



# Eastern Green Link 2 - Marine Scheme

## Environmental Appraisal Report Volume 2

### Chapter 2 - Project Description

**nationalgrid**



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## 2. Project Description

### 2.1 Introduction

This chapter of the Environmental Appraisal Report (EAR) describes the Marine Scheme, which comprises a submarine High Voltage Direct Current (HVDC) link extending approximately 436 km from the Scottish landfall at Sandford Bay, Scotland to the English landfall near Fraithorpe Sands, England.

The physical aspects of the Marine Scheme are set out in terms of the Installation, Operation and Maintenance and Decommissioning Phases of the Marine Scheme as summarised below:

- **Installation Phase:** Scale and key characteristics of the submarine cable system, infrastructure and equipment to be used during cable laying, jointing and burial. Options for the cable installation including pre-installation survey methods, types and numbers of vessels to be used, and installation techniques.
- **Operation and Maintenance Phase:** The in-situ physical characteristics of the submarine cables including information about their design, operation, repair and maintenance. Emissions from the cables produced during their operation, in the form of heat, and electromagnetic fields (EMF) are also discussed.
- **Decommissioning Phase:** Activities involved in decommissioning a submarine power cable at the end of its operational life.

This Chapter considers the Marine Scheme only. Terrestrial aspects of the Project, the Scottish and English Onshore Schemes, are not presented here. They are presented in support of onshore planning applications under the Town and Country Planning (Scotland) Regulations 1997, and the Town and Country Planning Act 1990, submitted to Aberdeenshire Council in November 2021 (ref APP/2021/2681) and East Riding of Yorkshire Council and Selby District Council (which was submitted in May 2022) respectively.

The Scottish and English Onshore Schemes and Marine Schemes overlap in the intertidal zone between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS), where the marine and terrestrial planning systems overlap.

At the time of writing, the contract to undertake the installation works has not been awarded, and therefore the proposed installation methodology and exact timing has not been finalised. It is therefore acknowledged that final design and installation methods of the Marine Scheme differ slightly from the details that have been presented in this chapter and reported in the EAR. However, in order to ensure the EAR is as robust as possible, the technical chapters assess the range of likely installation methods to ensure that the envelope of effects appraised will encompass the realistic worst case and actual installation method, once confirmed. The potential effects appraised within this EAR has taken into account the range of parameters within which the detailed design will be developed following appointment of the installation contractor. These parameters will be superseded by, but not exceeded by, a Cable Burial and Protection Plan produced post consent as described in Chapter 17: Schedule of Mitigation.

### 2.2 Marine Scheme Overview

The Marine Scheme will provide 2 Giga Watts (GW) of transmission reinforcement from Scotland to England. It comprises a submarine HVDC cable system, within a Marine Installation Corridor approximately 436 km long and up to 500 m wide.

The Marine Installation Corridor extends from MHWS at the Scottish landfall at Sandford Bay crossing Scottish territorial waters, Scottish offshore waters, English offshore waters and English territorial waters to MHWS at the English landfall at Fraithorpe Sands (see Chapter 1: Introduction, Figure 1-1).

The Marine Installation Corridor follows a broadly north to south alignment from the kilometre point (KP) 0 at the Scottish landfall, to KP436 at the English landfall. Approximately 150 km of the Marine

Installation Corridor is within Scottish waters (territorial and offshore) and approximately 286 km within English waters (territorial and offshore).

The installation contractor (once appointed) will undertake detailed route development within the consented Marine Installation Corridor. The potential alignments of cables within the Marine Installation Corridor will then be subjected to micro-routeing, informed by pre-installation evaluation of site-specific survey data, to avoid or minimise localised technical and environmental constraints. This has the potential to alter the KPs referred to in this EAR. For the avoidance of doubt, this EAR and all KPs cited within it are in reference to revision 04 of the Route Position List (RPL): RPL Peterhead\_Drax\_Rev04.

All water depths within this chapter are quoted to below Lowest Astronomical Tide (LAT) unless otherwise stated.

The Scottish and English elements of the Marine Scheme fall within the regulatory responsibilities of the Marine Scotland – Licensing Operations Team (MS-LOT) and the Marine Management Organisation.

## 2.2.1 Installation Programme

As shown in Figure 2-1, the installation of the Marine Scheme is indicatively anticipated to commence in 2025 and may take up to five years to complete avoiding winter months, where feasible. This will be dependent on vessel and equipment availability and suitable weather conditions. Activities such as surveys, route preparation, cable burial and cable protection are expected to be undertaken all year round, including winter months. It is anticipated that there will be between five and 10 cable lay campaigns with up to three months between campaigns depending on cable availability and the factory location.

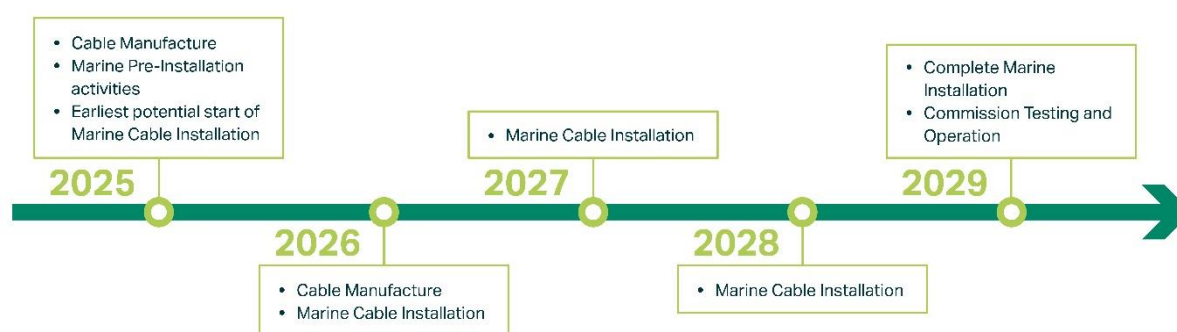


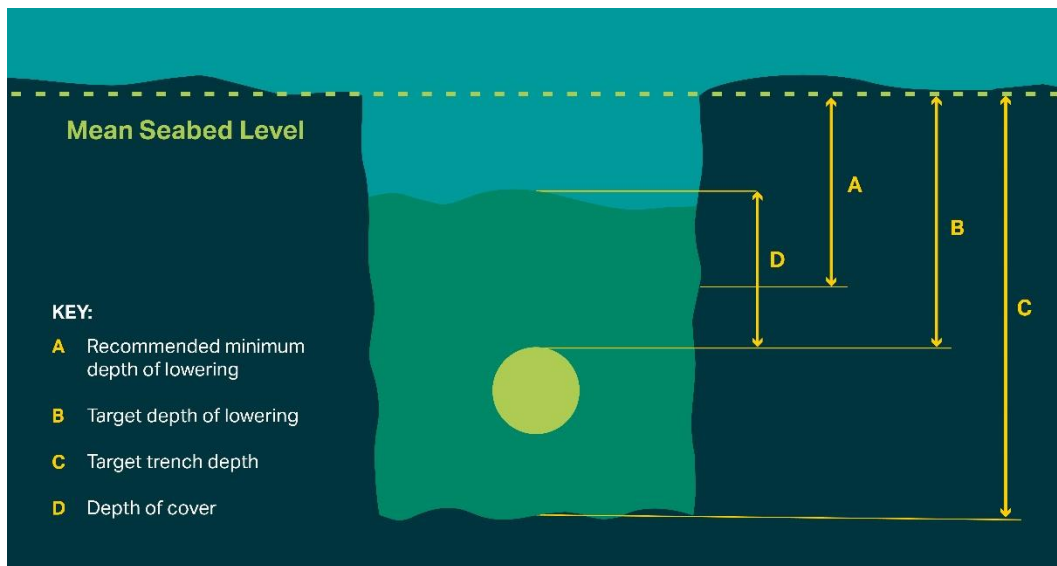
Figure 2-1: Indicative Installation Programme.

## 2.2.2 Marine Installation Corridor

The submarine HVDC cable system will comprise of two submarine HVDC cables and a separate Fibre Optic (FO) Cable (the cables) installed within the Marine Installation Corridor. The cables may be bundled together and installed in a single trench or may be trenched within two separate trenches. If the cables are installed separately, the FO cable will be bundled with one of the HVDC cables. A bundled approach with a single trench is currently considered the most likely option to be developed, however, a two-trench option cannot be ruled out and therefore is assessed as the reasonable worst case for the impact appraisal.

The cables will be trenched to a minimum depth of lowering of approximately 0.6 m (labelled A on Figure 2-2), with a target depth of lowering of approximately 1.5 m (labelled B on Figure 2-2) achieved where possible. Where the minimum depth of lowering cannot be met, a risk assessment will be undertaken to determine whether the achieved depth of lowering provides sufficient protection or whether remedial external protection is required. Each trench will be between one and six metres wide (depending on the nature of the seabed), with a potential area of associated seabed disturbance up to 25 m wide in some places.

If a two-trench approach is used, then the trenches will have a maximum separation of 30 m, although the separation expected to be less than 30 m wherever possible.



**Figure 2-2: Definition of trench parameters.**

### 2.2.2.1 Cable Landfalls

The Scottish landfall is the interface between the Scottish Onshore Scheme and the Marine Scheme. The location of the landfall is within Sandford Bay, to the south of Peterhead in Aberdeenshire as shown in Figure 2-3.

The English landfall is the interface between the Marine Scheme and the English Onshore Scheme. The location for the landfall is Fraisthorpe Sands, which lies between Hilderthorpe and Barmston in East Riding of Yorkshire as shown in Figure 2-4.

