placed on the seabed within the draft Order Limits and its location communicated to mariners through a Notice to Mariners.

Post-Lay Survey

4.5.228 A post lay burial survey would be completed once all cable lay and burial operations, including any remedial works are finished. The survey would consist of geophysical survey techniques such as MBES and cable tracker. The objective of the survey is to confirm the final seabed level along the cable and confirm the final burial depth.

Construction Installation Vessels

4.5.229 A range of different vessels would be required during construction of the English Offshore Scheme. The use of specific vessels such as the Cable Lay Vessel (CLV) or a Cable Lay Barge (CLB) would be confirmed once the installation contract has been awarded (post consent).

4.5.230 Details of vessels deployed on similar cable installation projects to the English Offshore Scheme have been used to inform the description of representative vessels. It is expected that the following types of vessels would be used; descriptions of each are provided in the subsequent sections:

- Survey vessels (including ASVs);
- Dredging vessel (such as TSHD);
- Cable lay vessel;
- Cable lay barge;
- Cable pull barge;
- Anchor handling tug;
- Jack-up / spud barge;
- Guard vessel;
- Construction and dive support vessels; and
- Rock placement vessels.

Survey Vessels

4.5.231 An offshore survey vessel is typically a medium to large sized ship, purpose built or converted for geophysical, geotechnical and environmental surveys in deep or open waters. These vessels are generally over 60 m in length and are equipped with Dynamic Positioning (DP), advanced sonar systems, sub-bottom profilers, and ROVs.

4.5.232 Nearshore survey vessels are smaller, more agile craft designed for operations in shallow coastal waters, estuaries and harbours. Ranging from 10 to 30 m in length, they are often catamarans or monohulls with shallow drafts. These vessels are equipped with multibeam echosounders, side-scan sonar and positioning systems suitable for high-resolution bathymetric and environmental data collection in constrained and environmentally sensitive areas.

4.5.233 Autonomous Surface Vessels (ASVs) may be used to carry out survey work in offshore and nearshore areas. These are small, remotely operated or automated vessels equipped with geophysical survey sensor. They are well suited to shallow or restricted waters and allow survey data to be collected safely and efficiently without the need for onboard crew.

Dredging Vessel

4.5.234 A dredging vessel, such as a Trailing Suction Hopper Dredger (TSHD), may be used where seabed material requires removal to facilitate cable installation, burial, or the creation of suitable seabed conditions at crossings or landfall approaches.

4.5.235 A TSHD is a self-propelled vessel typically ranging from 70 m to over 150 m in length and is equipped with one or more suction pipes fitted with drag heads that are lowered to the seabed to dredge sediments. Dredged material is stored temporarily within an onboard hopper and may be disposed of at a licensed offshore disposal site or re-used for seabed reinstatement, depending on project requirements.

4.5.236 The vessel is generally fitted with Dynamic Positioning (DP) or advanced positioning and navigation systems to ensure accurate dredging along the cable route. Operations are normally undertaken while the vessel is underway at slow speed, with activity levels and footprint dependent on seabed conditions and the depth of material to be removed.

4.5.237 Other dredging vessels that may be used include backhoe dredgers, grab dredgers, or multi-purpose shallow-draft dredgers. These are typically suited to landfall, nearshore or confined areas and would be used to dredge seabed material where access or water depth limits the use of larger vessels.

Cable Lay Vessel (CLV)

4.5.238 The CLV is a specialist ship designed specifically to carry and handle long lengths of heavy power cables. The CLV will be equipped with a DP system, which enables the vessel to be held very accurately in position despite the effects of adverse weather. The shallowest depth in which the CLV can operate will depend on the vessel used but is typically around 10 m LAT, although some vessels can operate in much shallower depths.

4.5.239 The cable will be loaded onto powered turntables (carousels) on the back of the CLV at the cable production factory. The cable will be transported in this manner to prevent any twists or kinks in the cable.

4.5.240 The CLV typically is assisted by a team of other vessels and possibly divers depending on the cable laying technique being used. The small vessels are used to monitor traffic and guard the vessel spread.

Cable Lay Barge (CLB)

4.5.241 A CLB may be required at the Anderby Creek Landfall. These types of vessels typically operate in water depths less than 10 m LAT. These shallow water operations are generally conducted upon flat top pontoon barges. These barges are fitted out with the necessary cable storage and working equipment.

4.5.242 Typically, a CLB uses anchors (up to 8 in total) to hold position covering an area of between 500 m and 1,000 m radius from the vessel, alternatively the CLB may use spud legs which can be jacked up and down allowing the barge to tether to the seabed if required.

4.5.243 The CLB typically is assisted by a team of other vessels and possibly divers depending on the cable laying technique being used. The small vessels are used to move anchors, monitor traffic and guard the vessel spread.

Cable Pull Barge / Jack Up Barge / Spud Barge

4.5.244 These barges are self-elevating platforms used in the nearshore cable landfall operations. The platform is towed into position, where one to four legs are lowered onto the seabed and the platform is jacked up above the waterline to provide a stable working base.

Anchor Handling Tug

4.5.245 Dedicated anchor handling tugs may be used to support the CLB. They can move the anchors to allow the barge to propel itself within the proposed Offshore draft Order Limits.

These specialised vessels are typically 30 m in length and have the ability to work in the shallower depths of the nearshore area. Jack-up/anchored barge or vessel/multi-cat.

4.5.246 A jack-up barge is a platform that generally has four to eight legs which can be adjusted for the sea conditions. These types of vessels may be used at the trenchless technique punch-out point to support the drilling and pull-in of the cables.

4.5.247 The jack-up barge does not have its own propulsion system, so it is towed into position by a tug.

Guard Vessel

4.5.248 Guard vessels are used to ensure the safety of mariners operating in the vicinity of construction and maintenance activities associated with the cable. They may be required to accompany the CLV or CLB, particularly in areas of high-frequency shipping. The guard vessel or other construction support vessels maintain surveillance around the CLV/CLB to monitor traffic and would notify other vessels to keep away from the installation spread to avoid the potential threat of collision.

4.5.249 Guard vessels are also used to protect areas of exposed cables prior to burial or deposit of external cable protection. A guard vessel may also be used to warn fishing vessels from areas of the route that are temporarily unprotected during the gap between cable lay and burial or the installation of external cable protection, to avoid any snagging of fishing gear.

4.5.250 Guard vessels are typically quite small, preferably locally sourced and crewed to the project location to ensure that they are familiar with areas they are guarding. They are frequently fishing vessels who are unable to fish their normal grounds due to the construction works.

Construction Support Vessels (CSV’s)

4.5.251 There are several other types of support vessels which would be used during the construction of the English Offshore Scheme. These are likely to include Dive Support Vessels (DSV), crew transfer vessels, general construction vessels (CSV) and small rigid inflatable boats. The DSVs and CSVs would vary in size depending on the type of activity they would be required to do and the working conditions. They may also undertake several different roles on a project, such as inspections for UXO or archaeology, PLGR, anchor handling or the placement of mattresses at crossing locations.

Rock Placement Vessels

4.5.252 Vessels used for rock placement are highly specialised. They comprise of a large hopper to transport the rock and a mechanism for the deployment of the rock at the correct location. This can use the following techniques:

- Side dumping where rock is pushed or tipped over the side of the vessel;
- Split hopper where the hopper separates to allow the rock to fall straight through the vessel on to the seabed below; and
- Flexible fall pipe where a retractable chute is used to accurately control a flow of rocks over the cable on the seabed.

4.5.253 The use of the fall pipe is the most accurate technique but can only be used in waters over 10 m in depth.

Indicative Vessel Movements

4.5.254 **Table 4-14** provides an indication of the types of vessels to be used during construction based on experience on other projects. Vessels would typically transit in a linear manner along the proposed English Offshore Scheme. However, their ports of origin are unknown at this stage and will not be known until an installation contractor has been appointed. **Table 4-15** provides an indication of the total number of vessels that would be used for activities for the English Offshore Scheme.

Table 4-14 Vessel Requirements for the English Offshore Scheme

Construction Activity	Maximum number of return trips per vessel type
Preconstruction survey vessels	156
Construction support vessels	1500
Anchor handling tug	90
CTV	452
Jack-up barge / cable laying barge / spud barge / multi-cat	50
Cable laying vessels	55
Guard vessels	600
Rock installation vessel	200

Table 4-15 Total number of vessels at any one time per construction activity

Activity	Maximum number of vessels at any one time
HDD / Pull-in	9
Nearshore Campaigns	17
Offshore Campaigns	17

4.6 Operation and maintenance

English Onshore Scheme

4.6.1 Routine inspection and periodic maintenance and repair of the English Onshore Scheme would be required during its operational lifetime and access point details will be subject to further design and will be assessed in the ES. The routing inspection would identify any damage or deterioration of the components or becoming life-expired and requiring replacement. Typical maintenance procedures are summarised in **Table 4-16**.