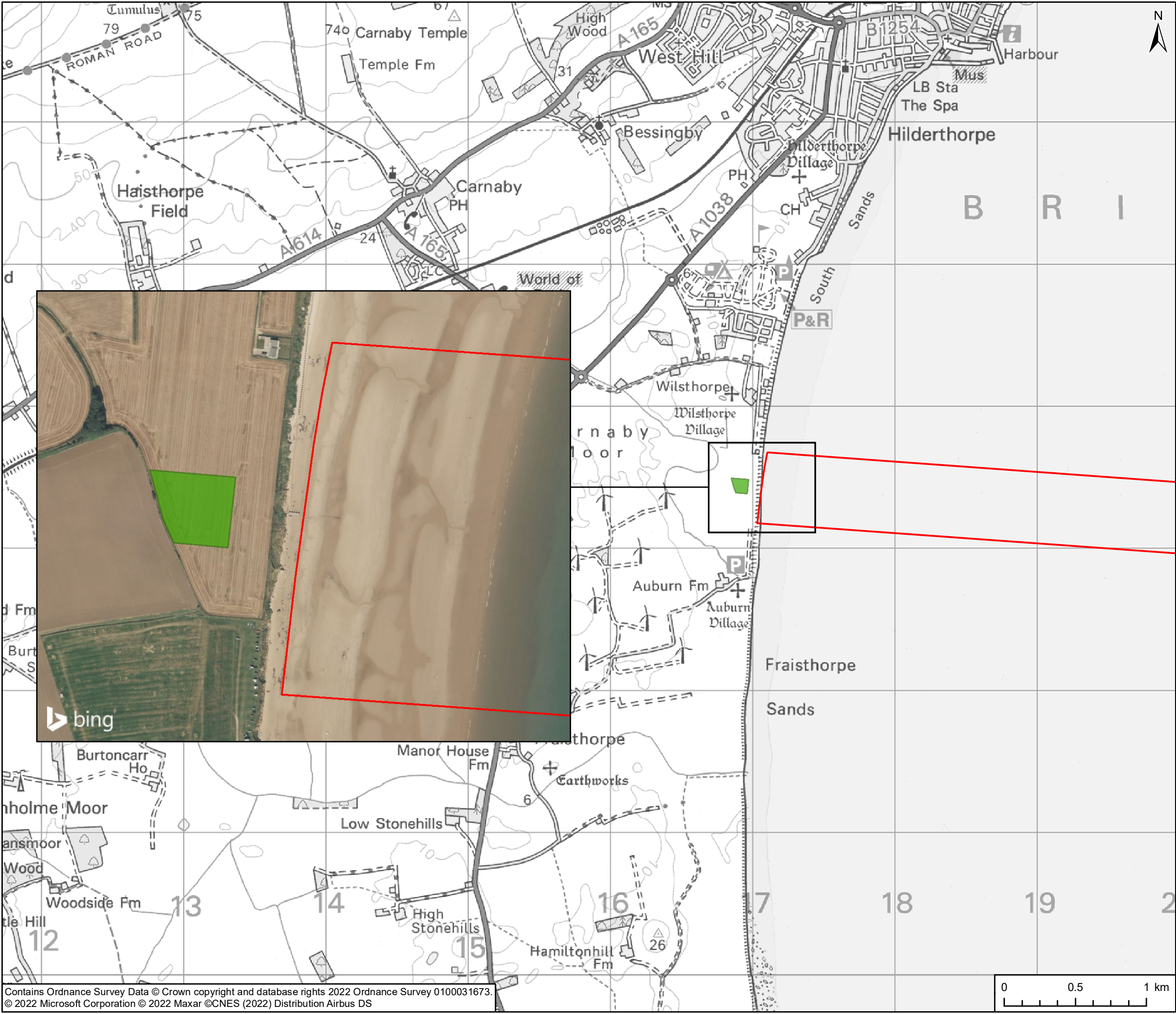
No activities are proposed in the intertidal zone at either landfall as trenchless Horizontal Directional Drilling (HDD) technology will be used, see Section 2.3.3 for further details.







GIS: LC Checked: KB Approved: FF



PROJECT

**Eastern Green Link 2**

KEY

- Marine Installation Corridor
- Indicative HDD Compound

TITLE

**Figure 2-4  
English Landfall Area**

REFERENCE

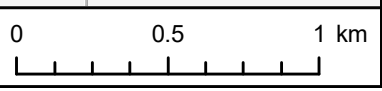
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### 2.2.2.2 Summary of Marine Installation Corridor Parameters

Key Marine Installation Corridor aspects and parameters are summarised below in Table 2-1.

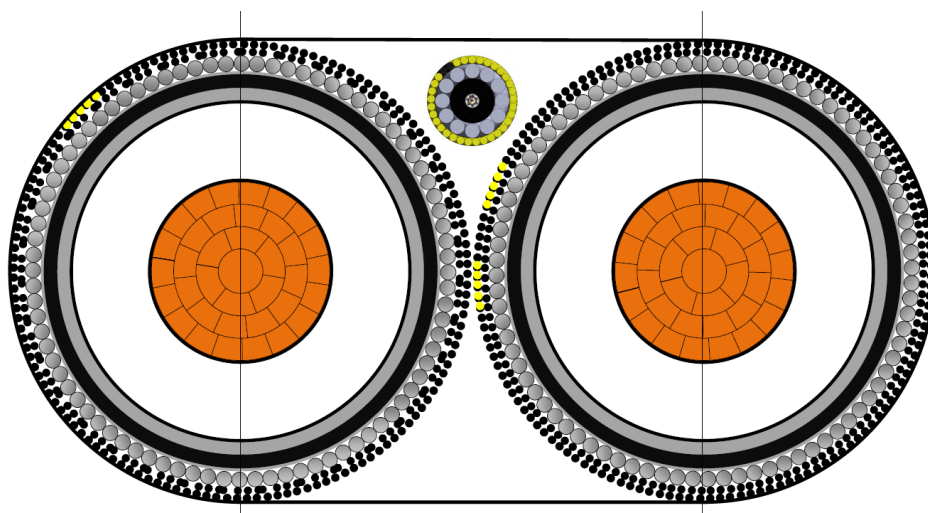
**Table 2-1: Summary of the Marine Installation Corridor aspects and parameters**

Aspect	Parameter	Value	Notes
Marine Installation Corridor	Width	500 m	-
	Total Length	436 km	-
	Length Scottish Waters	150 km	-
	Length English Waters	286 km	-
HVDC cables	Number	2	-
FO cable	Number	1	One FO cable, installed alongside one of the HVDC cables.
Cable installation trench	Number	2	Up to two trenches.
	Depth of lowering	0.6 to 1.5 m	Minimum depth of lowering approximately 0.6 m. Target depth of lowering of approximately 1.5 m.
	Width	1 m to 6 m	Depending on trenching tool.
	Disturbed area	25 m wide per trench	Up to 25 m per trench. Depending on trenching tool.
	Separation between trenches	30 m	Maximum value.

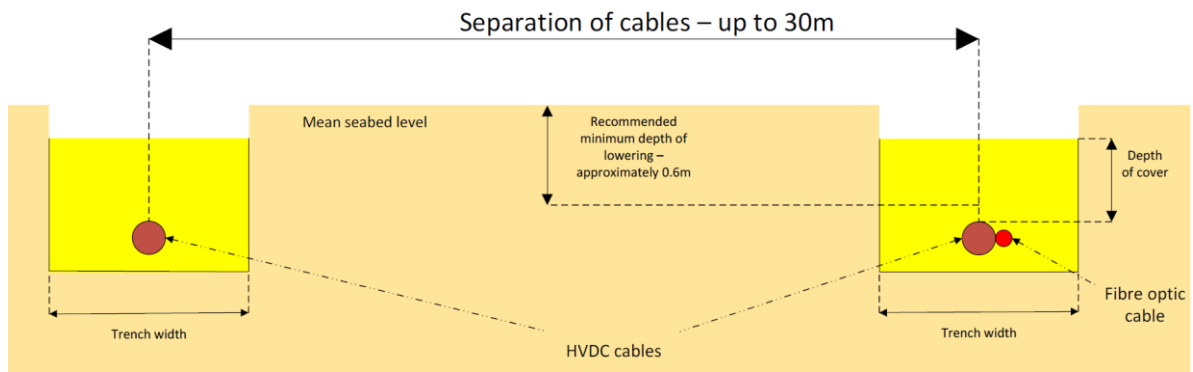
## 2.2.3 Submarine Cables

### 2.2.3.1 Cable Configuration

The Marine Scheme will provide a major reinforcement of the electrical transmission system between Scotland and England via two submarine HVDC cables. With a bundled approach, the two cables and the FO cable would be combined into a single bundle as shown in Figure 2-5. With a two-trench approach, each cable would be laid in a separate trench, with the fibre optic cable bundled with one of the HVDC cables as shown in Figure 2-6.



**Figure 2-5: Bundled HVDC cables with fibre optic cable.**



**Figure 2-6: Two-trench HVDC cables and fibre optic cable.**

### 2.2.3.2 HVDC Cable Design

The Marine Scheme will consist of a bi-pole HVDC cable system, comprising two single core metallic conductor cables (one per pole) with a total transmission capacity of up to 2 GW. The HVDC cables will transmit power at a nominal voltage of  $\pm 525$  kilo Volts (kV), one cable at +525 kV and the other at -525 kV.

The cables will have copper or aluminium conductors, there are three options for the insulation being considered at this stage:

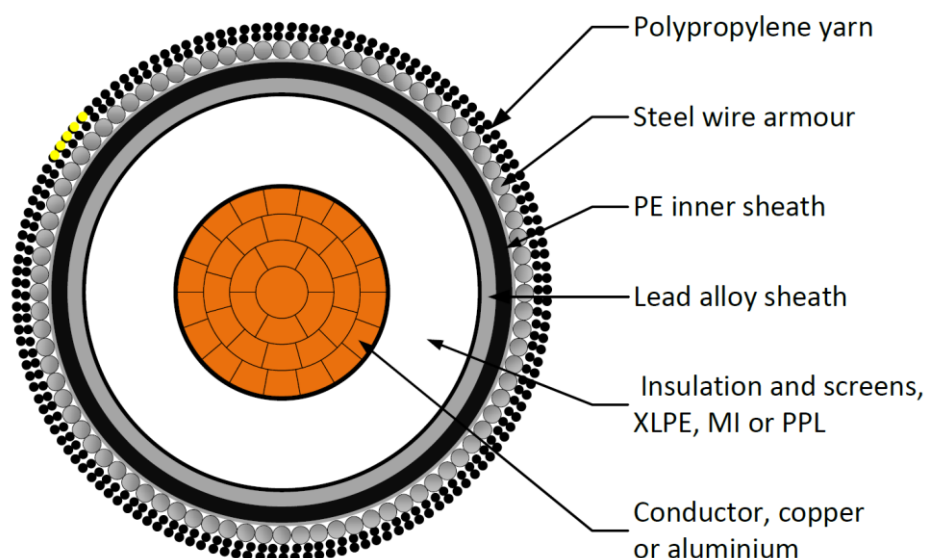
- Cross-linked polyethylene (XLPE), is extruded over the conductor and 'cured', to improve the electrical and mechanical properties;
- Mass-Impregnated (MI) cables use insulation made of multiple strips of Kraft paper, lapped onto the conductor in multiple layers. The paper is then impregnated with a compound that ensures that the electrical properties are maintained; or
- Paper-polypropylene laminate (PPL) cables are similar to MI cables, but each strip of Kraft paper has polypropylene layers laminated to either side of it, improving the electrical performance.

Outside of the electrical core (including the conductor and insulation) the construction of the cables is very similar (Figure 2-7):

- An extruded lead alloy sheath protects the electrical core from moisture; with an extruded polyethylene (PE) sheath over the lead alloy sheath;
- One or two layers of steel armour wires to provide mechanical strength and protection; and
- Two layers of polypropylene yarn to complete the construction.

Typically, each HVDC cable would have a diameter of 140 mm to 150 mm and a mass of 50 kg/m to 55 kg/m.

Regardless of the insulation technology selected, the cables will 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.



**Figure 2-7: HVDC cable construction.**

### 2.2.3.3 Fibre Optic Cable Design

A FO cable will be installed along with one of the two HVDC cables to provide a communications link between the two converter stations in Peterhead and Drax. The cable specification will be confirmed during detailed engineering, but will likely comprise a core of optical fibres, armoured with layers of steel wires, and sheathed with either a polypropylene or PE material for outer protection. The outer diameter of the fibre optic cable is expected to be between 20 mm to 30 mm.

The FO cable is not proposed to have any repeaters<sup>1</sup> within the marine environment.

### 2.2.3.4 Summary of Submarine Cable Parameters

Key submarine HVDC cable aspects and parameters are summarised below in Table 2-2.