Table 4-16 Indicative Maintenance Procedures

Scheme Element	Example Maintenance Works
Underground DC and AC onshore cables	Activity along the proposed DC and AC onshore cable routes would generally be limited to cable repairs and non-intrusive inspections. 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 like those outlined above for installation, albeit over a much smaller section.
Converter station	The converter station would be operated by a small team that visits the site weekly and otherwise as and when required. During maintenance (planned and unplanned), the number of personnel present on site would increase with the number of staff proportionate to the nature of the maintenance works being undertaken. Works include: • Visual inspections of equipment within converter station to ensure smooth and efficient working, • Servicing of equipment, such as cleaning, adjustment and lubrication. • Repair and replacement of equipment which is faulty or damaged.

English Offshore Scheme

4.6.2 The English Offshore Scheme would be designed to minimise any maintenance requirements. Following installation, routine maintenance of the HVDC subsea cables is not anticipated, however, the following activities may be periodically required during the operational phase:

- Inspection surveys, including geophysical surveys;
- Cable repair (if required) (noting that emergency repairs requiring immediate action are exempt activities and do not require a marine licence); and
- Reburial, remedial protection or maintenance and reinstatement of external cable protection features.

In-Service Survey Operations

4.6.3 Geophysical surveys would be undertaken periodically to monitor cable burial and the status of external cable protection e.g., remedial or at infrastructure crossings. If results of the as-laid survey show that the English Offshore Scheme is not at the required burial depth or has become exposed, remedial works could be undertaken as described in Paragraphs 4.5.197 to 4.5.215 Additional surveys may be undertaken after storm events which exceeded the design conditions.

4.6.4 Surveys would use the standard suite of geophysical techniques described in Paragraph 4.5.100 (i.e., multibeam echosounder, side-scan sonar, sub-bottom profiler, magnetometer etc). Nearshore and offshore survey vessels or an automated underwater vehicle would be used.

Cable Repair

4.6.5 Should a fault be identified by the cable monitoring system, it would be necessary to access the relevant location of the fault and retrieve the cable to the surface for inspection. The cable would be inspected with an ROV, then cut if it needs to be retrieved to the surface. The damaged section would then be repaired or replaced. The most common reason for a repair of a subsea cable is damage caused by third parties, typically by a vessel anchor strike on a shallow or exposed cable segment.

4.6.6 A cable repair would typically be carried out by a single vessel. For a shallow water repair, in less than 10 m of water, an anchored barge would typically be used. In deeper water, a DP cable vessel would be used. Vessels carrying out cable repair operations are restricted in their ability to manoeuvre and divers and/or ROV would be expected to be used with associated vessels.

4.6.7 The actual operational details and the precise configuration of a repair spread would depend on the type of repair identified. The typical steps would comprise:

- Loading of spare cable to the repair vessel;
- Survey to locate the damaged cable;
- Cable de-burial;
- Cable cutting and recovery to the surface;
- Splicing in the replacement section of cable; and
- Re-deployment of cable onto the seabed and re-burial.

4.6.8 A repair would require the insertion of additional cable and two additional cable joints. The additional cable length may be equal to or greater than approximately three times the depth of the water at the site, depending on how much damage the cable has sustained.

4.6.9 If the repair is of a single cable in a bundled pair, the pair of cables would need to be cut, and both brought to the surface. However, it is possible that both cables might be repaired as a precaution against undetected damage.

4.6.10 The extra length of a repaired cable section means that the repaired cable cannot be returned to its exact previous position and alignment on the seabed. The excess cable would be laid on the seabed in a loop to one side of the original route to form an ‘omega’ loop, as illustrated in **Plate 4-18**. This new piece of cable would then be buried into the seabed, or external cable protection would be deposited if burial is not feasible due to ground conditions or position.

4.6.11 A cable repair operation would be expected to take between two and six weeks depending on the type and extent of the damage, the burial requirements, and operational constraints such as weather.

4.6.12 The requirement for repair operations during the lifetime of the proposed English Offshore Scheme would depend on the number of faults, location of the faults, and the burial/protection method used for the original installation.

4.6.13 The maximum parameters for cable repairs over the lifetime of the English Offshore Scheme is provided in **Table 4-17**.

Table 4-17 Maximum parameters for cable repairs

Aspect	Parameter
Total length of repairs	13,000 m
Indicative length per repair	1,000 m
Total number of repairs over Project lifetime	13
Maximum width of external cable protection for repairs	16 m
Maximum height of external cable protection for repairs	2 m
Volume of cable protection per repair	14,000 m^3
Total cable protection area for repairs	208,000 m^2
Maximum number of vessels per repair	5

Cable Remediation

4.6.14 Cable remediation works may involve either reburial of exposed cables, or use of cable protection to cover the cable, where reburial is not possible.

4.6.15 A cable remediation will typically be carried out by a single vessel (for either cable reburial or protection), although up to four vessels may be used, allowing for survey vessels and guard vessels (where required). For a shallow water repair, in less than 10 m of water, an anchored barge will typically be used. In deeper water, DP vessels are favoured. Vessels carrying out cable remediation operations are restricted in their ability to manoeuvre.

4.6.16 The actual operational details and the precise configuration of a remediation spread will depend on the type of remediation required. However, typically, it would comprise of a survey to identify the area of exposure, cable re-burial or protection works, and a post-remediation survey to confirm that the cable is now fully protected (either by sufficient depth of lowering of the cable being achieved or though external cable protection).

4.6.17 The maximum parameters for cable remediation are provided in **Table 4-18**.

Table 4-18 Maximum parameters for cable remediation

Aspect	Parameter
Total length of remediations	8,000 m
Indicative length per remediation	1,000 m
Total number of remediations over Project lifetime	8

Aspect	Parameter
Maximum width of external cable protection for remediation	16 m
Maximum height of external cable protection for remediation	2 m
Volume of cable protection per repair	14,000 m^3
Total cable protection area for remediations	128,000 m^2
Maximum number of vessels per remediation	4

4.7 Emissions

4.7.1 The emissions that may occur during cable installation or operation are:

- Electric and magnetic fields;
- Heat; and
- Underwater sound.

English Onshore Scheme

Electric and Magnetic Fields

4.7.2 All equipment that generates, distributes or uses electricity produces Electric and Magnetic Fields (EMFs). Exposure limits for EMFs in the UK are set by the Government on advice from Public Health England, and the electricity industry strictly adheres to these limits. The exposure limits for both DC and AC cables originate from the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines, published in 1994 and 1998 respectively and recently updated in March 2020.

4.7.3 Other onshore emissions associated with traffic, air quality, noise, dust and lighting are outlined within the relevant technical aspect chapters within **Volume 1, Part 2 English Onshore Scheme** of this PEIR.

English Offshore Scheme

Electric and Magnetic Fields

4.7.4 The English Offshore Scheme would use Direct Current (DC) technology which has a frequency of zero hertz (0Hz) and would produce static EMFs.

4.7.5 Electric fields depend on the operating voltage of the equipment producing them and are measured in V/m (Volts per metre). As the proposed English Offshore Scheme cables would be enclosed in a solid metal sheath, which screens the electric fields, they would not produce an external electric field. However, they would produce a magnetic field, which is not screened by the metal sheath, and seawater moves through the magnetic field, a small localised electric field is produced. This is known as an induced electric field.

4.7.6 Magnetic fields depend on the electrical currents flowing, which vary according to the electrical power requirement at any given time and are measured in μT (microtesla). Magnetic fields generated by the operational cables diminish rapidly with distance from the source.

4.7.7 The earth also produces its own DC magnetic field, which in the UK is around 50 μT, but this can vary due to geomagnetic material such as ferromagnetic rocks. Given the natural magnetic field, the background induced electric field could range between 4.9 and 61.3 μV/m in tidal velocities ranging between 0.1 m/s and 1.25 m/s.

4.7.8 The estimated magnetic fields for the English Offshore Scheme have been calculated for a single cable configuration of bundled HVDC cables. Currently the trenchless technique for the Project has not been finalised, therefore there is up to 300 m between MHWS and the trenchless technique exit point that has been excluded from the modelling scenarios. This will be included within the ES once the trenchless technique design has been finalised and following the results of survey work.