**Table 2-2: Summary of cable aspects and parameters.**

Aspect	Parameter	Value	Notes
HVDC cables	Configuration	Bi-pole	One cable per pole
	Number	2	-
	Joints	18	Up to nine joints per cable, with one every 50 km to 100 km. Up to 18 joints in total in nine broad locations (with exact joint numbers and locations dictated by installed cable lengths along the route and cable carrying capacity of the CLV or CLB).
	Operating voltage	525 kV	-
	Transmission capacity	2 GW	2 GW in total for the Marine Scheme.
	Diameter	140 mm to 150 mm	Two cables of up to 150 mm in diameter
FO cable	Number	1	-
	Joints	9	Up to 9 joints, collocated with the HVDC cable joints (with exact joint numbers and locations dictated by installed cable lengths along the route and cable carrying capacity of the CLV or CLB).
	Diameter	20 mm to 30 mm	-

<sup>1</sup> As part of FO cable systems used over long distances, repeaters are often used in order to amplify optical signals.

## 2.3 Installation Phase

### 2.3.1 Installation Vessels

The use of particular vessels, such as a CLV or a CLB, as well as particular installation technologies such as cable trenching tools or ploughs will be confirmed on award of the installation contract (post-consent).

Details of resources recently deployed or proposed for installation of cables similar in scale and character to the Marine Scheme have been used to inform the description of representative vessels below.

#### 2.3.1.1 Cable Laying Vessel

The CLV is a specialist vessel designed to carry and handle long lengths of power cables. Figure 2-8 provides examples of CLVs, which are equipped with DP systems enabling the CLV to hold position accurately without the deployment of anchors. In combination with the cable tensioner onboard the vessel, the use of the DP system enables the cable to be accurately positioned on the seabed.

CLVs can carry long lengths of cable, typically up to 100 km or more (Figure 2-9) but are large vessels, and as such, maybe constrained by their draught when operating close to shore. Therefore, a CLB or jack up vessel (see below) may be used to undertake cable laying activities in shallow waters.



Figure 2-8: Representative Cable Laying Vessels (Left: Topaz Installer, Right: Aker Connector).



Figure 2-9: Typical factory and CLV turntables.

#### 2.3.1.2 Cable Lay Barge

As described in Section 2.3.1.1, CLVs maybe constrained by their draught and therefore at the landfalls a separate shallow water vessel such as a CLB may be required (Figure 2-10). Shallow water operations are normally conducted from flat-top pontoon barges that are mobilised on an ad-hoc basis.

The flat-top pontoon barge(s) will be fitted with the necessary cable storage and working equipment and up to an eight-point mooring system which will be used to manoeuvre the barge during installation activities. Each anchor could be up to 2 m in length and will be deployed up to 800 m from the CLB (within the Marine Installation Corridor) to allow the barge to hold station, whilst the installation works are undertaken. A combined seabed footprint of up to 32 m<sup>2</sup> at each anchored work location is anticipated.



**Figure 2-10: Representative Cable Lay Barge.**

### 2.3.1.3 Jack-up Barges

A jack-up barge with up to four spud can legs, each with an up to 8 m diameter and giving a footprint of approximately 50 m<sup>2</sup> may be used at each work location. One work location is assumed for each of the four completed cable ducts, giving a total footprint of approximately 200 m<sup>2</sup> at each landfall.

### 2.3.1.4 Back-hoe Dredgers

The use of a back-hoe dredger may be required to support with pre-installation trenching. A back-hoe dredger is essentially a bucket digger operated from a shallow water barge. It may be self-propelled for positioning on site, or non-self-propelled and relying on the help of workboats. It will maintain position at each breakout by deployment of either spud legs or an anchor array, with a seabed footprint (anchor or spud can) not exceeding 100 m<sup>2</sup> at each exit pit location. It may be also used to excavate the shallow water sediment to provide a trench for the cable to be installed in. Excavated material will be side cast within the Marine Installation Corridor.

### 2.3.1.5 Rock Placement Vessels

A rock placement vessel (Figure 2-11) features a large hopper to transport rock to the required location and a mechanism for deployment of the rock on site. The standard deployment techniques are:

- Flexible fall pipe – a retractable chute is used to control the flow of rock to the seabed. At the end of the fall pipe, a fall pipe remotely operated vehicle is mounted allowing for accurate control of the end of the fall pipe above the seabed and to survey rock placement locations; or
- Side placement – rock is placed over the side of vessel in a controlled manner. A side-placement vessel is typically used for shallow water rock placements. This will be done using either grabs or a side placement unit to ensure accurate placement and controlled rock flow.

Where cable protection using rock placement is required, a targeted placement method e.g., fall pipe vessel will be used rather than using vessel-side discharge methods.





**Figure 2-11: Representative fall-pipe rock placement vessel.**

### 2.3.1.6 Guard Vessels

Guard vessels may be required to maintain surveillance around the CLV, CLB or other vessels with restricted manoeuvrability, particularly in areas of high-density marine activities, where it is considered necessary to ensure other vessels keep clear of the installation activity to avoid the risk of collision. Additionally, they may be required to protect the cable prior to trenching or external protection and also to protect free ends of cable left on the seabed whilst the CLV is reloading.

All guard vessels will use RADAR with Automatic RADAR Plotting Aid (ARPA) to monitor vessel activity and predict possible interactions.

### 2.3.1.7 Specialised Support Vessels

Specialised support vessels may be required to support a range of other activities, including surveys using ROV or geophysical equipment, diving activities, cable trenching (e.g., ploughing, jet trenching, trenching, PLGR), installation of required cable protection system.

### 2.3.1.8 Vessel Operating Parameters

#### Vessel Speeds

Table 2-3 provides an indicative summary of vessel speeds that can be anticipated during the installation phase of the Marine Scheme.

**Table 2-3: Indicative vessel speeds.**

Vessel	Operational speed	Transit speed
CLV (simultaneous cable lay and trenching)	0.5 km to 5 km per day (subject to sediment type, trenching equipment used etc.)	6 knots to 12 knots
CLV (cable lay without simultaneous trenching)	Up to 7 km per day	6 knots to 12 knots
CLB / Jack-up Barges	Stationary	4 knots to 10 knots
Trenching Vessels	0.5 km to 5 km per day	6 knots to 12 knots
Guard Vessels	0 to 4 knots	4 knots to 10 knots
Support Vessels	Up to 7 km per day	6 knots to 12 knots
Rock Placement Vessels	0.5 km to 3 km per day	6 knots to 12 knots

### **Vessel Campaigns**

Between five and ten cable lay campaigns will be required to complete the installation of the Marine Scheme, the duration of each cable lay campaign will be related to the cable carrying capacity of the CLV or CLB, and the co-ordination with other activities such as HDD at the landfalls. There may be up to three months between cable lay campaigns, with most avoiding the winter months. The campaigns are likely to be spread over two to three years although up to five years could be required, as described earlier. Cable lay activities can be expected to be undertaken in weather conditions up to Force 7 and a significant wave height of up to 3 m.

## **2.3.2 Pre-Installation Activities**

### **2.3.2.1 Pre-Installation Studies and Surveys**

Pre-installation surveys will be undertaken to inform detailed engineering and cable installation planning. These surveys will focus on the collection of detailed information within the preferred route for each of the HVDC cables and will inform final route engineering accounting for previously unrecorded obstructions, hazards (including UXO), sensitive features, or significant changes to seabed conditions and bathymetry. This will allow micro-routeing within the Marine Installation Corridor by the preferred contractor, once appointed.

Pre-installation surveys are likely to involve a range of standard marine survey techniques including:

- Bathymetry: Multi-Beam and Single Beam Echo Sounders (MBES and SBES) to record water depth, prepare a three dimensional (3D) digital terrain model of the seabed, and to identify relevant bedforms;
- Side Scan Sonar (SSS): Mapping of the seabed surface and identification of sediment types. Obstacles lying on the seabed, such as wrecks, debris, UXO, and surface-laid or exposed pipelines and cables that might impede cable installation can be identified from the SSS outputs;
- Sub-Bottom Profiling (SBP): Directing a pulse of acoustic energy into the seabed and using reflections from the sub-surface geology to assess the thickness, stratification, and nature of the seabed sediments;
- Magnetometer/Gradiometer: Passively detect 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;
- Benthic Ecology: Drop Down Video or Remotely Operated Vehicle (ROV) mounted cameras may be used to confirm the locations and extents of sensitive benthic habitats or features. This would inform micro-routeing of submarine cable systems to avoid or minimise interactions with these features in so far as practicable;
- Geotechnical: Vibrocore and Cone Penetration Test (CPT) samples may be obtained to inform engineering method decisions, micro-routeing and installation tool selection at specific locations. This would verify whether ground conditions are suitable for cable trenching as well as to assess the bearing capacity of the seabed sediments with regards to crossing structures and trenching equipment intended to be used; and
- Visual inspection by ROV might be required of submarine assets to be crossed.

The potential for UXO to affect the development of the Marine Scheme will be informed by a desk-based assessment undertaken post consent and informed by the pre-installation survey data. The assessment will consider the risk of encountering UXO within the Marine Installation Corridor. Following the desk-based assessment, the current management strategy is anticipated to include:

- Site specific UXO surveys in areas of moderate and high risk;
- Micro-routeing to avoid potential UXO (pUXO) wherever possible;
- Where micro-routeing is not possible, it is anticipated that individual UXO target identification/verification surveys will be undertaken to confirm the status of each pUXO. This may involve carefully excavating a small area on the seabed (using a diver with handheld excavation tools in water depths of less than 10 m and an ROV in waters deeper than 10 m) at the target

location, typically 2 m in diameter and 1 m in depth until the item is excavated sufficiently to identify the pUXO; and

- Should a target be confirmed as a UXO, then clearance of the target shall be undertaken before any further work occurs.

It is assumed that UXO will be avoidable and no UXO clearance will be required, as such this activity is not within the scope of the EAR. If UXO clearance is required, it will be subject to separate Marine Licence and European Protected Species applications, which will be informed by dedicated environmental appraisal.

### 2.3.2.2 Route Preparation

Route preparation activities likely to be undertaken prior to the installation of the submarine cables include:

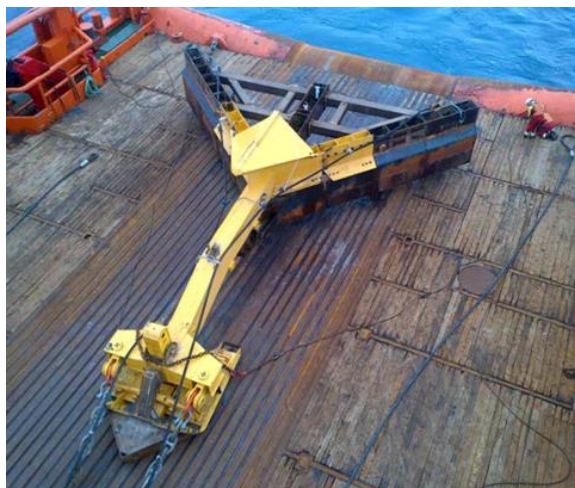
- Cable route clearance;
- Pre-lay grapnel run;
- Sandwave lowering;
- Sea trials; and
- Pre-lay submarine intervention, e.g., installation of crossing infrastructure.

No pre-sweeping of sandwaves using dredgers is required or proposed within the Marine Installation Corridor.