4.7.9 All calculations were performed assuming the current maximum circuit separation and minimum burial depth, and 100% load giving a worst-case scenario. The maximum magnetic field for each design option was calculated at vertical distances of 0 m to 20 m from the seabed, and horizontal drop off along the seabed. A worst-case (minimum) burial depth of 1 m was used for all calculations. The assessment is provided in **Volume 2, Part 1, Appendix 4.A Electric and Magnetic Field Assessment.**

Magnetic Compass Deviation

4.7.10 Magnetic compasses, whether traditional magnetic needle designs or alternatives such as fluxgate magnetometers, operate from the Earth's magnetic field, and are susceptible to any perturbation to the Earth's magnetic field by other sources.

4.7.11 The MCA in their response to the Scoping Opinion stated that "*The MCA would be willing to accept a three-degree deviation for 95% of the cable route and for the remaining 5% of the cable route there must be no more than a 5 degree electromagnetic compass deviation. On receipt of the study, the MCA reserves the right to request a deviation survey of the cable route post installation."*

4.7.12 The magnetic fields and compass deviation at the sea's surface were calculated for the proposed English Offshore Scheme for the same three design scenarios considered by the EMF calculations. The assessments were performed using cable orientation and depth from bathymetry data. The orientation of the cables to north, separation and depth, as well as the current flowing in the cable, will all impact the extent a compass is deviated from the Earth's magnetic north.

4.7.13 The compass deviation calculations assume that the cable would be buried 1 m below the seabed. The compass deviation calculation results are calculated at the sea surface. In practice, the draft of any vessel will limit the sea depth that applies, and the compass is likely to be situated above the water line, both of which will reduce the compass deviation that will be found in practice.

4.7.14 The calculations, presented in **Volume 2, Part 1, Appendix 4.A Electric and Magnetic Field Assessment**, show that when HVDC cables are bundled, the MCA thresholds are not exceeded.

Heat

4.7.15 As well as EMF, cables generate heat as a by-product of transmitting electricity. The generated heat has the potential to raise the temperature of the seabed in proximity to the cables and consequently, alter the surrounding habitat, potentially resulting in impacts to benthic and fish species. The heat losses from the cables are related to the physical and thermal properties of the cables. A number of scenarios were modelled to evaluate the thermal performance of the cables, including directly buried in a bundle to differing depths and contained within a duct at the Anderby Creek Landfall at various depths. The results presented in **Volume 2, Part 1, Appendix 4.B EGL 5 Heat Calculations** and show that for cables operating at full power, temperature would be raised in the immediate vicinity of cables but reduces within increasing distance. The heat would be highly dependent on the depth of burial and the thermal resistance of the surrounding seabed. Temperature is likely to fluctuate as the cables would be unlikely to be operating at maximum capacity all the time or for extended periods of time (months/years).

Underwater Noise

4.7.16 The predominant noise generating activities during the installation and operations of the proposed English Offshore Scheme would be from:

- Geophysical survey equipment (e.g., side scan sonar, multi-beam echosounder and sub-bottom profiler);
- Cable trenching (vessel and equipment noise);
- Placement of external cable protection (vessel, equipment and rock placement noise);
- Investigation and clearance of potential UXO (note clearance is subject to a separate Marine Licence); and
- Movement of vessels.

4.7.17 UXO clearance is being consented via separate Marine Licence and is therefore not assessed in detail, a high-level assessment is provided only to ensure a holistic view of the Project.

4.7.18 The above activities include both impulsive and non-impulsive (continuous) anthropogenic sound sources:

- Impulsive sounds include pulses generated during geophysical surveys, which can be characterised by short duration pulses, broad bandwidth and have rapid rise and decay period with high peak pressures.
- Non-impulsive sounds include the continuous sounds from vessel movements, which can be characterised by low level sounds spread over a longer period of time that do not have a rapid rise and decay times or high peak pressures.

4.7.19 Underwater modelling was undertaken for Eastern Green Link 3 and Eastern Green Link 4 and has been referred to for the English Offshore Scheme. Results of the underwater noise modelling are included in **Volume 2, Part 3, Appendix 21.A Eastern Green Link 3 and Eastern Green Link 4 Underwater Noise Technical Assessment.**

4.8 Decommissioning and Demolition

Introduction

4.8.1 NPS EN-1 (Ref 4.2) Paragraph 4.3.5 states that the ES should cover the decommissioning of a project. Decommissioning of electricity networks is not specifically covered in NPS EN-5 (Ref 4.4) although Paragraph 2.1.4 recognises that generally, nationally significant electricity networks are likely to have an ongoing function, but will be subject to maintenance, reinforcement works and for assets to be replaced when they come to the end of their lifespan.

4.8.2 There are currently no specific plans to decommission the Project. It is expected that the transmission of electricity would continue for as long as there is a business case for doing so and that any decommissioning activity would occur decades into the future. To date, relatively few transmission projects have been decommissioned since the main expansion of such infrastructure in the 1950s and 1960s.

4.8.3 It was proposed within the EIA Scoping Report (Ref 4.10) that a full decommissioning assessment of the English Onshore Scheme be scoped out, with which the Planning Inspectorate agreed within the Scoping Opinion, based on the level of information provided. This justification (updated where relevant) is provided in **Table 4-19.** If the English Onshore Scheme, or any part of it, were to be decommissioned, a written scheme of decommissioning would be submitted for approval by the relevant planning authorities. The decommissioning works would follow NGET processes at the time for assessing and avoiding or reducing any environmental impacts and risks. Potential effects from works required for decommissioning would be separately assessed at the time of decommissioning. Further description is provided below regarding the works that could take place should the Project be decommissioned.

English Onshore Scheme

Converter Station

4.8.4 The anticipated operational life of the proposed converter station would be a minimum of approximately 40 years. It is likely that during this period refurbishment and plant replacement would extend the life of the proposed converter station. If decommissioning is required, the scale and nature of activities would use similar methods as those required to install the assets. The main components would be dismantled and removed for recycling wherever possible.

HVAC and HVDC Underground Cables

4.8.5 Dependent on the requirements at the time, 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. If decommissioning is required, it is expected that it would use similar methods as those required to install the assets.

Anderby Creek Landfall

4.8.6 The expected minimum operational life of the Anderby Creek Landfall infrastructure is 40 years, with replacement only expected to occur upon the failing of specific assets.

4.8.7 The below ground TJB providing onshore to offshore cable interface may be left in place as well as the ducts installed to bring the cables onshore. As a result, it is expected that there would be similar methods to remove these components as those used to install the asset.

English Offshore Scheme

4.8.8 The minimum design life of the Projects subsea cables is 40 years, although with repairs, some cable systems last upwards of 60 years. The English Offshore Scheme will require a Licence or Lease from The Crown Estate. An Initial Decommissioning Plan (IDP) will be written once the final route and construction methodology is chosen. This is a legal requirement necessary to secure The Crown Estate Licence. The IDP will form the basis of the Final Decommissioning Plan which would be developed in consultation with The Crown Estate and in line with the following decommissioning principles:

- The measures and methods for any decommissioning would comply with any legal obligations which would apply to the decommissioning of the English Offshore Scheme when it takes place;
- All sections of the cables within 12 NM would be removed except for any section or sections which are preferable to leave in situ having regard to the principles below; — that the measures and methods for any decommissioning are the best for, or minimise the risks to:
  - the safety of surface or subsurface navigation;
  - other uses of the sea;
  - the marine environment including living resources; and/or; and
  - health and safety.
- The seabed would be restored, as reasonably as possible and to the extent reasonably practicable, to the condition that it was in before the cable was installed.

4.8.9 The IDP is periodically reviewed and updated in line with the applicable guidance and regulations at the time of writing.

4.8.10 The full environmental impact of works required to decommission the Projects would be assessed at the time of decommissioning. Removal of the subsea cable is a similar process to the installation of the cable, but in reverse. The environmental impact can therefore not be fully assessed until the environmental conditions at the time of decommissioning are established.

Environmental Effects of Decommissioning

4.8.11 It is anticipated that rather than the Project be decommissioned, parts would be replaced to extend the operational life. As such, the operational assessments in the PEIR have been undertaken under the assumption that the Projects will continue to operate in perpetuity. For the English Onshore Scheme in particular, the environmental impact of decommissioning cannot be fully assessed until the environmental conditions at the time of decommissioning are established. It is not anticipated that impacts from decommissioning would be any greater than impacts from the construction phase.