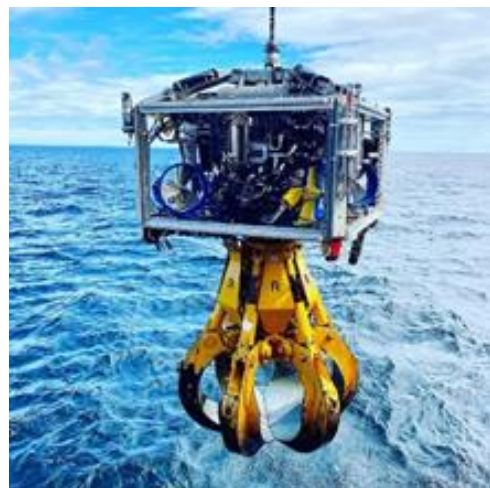
#### **Cable Route Clearance**

Prior to installation, obstructions that may hinder installation, including boulders, Out of Service (OOS) third party submarine assets and smaller debris such as discarded fishing gear, wires etc., will be cleared.

If they cannot be avoided, then it may be necessary to move large stones and/or boulders out of the way so that the installation equipment can operate. To clear a path for the cable installation equipment, a plough, similar to that shown in Figure 2-12, may be towed across the seabed, pushing boulders aside. Typically, a swathe of between 10 m and 25 m width will be cleared per cable trench. It is anticipated that this method could be employed over a total of 168 km of the Marine Installation Corridor. Alternatively, a grab, similar to that shown in Figure 2-13, may be used to clear boulders or other obstructions from within the proposed installation routes.



**Figure 2-12: Typical plough used to clear boulders.**



**Figure 2-13 Typical grab used to clear boulders.**

Four OOS cables have been identified crossing the Marine Scheme. At the known location of the OOS cables, a de-trenching grapnel will be deployed to retrieve them from the seabed (Figure 2-14). The de-trenching grapnel typically penetrates up to 2 m into the seabed. The section of OOS cable crossing obstructing the Marine Installation Corridor will be cut away with permission of the asset owner.

Alternatively, an ROV may be used to de-bury and cut and remove the OOS cable. The cut ends will then either be secured to the seabed using clump weights or reburied in accordance with International Cable Protection Committee (ICPC) recommendations.

The clearance of OOS cables will be undertaken by specialist support vessels equipped with an ROV for submarine intervention.



**Figure 2-14: Typical de-trenching grapnel.**

### **Sandwave Lowering**

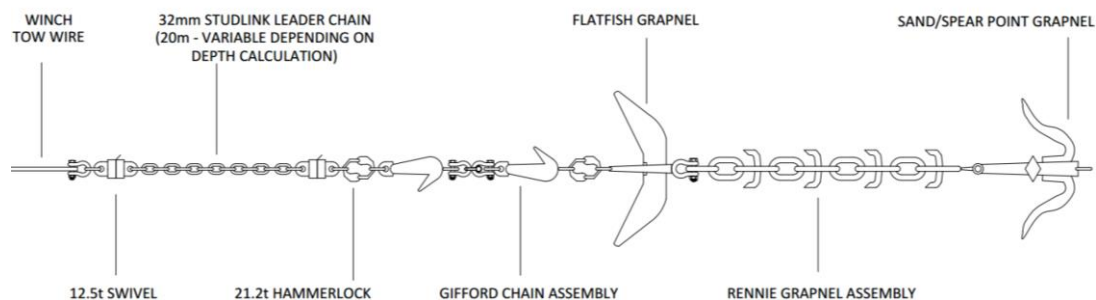
Mass Flow Excavators (MFE) will be used where sandwave lowering is required to support cable trenching by displacing sediment. Further details on MFE are provided in Section 2.3.4.3. There is no requirement for pre-sweeping of sandwaves using dredgers to remove sediment onto a vessel and deposit it away from the Marine Installation Corridor.

### **Pre-lay Grapnel Run**

Seabed debris, such as wire, nets, ropes and other anthropogenic material which may be present on the seabed, can be detrimental to the installation process.

A pre-lay grapnel run (PLGR) will be conducted prior to cable laying in order to remove such debris from the proposed installation route and minimise threats to the cable installation process. The PLGR involves towing a string of specially designed hooks or grapnels (Figure 2-15) along the centre line of the entire cable route, to clear a swathe of up to 3 m. The grapnels are designed to remove debris on the seabed surface of, or just below it. If the cables are laid separately separate PLGRs will be conducted along each of the proposed installation routes.

Debris caught with the grapnel will be recovered to the deck of the vessel for onwards recycling or disposal onshore, via a licenced waste facility.



**Figure 2-15: Typical PLGR grapnel.**

### Sea Trials

In areas of very hard or very soft seabed, submarine cable trenching tools may be trialled within the Marine Installation Corridor, to determine if they meet the required target trench depth. This may include trials of pre-trenching using a displacement plough and / or a mechanical trencher. Trials may also be undertaken to determine the outcomes of boulder clearance and minimise the potential use of rock placement.

### Crossings Preparation

Within the Marine Installation Corridor there are third-party assets such as in service cables and pipelines to be crossed by the Marine Scheme's cables. Each crossing will be designed in detail as part of the development of crossing agreements for each of the cables and pipelines to be crossed in accordance with the ICPC recommendations.

Pre-installation activities include:

- Survey and visual inspection of the crossing location by ROV in advance; and
- Rock placement, concrete mattresses or pipe bridge is installed over the existing asset to create separation between it and the cables when they are later installed.

Further details on the crossing types proposed and typical installation activities to be utilised by the Marine Scheme is provided in Section 2.3.4.2.

### 2.3.2.3 Summary of Pre-installation Activity Parameters

Key pre-installation aspects and parameters are summarised below in Table 2-4.

**Table 2-4: Summary of route preparation aspects and parameters.**

Aspect	Maximum Zone of Influence	Scottish Waters		English Waters	
		Territorial Waters	Offshore Waters	Offshore Waters	Territorial Waters
Plough or grab to remove boulders	Where required, across a swathe of 10 m to 25 m per cable trench.	21.6 km *	30.3 km *	85.4 km *	29.9 km *
PLGR	Corridor of 1 m to 3 m per cable trench.	28.4 km *	121.8 km *	246.3 km *	38.7 km *
Sandwave lowering	Footprint depends on density of seabed sediments. May be up to 10 m in width in loosely packed sands, but typically less than 6 m.	9 km *	8.5 km *	5 km *	1.5 km *
Sea trials	Corridor of 10 m to 15 m within Marine Installation Corridor	2 km	5 km	5 km	3 km
Crossing preparation (rock placement)	See Table 2-7				
Crossing preparation (concrete mattresses)	Area up to 18 m <sup>2</sup> (6 m x 3 m) Up to 0.3 m thick Weigh up to 9.1 tonnes	42 per pole *	None anticipated	108 per pole *	None anticipated
Crossing preparation (separator system)	Use would be subject to crossing agreement.	0.7 km per pole *		1.8 km per pole *	
Crossing preparation (pre-cast concrete bridge)	Use would be subject to crossing agreement.	3 per pole *		6 per pole *	

\* To be multiplied by two if cables trenched separately

### 2.3.3 Landfall Installation

This section presents details of the installation works planned below MHWS at both the Scottish and English landfalls. It should be noted that the installation techniques detailed below may be revised following further engagement with other developers who may be looking to landfall in the Peterhead area in order to promote co-existence between projects and to optimise use of the landfall.



### 2.3.3.1 Horizontal Directional Drilling

Horizontal Directional Drilling (HDD) is a trenchless installation method which does not require any intrusive works within the intertidal zone (between MHWS and MLWS), therefore it avoids any direct interactions within this zone. HDD will start from temporary drilling compounds, one located within each of the Scottish and English Onshore Schemes.

The Transition Joint Bay (TJB) where the submarine cables will connect to the onshore cable system, within both the Scottish and English Onshore Schemes will be located within the temporary drilling compound.

Up to four cable ducts will be installed at each landfall (eight ducts for the Marine Scheme in total), as follows:

- Two ducts for HVDC cables (one for each cable).
- One duct for the FO cable; and
- One spare duct.

It is assumed that there may be up to two aborted or failed drills<sup>2</sup> at each landfall as a worst case (four aborted drills for the Marine Scheme in total).

Completed ducts are currently anticipated to breakout within exit pits at approximate locations below MHWS within the Marine Installation Corridor, as shown in Figure 2-16 for the Scottish landfall and Figure 2-17 for the English landfall. Each completed borehole may be up to 1.5 km in length. Indicative depths for the breakout locations are as follows:

- Sandford Bay: 11 m to 20 m; and
- Fraithorpe Sands: 5 m to 6 m.

The use of a back-hoe dredger or MFE (see Section 2.3.4.3 for further details) will be required to support the creation of the exit pits in advance of breakout. An area up to 5,000 m<sup>2</sup> may be excavated at each landfall to form the exit pits (10,000 m<sup>2</sup> total for the Marine Scheme). The target depth of lowering for each of the exit pits will be between 1 m and 3 m, however, the exit pit may need to be 3 m to 5 m deep to achieve this.

A small diameter (250 mm) pilot hole will then be drilled from the temporary drilling compounds located within the Scottish and English Onshore Schemes, emerging at the excavated exit pit location, within the Marine Scheme. The pilot hole will then be widened in several stages using reaming (borehole widening) techniques until the required diameter of up to 660 mm is achieved.

Drilling fluids will be used to suspend rock cuttings and carry them out of the borehole, cooling the drilling equipment, clearing debris from the drilling bit, sealing the borehole and reducing friction on the drilling equipment. The majority of the drilling fluid is able to be reused post-treatment, with any waste drilling fluid taken offsite by tanker for treatment and disposal via a licenced facility.

The drilling fluid will be selected by the contractor on the basis of drilling performance and environmental requirements, with the most commonly used fluids being bentonite based<sup>3</sup>. The drilling fluid selected by the contractor will be biologically inert and selected from the Centre for Environment, Fisheries and Aquaculture Science (Cefas) approved list of drilling fluids<sup>4</sup> to ensure no harmful effect on the surrounding marine environment.

Some drilling fluid and solids (including drill cuttings and drilling mud) will be lost to the marine environment during breakout, reaming and during duct installation. During HDD works, the estimated discharge to the marine environment per borehole is up to 2000 m<sup>3</sup> of fluid and up to 80 m<sup>3</sup> of solids. There is therefore estimated to be a total of up to 12,000 m<sup>3</sup> of fluid and up to 480 m<sup>3</sup> of solid discharged from up to six boreholes at each landfall. These losses are unavoidable, however will be minimised

<sup>2</sup> A drill is the method used to create a bore under the ground before the duct is installed.

<sup>3</sup> Bentonite consists predominantly of clay minerals and is generated frequently from the alteration of volcanic ash. It is considered to be a clean, inert and non-polluting substance. As such it is included on the OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (Cefas, 2018).

<sup>4</sup> Offshore Chemical Notification Scheme (OCNS) managed by Cefas.

insofar as practicable through the implementation of industry best practice for example, clearing runs or reducing the volume of drilling fluids in the borehole prior to breakout to the marine environment.

### 2.3.3.2 Duct Installation

After reaming, a duct<sup>5</sup> will be installed to line the borehole and a messenger wire then passed through the duct, with ends emerging from both the onshore drilling compound and the breakout area. The messenger wire will later be used to pull the submarine cable system through the cable conduit.

Two potential methods may be used for HDD duct installation; both are described below.