4.8.12 Acknowledging the complexities of completing a detailed assessment for decommissioning works up to 40 years in the future for the English Onshore Scheme and given that there are no current plans to decommission the Project, an assessment of effects associated with decommissioning is not presented in Volume 1, Part 2 English Onshore Scheme and Part 4 of this PEIR. Instead, **Table 4-19** below summarises the assessment of the likely significant effects associated with decommissioning for each environmental aspect based on existing information. **Table 4-19** assumes that standard good practice measures would be implemented during decommissioning activities, as these would be typical measures employed on large NGET contracts. **Table 4-19** does not consider changes to the baseline environment, outside of those noted within the future baseline section of **Volume 1, Part 2, Chapters 6 – 16** and **Volume 1, Part 4, Chapter 26 - 27**, as there could be a number of scenarios that could occur. However, it is noted that the baseline environment could change and would be assessed at the time of decommissioning.

4.8.13 Given the level of information available regarding the approach to decommissioning for the English Offshore Scheme, reasonable assumptions with regards to likely environmental impacts at the time of decommissioning can be made. As such, **Volume 1, Part 3, English Offshore Scheme** has considered impacts associated with decommissioning within the technical aspect chapters.

Table 4-19 Preliminary summary of decommissioning effects

Aspect	Summary Assessment
Part 2, English Onshore Scheme	
Chapter 6 Biodiversity	The footprint of any decommissioning works is likely to be the same, or smaller, than the ground disturbed during construction of the English Onshore Scheme and the effects are anticipated to be no worse than those identified during construction. There could be effects to protected species and habitats at the time of decommissioning. However, these are likely to be managed through standard good practice measures and / or the measures set out in relevant consents or European Protected Species (EPS) licences required at the time, as informed by update baseline ecological surveys and assessment. Therefore, significant effects to biodiversity during decommissioning are predicted to the same (or less) than those identified by the construction stage assessment.
Chapter 7 Cultural Heritage	The footprint of any decommissioning works is likely to be the same, or smaller than the ground disturbed during construction of the English Onshore Scheme. As the ground within this area would have already been disturbed during construction, it is unlikely that archaeological remains would be present. Therefore, there are

Aspect	Summary Assessment
	unlikely to be any significant effects to buried archaeology during decommissioning.
Chapter 8 Landscape and Amenity	The footprint of any decommissioning works is likely to be the same, or smaller than the ground disturbed during construction of the English Onshore Scheme and the effects are anticipated to be no worse than those identified during construction. The removal of above ground infrastructure to foundation level including the converter station could have beneficial effects on views and the landscape character of the area during decommissioning works, however these are unlikely to be significant. Significant effects to landscape and visual amenity during decommissioning are therefore predicted to be the same (or less) than those identified by the construction stage assessment.
Chapter 9 Water Environment	The footprint of any decommissioning works is likely to be the same, or smaller than the ground disturbed during construction of the English Onshore Scheme and the effects are anticipated to be no worse than those identified during construction. There could be short-term temporary effects to watercourses (e.g. pollution risks) and on the land drainage regime during decommissioning. However, these effects would be expected to be managed by standard good practice measures applied at the time. Therefore, no likely significant effects to the water environment during decommissioning are anticipated.
Chapter 10 Geology and Hydrogeology	The removal of above ground infrastructure to foundation level is not likely to have significant effects on the geology. The removal of underground cables and associated underground infrastructure if conducted in a similar manner to the installation is unlikely to have significant effects on the geology. Leaving underground cables in situ in part or entirely is unlikely to have significant effects on the geology.

Aspect	Summary Assessment
	There is potential for short-term temporary effects to hydrogeology (e.g. pollution risks from contaminated land) during decommissioning. However, these effects would be managed by standard good practice measures applied at the time. Therefore, there are unlikely to be any significant effects to the geology and hydrogeology during decommissioning.
Chapter 11 Agriculture and Soils	The footprint of any decommissioning works is likely to be the same as, or smaller than the ground disturbed during construction of the English Onshore Scheme and the effects are anticipated to be no worse than those identified during construction. There could be temporary loss of agricultural land, including Best and Most Versatile (BMV) land, temporary disruption to agricultural operations and temporary impacts on soil function. However, all land disturbed temporarily would be reinstated to its pre-decommissioning condition and it is not anticipated that any additional permanent land take would occur. As such there are unlikely to be any significant effects to agriculture and soils during decommissioning.
Chapter 12 Traffic and Transport	The decommissioning works would generate traffic associated with the construction vehicles required to transport materials off site and associated staff vehicles. The decommissioning works are likely to involve a similar, or smaller, workforce than during construction as the works could be phased and managed. Therefore, significant effects to traffic and transport during decommissioning are predicted to be the same (or less) than those identified during the construction stage assessment.
Chapter 13 Noise and Vibration	The decommissioning of the English Onshore Scheme, including demolition of the converter station, and excavation and removal of underground cabling has the potential to generate short-term, localised noise and vibration impacts. However, it is unlikely that these noise and vibration impacts would be materially different to those identified during the construction phase. Furthermore, given that

Aspect	Summary Assessment
	decommissioning is expected to occur at least 40 years in the future, advancements in vehicle and machinery technology are likely to reduce noise and vibration generation. Where noise and vibration levels hold the potential to exceed acceptable thresholds, best practicable means (BPM) would be implemented to control these, including measures such as noise barriers and plant specification, to reduce the generated impacts. As such with the inclusion of these mitigations and control measures, significant effects from noise and vibration during decommissioning are considered unlikely.
Chapter 14 Air Quality	There is potential for emissions to air to be generated from vehicle exhaust emissions, Non-Road Mobile Machinery and diesel generators associated with the decommissioning phase of the English Onshore Scheme. However, in the future when decommissioning is likely to take place, emissions from vehicles and generators are predicted to decrease over time due to new technology, increasingly stringent emission regulations and cleaner fuel formulations. Therefore, there are unlikely to be significant effects on air quality associated with vehicle emissions and generators during the decommissioning phase of the English Onshore Scheme. There is also potential for fugitive dust emissions to arise from construction activities. However, these effects would be managed by standard good practice measures applied at the time. Assuming standard good practice measures are implemented, residual effect from all dust generating activities are unlikely to be significant during the decommissioning phase of the English Onshore Scheme.
Chapter 15 Socio-economics, Recreation and Tourism	The footprint of any decommissioning works is likely to be the same, or smaller than the ground disturbed during construction of the English Onshore Scheme and the effects are anticipated to be no worse than those identified during construction. There is the potential for short-term, temporary effects on amenity for residents, recreational users of PRoW, tourist and community facilities,

Aspect	Summary Assessment
	associated with air quality and dust, noise and vibration, and visual impacts. In line with the above assessments however, these are anticipated to be not significant during decommissioning, and therefore any perceptible adverse impact on residential, recreational, tourist and community receptors are not considered to be significant. These effects are expected to be managed by standard good practice measures applied at the time. Given the works associated with decommissioning are anticipated to be smaller than during construction, any beneficial effects relating to construction employment generation are also anticipated to be short term, temporary, and minor. It is not considered that temporary accommodation for construction employees will be required, due to the scale, duration, and short term nature of the decommissioning works. Therefore, no likely significant effects related to socio-economics, recreation and tourism during decommissioning are anticipated.
Chapter 16 Health and Wellbeing	The footprint of any decommissioning works is likely to be the same, or smaller than the ground disturbed during construction of the English Onshore Scheme and the effects are anticipated to be no worse than those identified during construction.
Part 4, Project Wide	
Chapter 26 Greenhouse Gases	The scale of GHG emissions associated with any future decommissioning works are forecast to be lower than currently assessed for the construction phase. There are no additional activities specific to decommissioning not identified in the construction phase assessment. In practice, items such as marine cables may be left in situ rather than being recovered. Plant equipment and marine vessels associated with any works are likely to be less carbon intensive due to future fuel switching or use of alternative fuels.
Chapter 27 Cumulative Effects	The intra-project cumulative effects would depend on the potential effects identified from

Aspect	Summary Assessment
	the different aspects at the time. However, it is unlikely that the effects would be different to those identified within individual aspect chapters and therefore there would be no new or different significant effects for the decommissioning phase when compared to construction of the Project. The inter-project Cumulative Effects Assessment (CEA) would depend on the proposed developments within the vicinity at the time of decommissioning. Therefore, an assessment of inter-project cumulative effects is not possible at the current time.

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