#### ***Pulled Duct Installation***

Pulled installation is undertaken as follows:

- The ducts would be prefabricated and stored at an advance marine facility such as a nearby port until they are required. This is considered to be part of the port's routine operations and hence is not a licensable activity and does not require further assessment within the EAR.
- The ducts are towed by sea to the Marine Installation Corridor within Scottish and English territorial waters prior to installation.
- A pulling head is attached to the duct and the duct flooded with seawater to reduce its buoyancy.
- The pulling head and duct is pulled through the borehole towards the drilling compound above MHWS.
- Temporary protective mattresses are placed over the breakout point to protect the installed duct.

During pulling, the duct may displace drilling fluid from the borehole, which may be lost to the marine environment at the breakout point (all losses will be minimised wherever practicable).

#### ***Pushed Duct Installation***

Pushed duct installation would include the following stages:

- The duct is pushed from land through the borehole until it emerges within the exit pit.
- Pushing may be assisted by a workboat using a cable to draw the duct through the borehole towards the exit pit.
- Temporary protective mattresses are placed over the breakout point to protect the installed duct.

During pushing, the duct may displace drilling fluid from the borehole, which may be discharged to the marine environment at the breakout point.

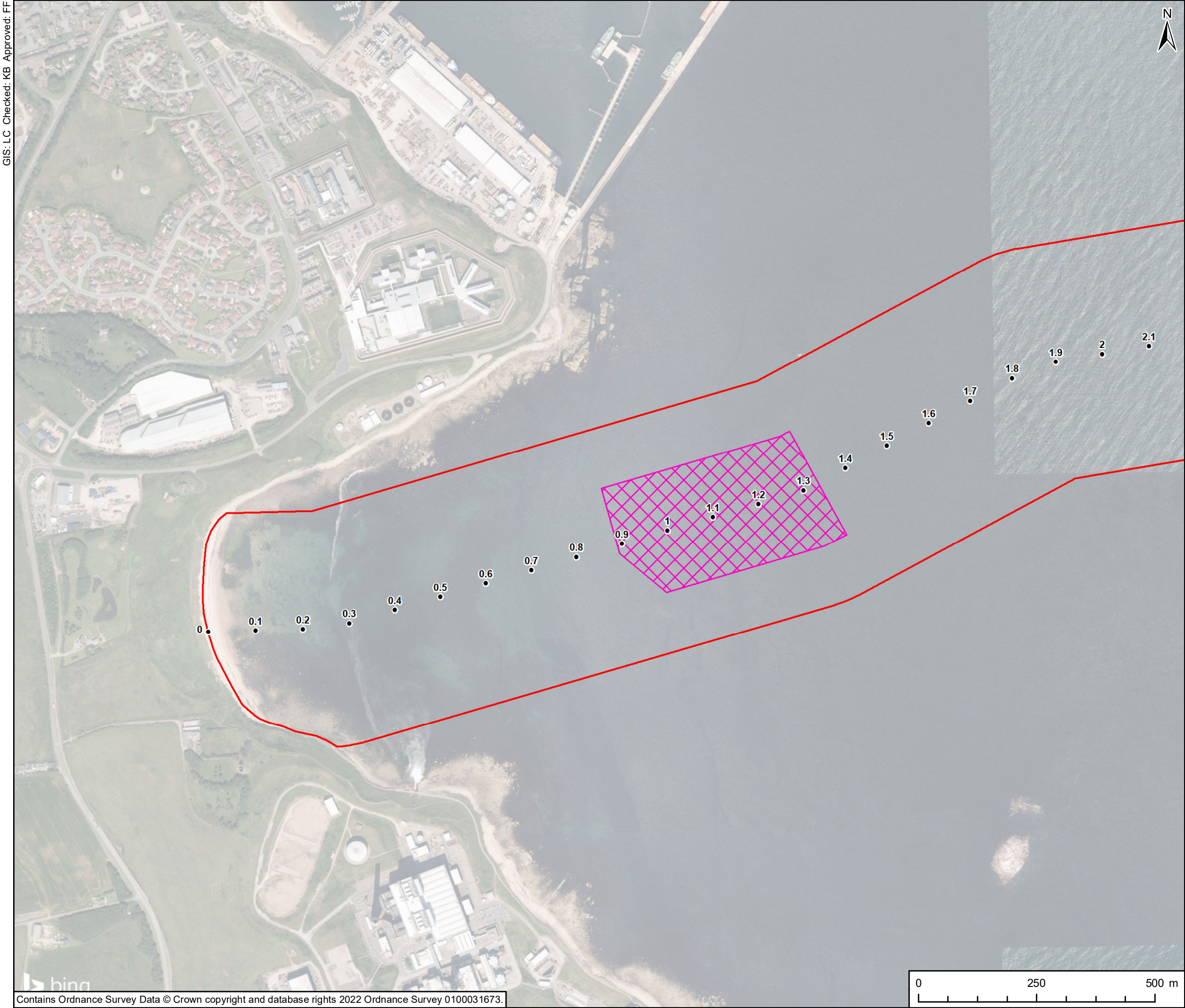
Up to 24 temporary protective concrete mattresses may be used within the footprint of the breakout area within the Marine Scheme to protect from damage before and during cable installation. Each mattress will cover an area up to 18 m<sup>2</sup> (3 m by 6 m), be up to 0.3 m thick and weigh up to 9.1 tonnes.

It has been assumed that works associated with the HDD (including both drilling and duct installation) will take up to six months to complete at each landfall.

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<sup>5</sup> A duct is a component typically made from High Density Polyethylene (HDPE) or steel with a maximum outer diameter of 500 mm, which is used to reinforce the borehole ahead of onward use to support the installation of the cable system.





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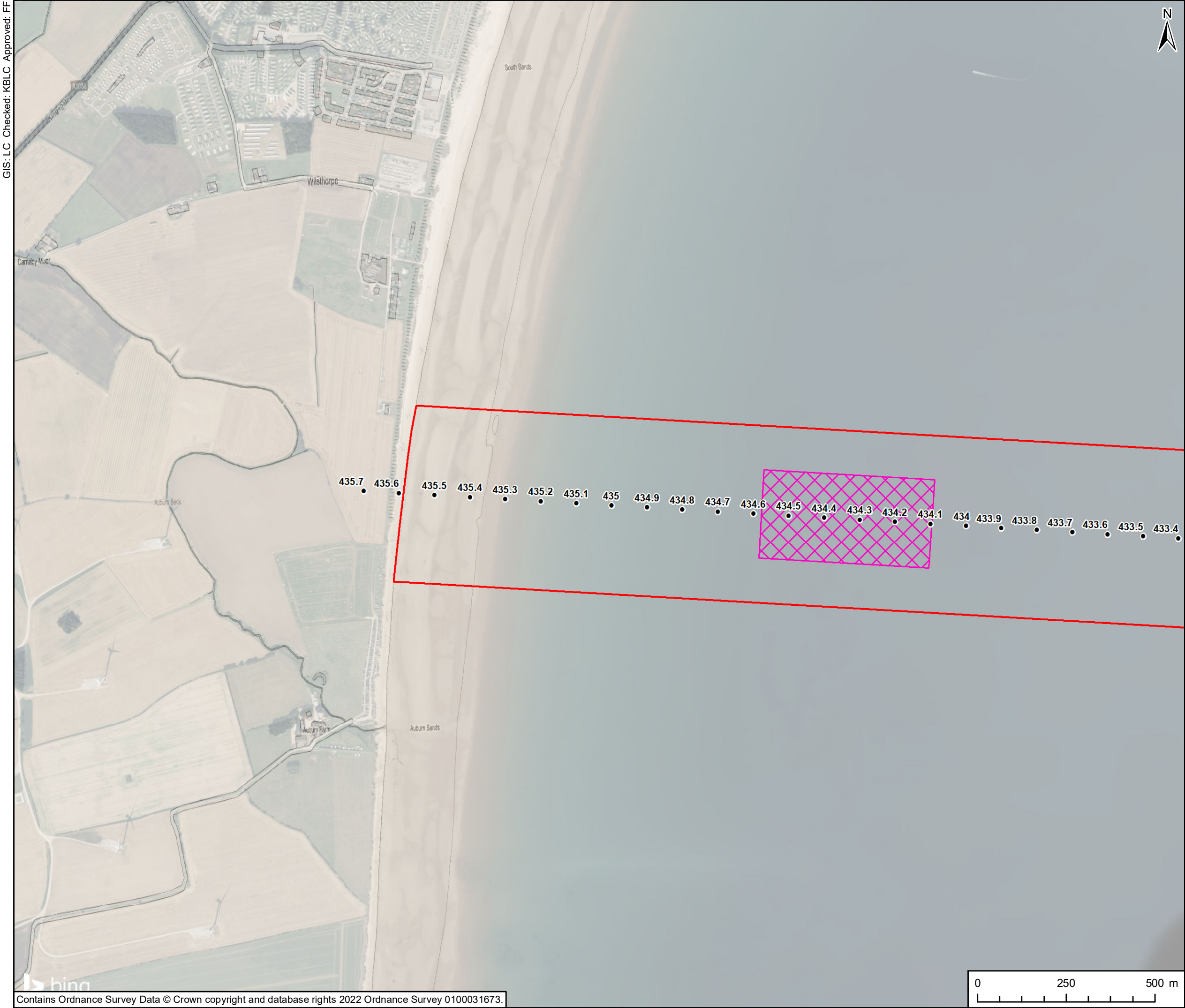
PROJECT  
**Eastern Green Link 2**

- KEY
- Marine Installation Corridor
  - Kilometre Point (KP)
  - Potential HDD Breakout Area - Sandford Bay (11-20m LAT)



TITLE  
**Figure 2-16  
Potential Breakout Area at Sandford Bay  
(Scottish Landfall)**





PROJECT  
**Eastern Green Link 2**

- KEY
- Marine Installation Corridor
  - Kilometre Point (KP)
  - Potential HDD Breakout Area - Fraisthorpe Sands (5-6m LAT)

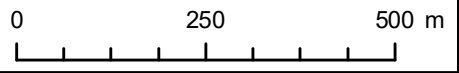


TITLE  
**Figure 2-17  
Potential Breakout Area at Fraisthorpe Sands (English Landfall)**

REFERENCE  
SEGL2\_M\_EAR\_2-17\_v3\_20220614

SHEET NUMBER  
1 of 1

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14/06/2022



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### 2.3.3.3 Cable Pull In

Cables will be installed through each of the ducts as follows:

- The temporary concrete mattresses protecting the breakout point and duct will be removed;
- Within the exit pit, the end of the installed duct may need to be exposed using either a MFE (as described in Section 2.3.4.3) or diver assisted excavation machines;
- Pre-cut trenching may be undertaken using a back-hoe dredger or MFE (as described in Section 2.3.4.3) to create a trench leaving the exit pit and following the final cable route; this is expected to be for a distance of up to approximately 100 m from the exit pit;
- A bell mouth<sup>6</sup> will be installed within the exit pit to guide the cable into the duct;
- A CLV or CLB will bring the HVDC cable (and FO cable if being installed in the same duct) to the location of the exit pit;
- The HVDC cable (and FO cable if being installed in the same duct) will be connected to the messenger wire and winched landward through the duct. Alternatively, the FO cable may be installed within its own duct;
- The cable will be winched to a position past the TJB where it can be anchored or jointed to the onshore cables;
- The bell mouth will be removed, and a flange installed to seal the duct;
- The cable may be fixed in the duct using an appropriate material, such as grout, bentonite or similar which will be pumped into the duct from land, with a small amount of material lost from the bleed valve at the seaward end, although this loss will be minimised as far as practicable;
- If the FO cable is installed in its own duct, it will then be bundled with one of the HVDC cables as they exit the capped duct; and
- In depths shallower than 10 m, cables will be buried using the most appropriate method(s) depending on the seabed conditions, including MFE or diver operated jet trencher.

Each cable pull is expected to take up to one week of 24-hour working, depending on the operability of the installation vessels and suitable weather conditions.

Once the cables are installed, the exit pit may be backfilled using rock placement, noting that concrete mattresses may be utilised below the rock placement to stabilise the HDD exits. The HDD exit pit is anticipated to be backfilled to the original mean seabed level, and as such no significant elevation from the seabed is expected.

### 2.3.3.4 Installation Vessels

Several vessels may be used to install the cables at the landfalls, operating in depths of less than 10 m, including a CLV, CLB or jack-up barge. These vessels may also be supported by guard and anchor handling vessels. A description of the vessels is provided in Section 2.3.1.

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

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<sup>6</sup> A bell mouth is a device which is used to help guide the cable through the cable duct and avoid damage to both the cable and the duct.



### 2.3.3.5 Summary of Landfall Installation Parameters

Key landfall installation activities aspects and parameters are summarised below in Table 2-5.

**Table 2-5: Summary of landfall activities aspects and parameters.**

Aspect	Maximum Zone of Influence	Scottish Waters		English Waters	
		Territorial Waters	Offshore Waters	Offshore Waters	Territorial Waters
Completed boreholes	Boreholes up to 1.5 km in length and 660 mm in diameter.	Up to 4	Not applicable.		Up to 4
Aborted boreholes	Boreholes up to 1.5 km in length and 660 mm in diameter.	Up to 2	Not applicable.		Up to 2
HDD exit pit excavation	Area of the seabed directly affected by works associated with the excavation of exit pits at each landfall (including equipment spread). Depth of lowering is expected to be 1 m to 3 m.	5,000 m <sup>2</sup>	Not applicable.		5,000 m <sup>2</sup>
Drilling fluid losses	2,000 m <sup>3</sup> of drilling fluids and 80 m <sup>3</sup> of solids (drill cuttings) to be discharged into the marine environment per borehole.	12,000 m <sup>3</sup> of drilling fluids and 480 m <sup>3</sup> of solids.	Not applicable.		12,000 m <sup>3</sup> of drilling fluids and 480 m <sup>3</sup> of solids.
Breakout point protection after installation of cable ducts	Anticipated that ducts and cables will be buried using MFE or diver operated equipment. Concrete mattresses may be used as temporary protection at six per duct.	5,000 m <sup>2</sup> pre-cut trenching 24 concrete mattresses See Table 2-7 for details on rock protection	Not applicable.		5,000 m <sup>2</sup> pre-cut trenching 24 concrete mattresses See Table 2-7 for details on rock protection
Nearshore vessels	Area of seabed disturbance for jack-up barges as a result of spud cans.	200 m <sup>2</sup>	Not applicable.		200 m <sup>2</sup>
	Area of seabed disturbance for CLB. Each anchor up to 2 m in length and deployed up to 800 m from CLB within Marine Installation Corridor.	32 m <sup>2</sup> at each anchored work location	Not applicable.		32 m <sup>2</sup> at each anchored work location
	Area of seabed disturbance for back-hoe dredger, which maintain position via anchors or spud can.	100 m <sup>2</sup> at each exit pit location	Not applicable.		100 m <sup>2</sup> at each exit pit location

### 2.3.4 Submarine Cable Installation

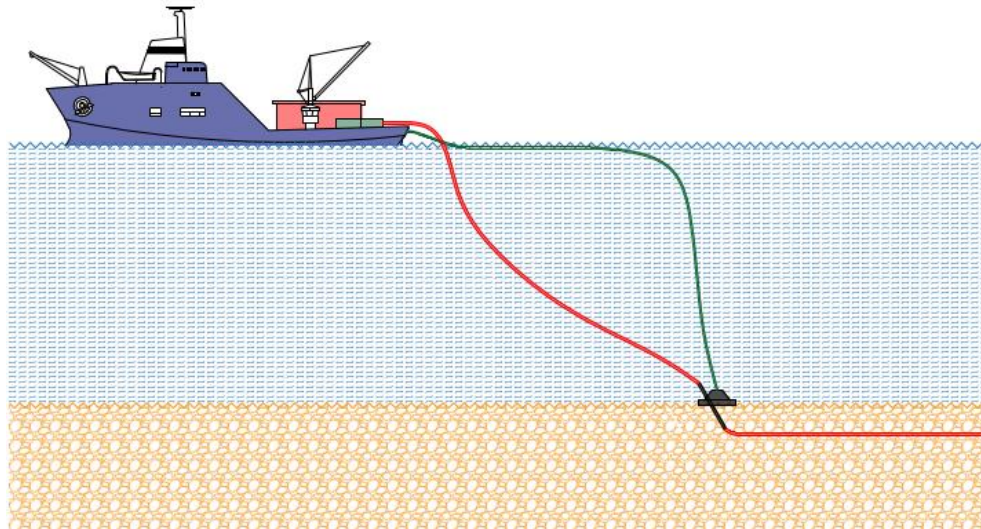
This section considers the potential cable laying methods proposed, with the subsequent trenching of cables discussed in Section 2.3.4.3. The following cable laying methodologies may be used:

- Simultaneous cable lay and trenching; and
- Surface cable lay followed by post-lay trenching of the cables.

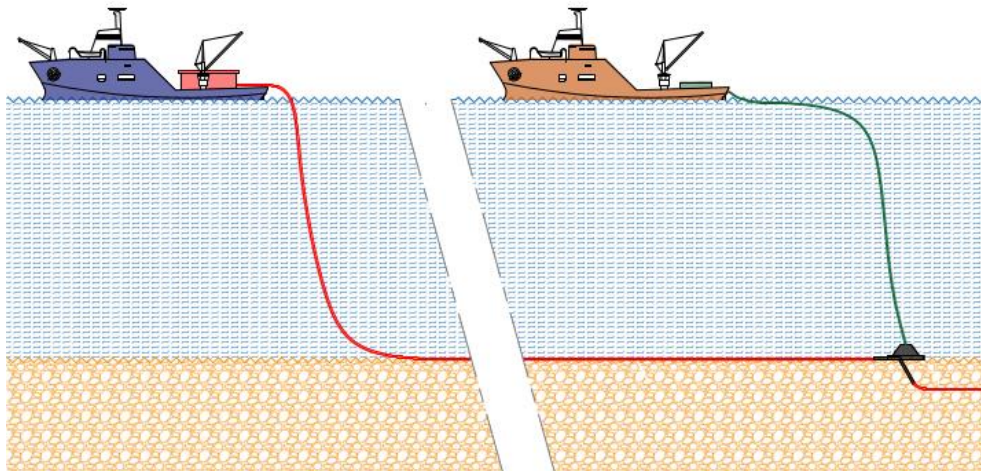
During simultaneous cable lay and trenching, the CLV may also deploy the trenching equipment, or it may be deployed by another vessel following approximately 1 km behind the CLV, creating a single group of vessels and equipment (Figure 2-18). The vessel(s) may move relatively slowly, depending on the seabed type encountered, as speeds of between 0.5 km and 5 km per day, appearing effectively stationary to other shipping.

When surface lay is followed by post lay burial of the cable the two parts are discrete operations separated in both distance and time (Figure 2-19). The CLV can progress at speeds of up to 7 km per day, with the trenching vessel following behind more slowly.

A temporary 500 m (advisory) safety zone will be established around the installation vessels, which ever method is selected for the installation of the cable.



**Figure 2-18: Simultaneous lay and trenching.**



**Figure 2-19: Post-lay trenching.**

### 2.3.4.1 Cable Jointing

A CLV or CLB cannot carry the entire cable required for the submarine cable route length in a single load, therefore the cables will be installed in sections, with joints between the sections as follows:

- When the cable end is reached of a section of cable, the end will be temporarily left on the seabed with a pick-up attachment to enable retrieval using an ROV.
- The CLV will leave the site to load a new length of cable, before returning to site, retrieving the end of the existing cable and jointing the new cable section to the existing cable end left on the seabed.
- Cable laying then continues until the end of the new cable length is reached and the jointing process is repeated as necessary.

Jointing will be required every 50 km to 100 km, with the jointing distances determined by the amount of cable that the CLV or CLB can carry. Cable joints will be made onboard the CLV and take up to a week to complete, during which the CLV will maintain position by DP. Once the cable joint has been made on board the vessel, cable laying will continue as normal.

Joints will either be trenched into the seabed or external protection such as rock berms applied where trenching is not possible. As far as possible, the Marine Scheme will ensure that joints are not located within higher risk areas where the prolonged presence of the installation vessels is not desirable.

### 2.3.4.2 Crossings

Twenty-four assets have been identified as crossing the Marine Installation Corridor (summarised in Table 2-6 and shown in Figure 2-20). Crossing agreements will be made with the parties owning assets crossed by the Marine Scheme and all parties have or are in the process of being informed about the potential for a crossing. The agreements will detail the physical design of the crossing and the rights and responsibilities of both parties to ensure the ongoing integrity of the assets and minimise snagging risk as far as practicable. The physical crossing design will vary depending upon the size, type, location and burial state of the asset to be crossed. The assets will be crossed via one of the following:

- On 'bridge' comprised of rock placement;
- On concrete mattresses;
- Using a separator system, such as tubular protection system, put around the cable during its installation; or
- Pre-cast concrete pipe bridge (potentially to be used for pipeline crossings only that would already present a snagging risk, although will avoid using if alternative design can be agreed).

There is potential for presently unknown crossings to be required and if so, proximity and crossing agreements will be agreed with the asset owner and will be in line with the overarching detail provided in this section.

A typical sequence of installation is:

- Survey and visual inspection of the crossing location by ROV in advance;
- Rock placement, concrete mattresses or pipe bridge is installed over the existing asset to create separation between it and the cables;
- An exclusion zone for use of trenching equipment will be defined on either side of the existing asset, in agreement with the asset owner. This means that, for example, a cable plough if used, must transition out of the seabed before reaching the exclusion zone boundary;
- The Marine Scheme's cables will be surface laid across the rock placement, concrete mattresses or bridging structure;
- If the existing asset to be crossed is considered to be buried sufficiently deep, the cables may be surface laid over the crossing location within a separator system;
- After crossing, trenching of the cable will continue outside of the exclusion zone; and
- Further rock placement or concrete mattresses will then be laid over the cable along the exclusion zone including the transition out and transition in zones.

A minimum vertical separation between the asset and the Marine Scheme cables will be agreed with the asset owner, although this will typically be 200 mm to 500 mm. The crossing will be engineered to achieve the agreed vertical separation. The horizontal separation between the crossing structure and any anodes on pipeline crossings will be agreed with the asset owner, although typically anodes are required to be avoided by rock placement by between 10 m to 15 m.

The crossing design for each asset will indicate the seabed footprint of the crossing structure. Indicative diagrams of typical methods of asset crossings are presented in Figure 2-21 to Figure 2-26. These diagrams provide an indication of the size of the footprint for different crossing structures. It should be noted that the size of the actual footprint will depend upon the:

- Type of crossing structure;
- Depth of lowering of the asset which is to be crossed;
- Water depth; and
- Extent of the trenching exclusion zone.

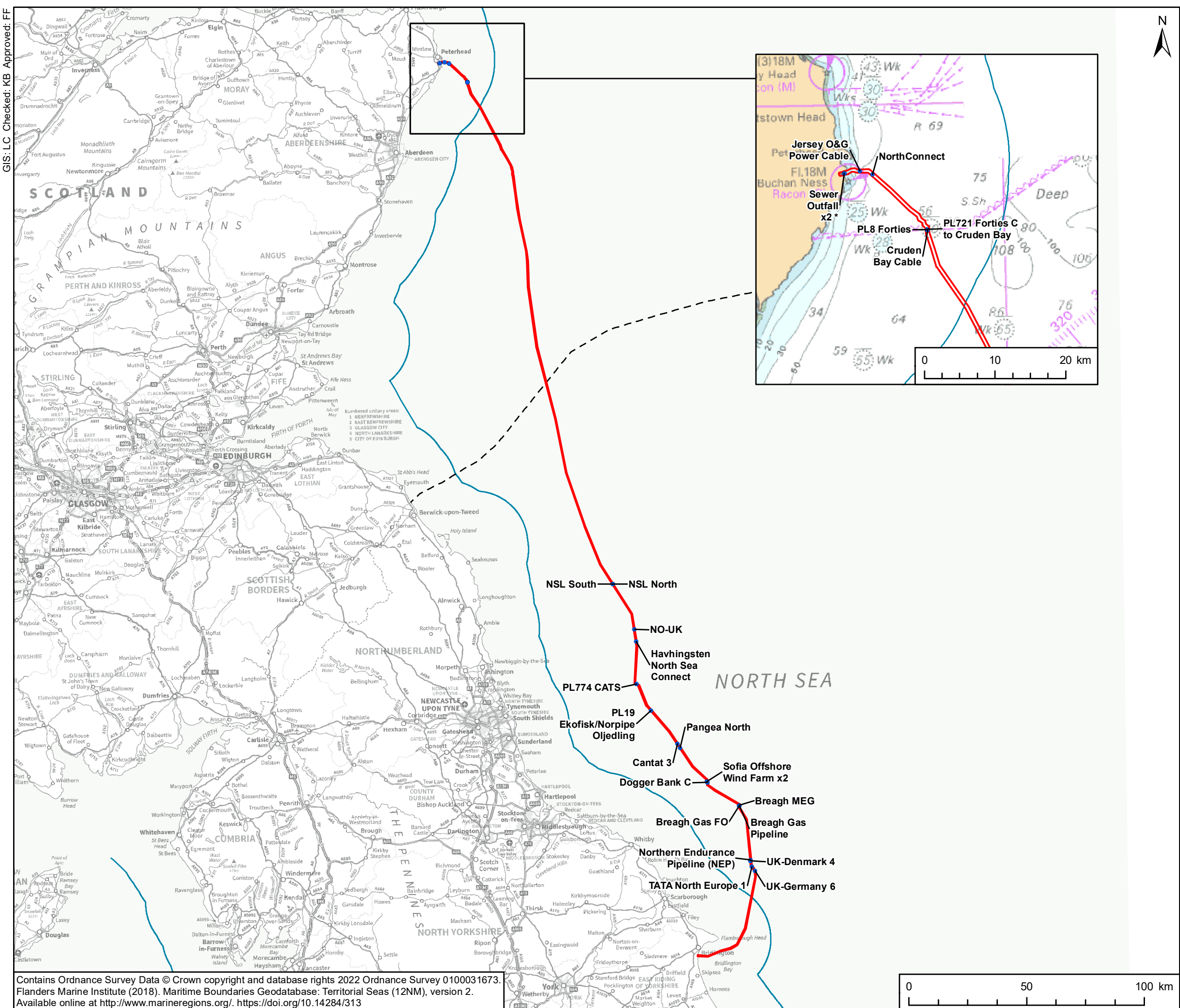
**Table 2-6: Currently Anticipated Crossings along the Marine Scheme.**

KP	Waters	Name	Owner	Type	Status
0.8	Scottish territorial waters	Outfalls x 2 *	Scottish Water	Outfall	In Service
3.1		Jersey Oil and Gas proposed cable	Jersey Oil and Gas	Power	Planned
5.1		NorthConnect	NorthConnect	Power	Consented (on hold)
16.4		PL721 Forties C to Cruden Bay	Ineos	Pipeline	In Service
16.4		PL8 Forties	Ineos	Pipeline	OOS – anticipated to be used again
16.5		Cruden Bay Cable	Tampnett	FO cable	In Service
240.8	English offshore waters	North Sea Link (NSL) North	National Grid	Power	In Service
240.8		NSL South	National Grid	Power	In Service
262.6		NO-UK	Altibox Carrier	FO cable	In Service
267.8		Havhingsten North Sea Connect	Alcatel Submarine Networks (ASN)	FO cable	Planned
286.4		PL774 CATS	Kellas Midstream (Owner); Wood Group (Operator)	Pipeline	In Service
299.6		PL19 Ekofisk / Norpipe Oljedling	Norpipe Oil AS (Owner); ConocoPhillips Skandinavia AS (Operator)	Pipeline	In Service
317.6		Cantat 3	Faroese Telecom	FO cable	OOS
319.6		Pangea North	ASN	FO cable	In Service
338.1		Sofia Offshore Wind Farm x 2	RWE / Innogy	Power	Planned
338.5		Dogger Bank C	Dogger Bank	Power	Planned
355.8		Breagh MEG	Ineos	MEG Line	In Service
356.1		Breagh Gas FO	Ineos	FO cable	In Service
356.1		Breagh Gas Pipeline	Ineos	Pipeline	In Service
380.0		North Endurance Pipeline	BP (consortium)	Pipeline	Planned
380.3		UK-Denmark 4	BT	FO cable	OOS
382.9		TATA North Europe 1	TATA Communications	FO cable	In Service
385.1		UK-Germany 6	BT	FO cable	OOS
Not available	Scottish territorial waters	Atlantic Super Connector	ASC	Power	Concept
Not available	English offshore waters	Continental Link	NGV	Power	Concept

\* Crossed by HDD, not on seabed.



GIS: LC Checked: KB Approved: FF



PROJECT

Eastern Green Link 2

KEY

- Marine Installation Corridor
- UK Territorial Sea Limit
- Scottish/English Water Border
- Crossing Location

\* Crossed by HDD, not on seabed.

Two further crossings are anticipated for third party developments, one within Scottish territorial waters and one within English offshore waters.

TITLE

Figure 2-20  
Anticipated Locations of Crossings along the Project Marine Scheme

REFERENCE

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SHEET NUMBER

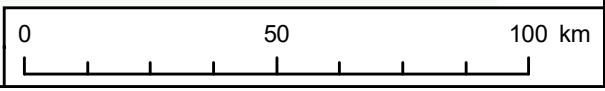
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Flanders Marine Institute (2018). Maritime Boundaries Geodatabase: Territorial Seas (12NM), version 2.  
Available online at <http://www.marinerregions.org/>. <https://doi.org/10.14284/313>

Coordinate System: ETRS 1989 UTM Zone 30N



Scale @ A3 1:1,500,000 / 1:500,000

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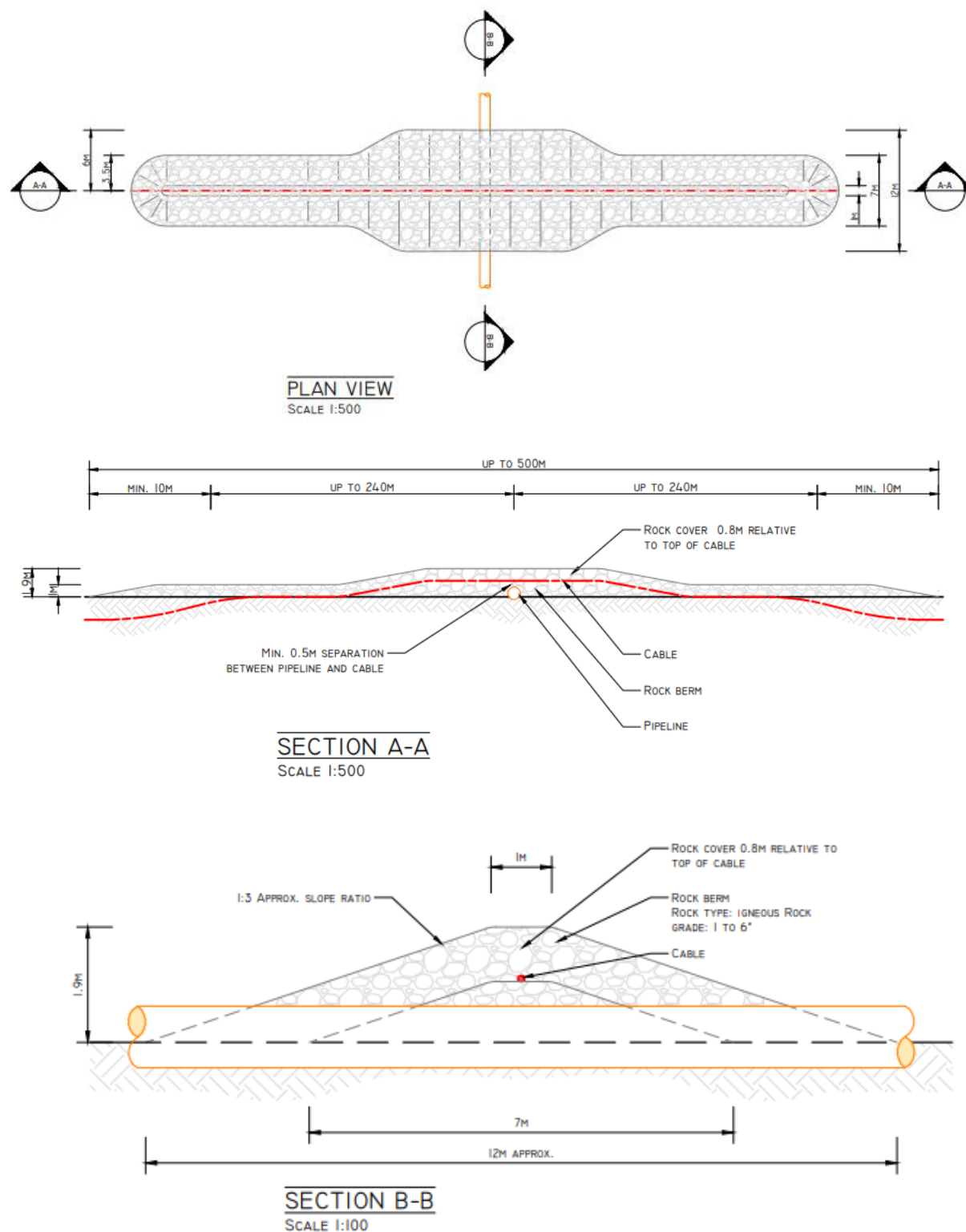


Figure 2-21: Representative pipeline crossing with rock over rock.

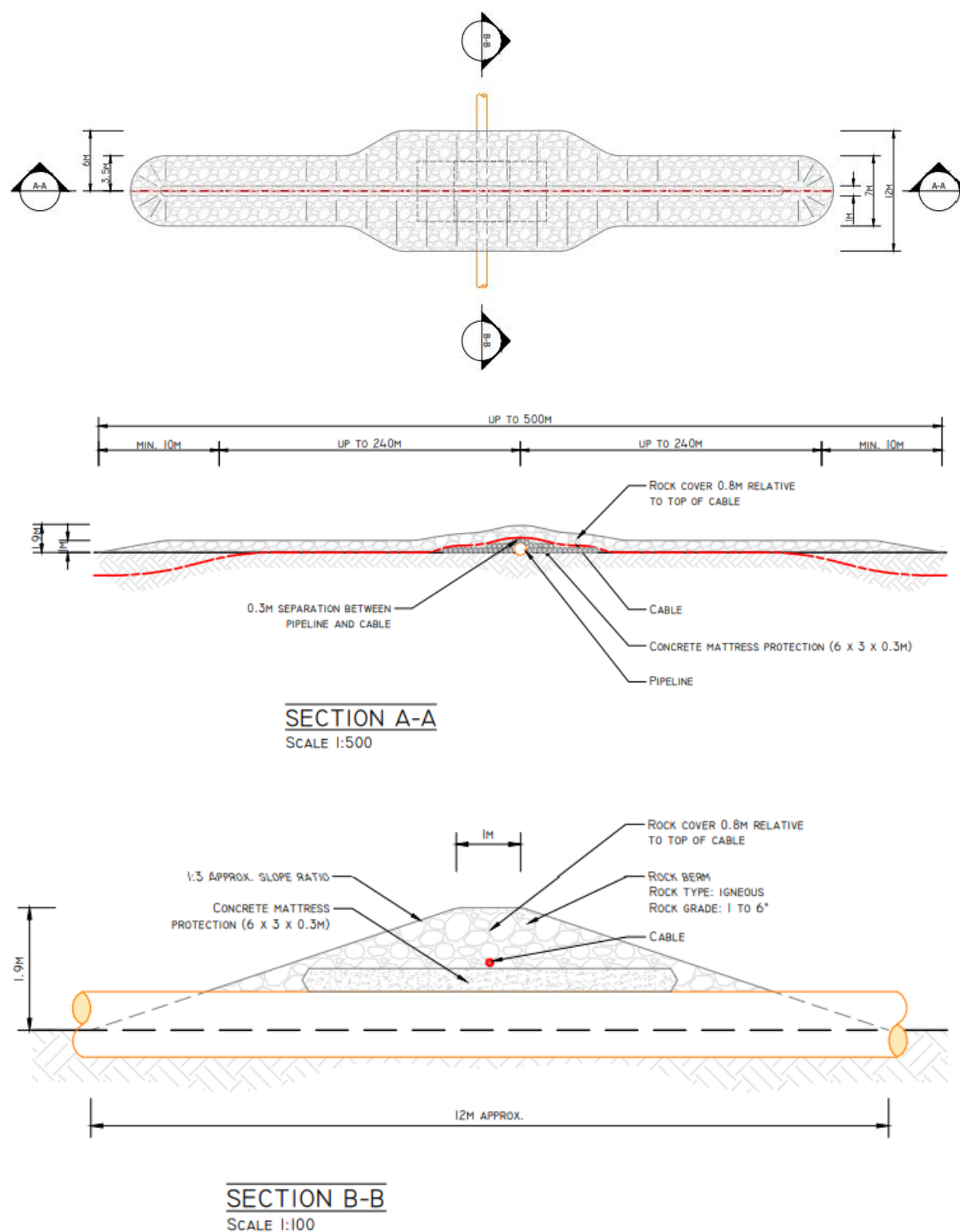
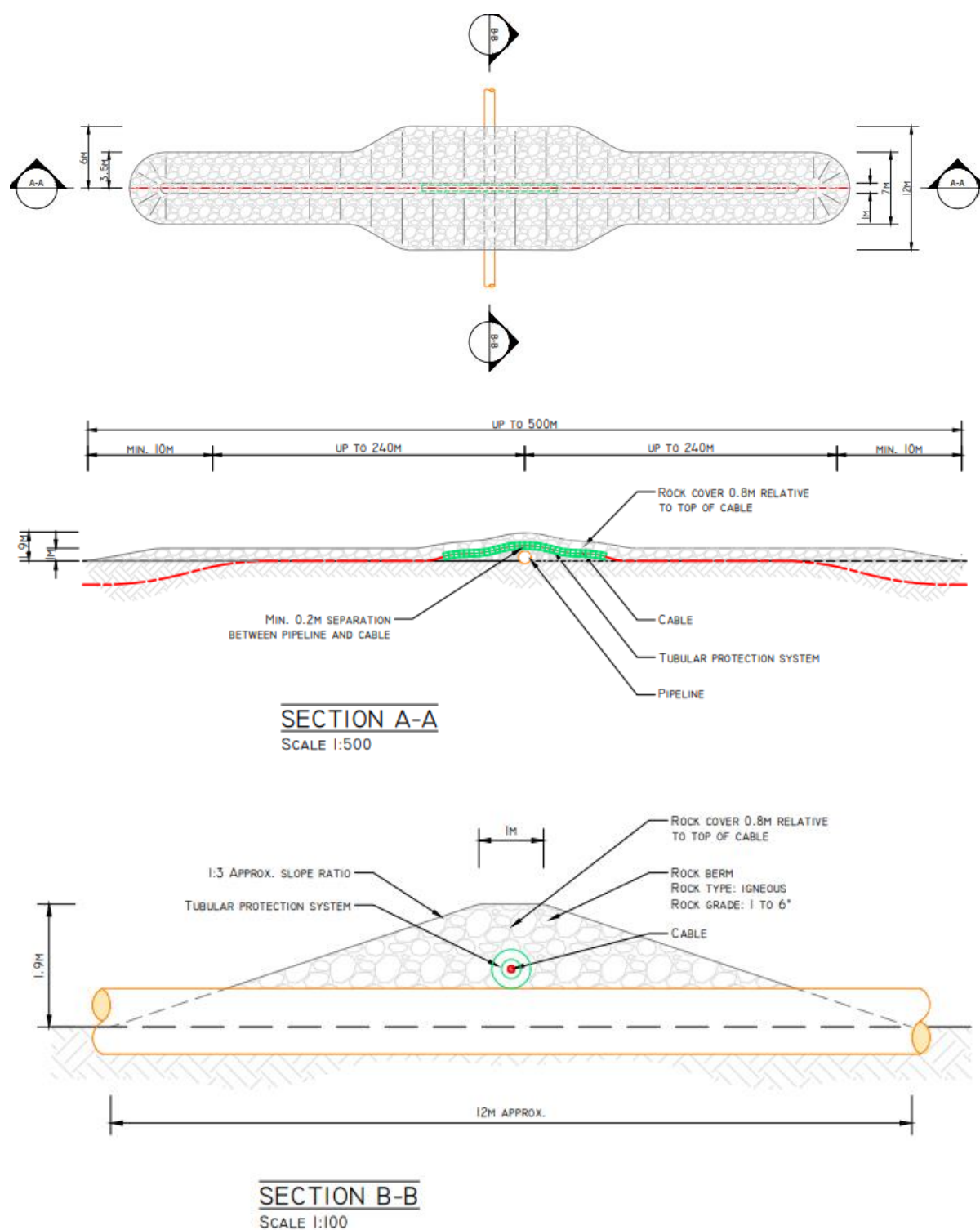


Figure 2-22: Representative pipeline crossing with concrete mattresses.



**Figure 2-23: Representative pipeline crossing with tubular protection and rock berm.**

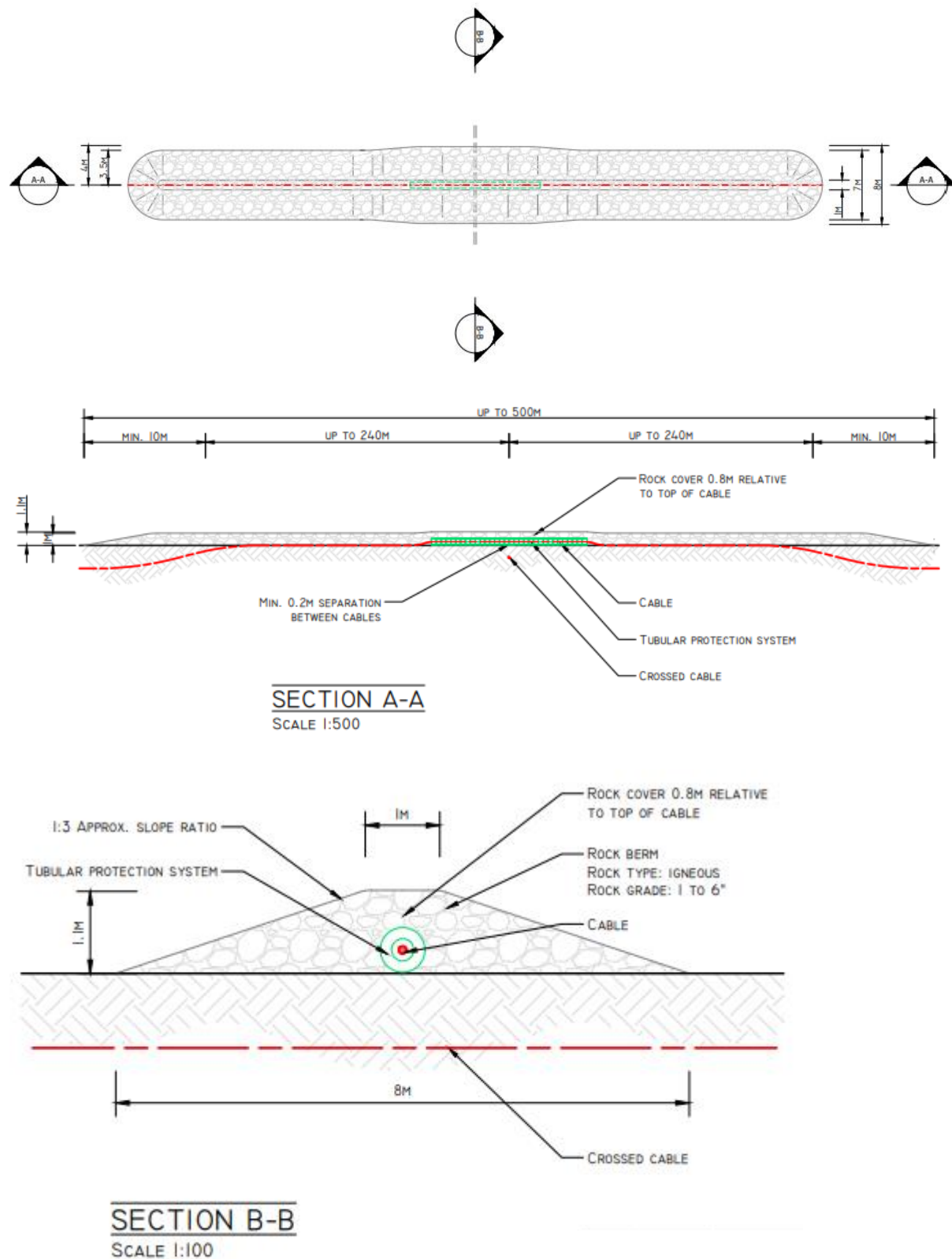


Figure 2-24: Representative cable crossing with tubular protection system and rock protection.

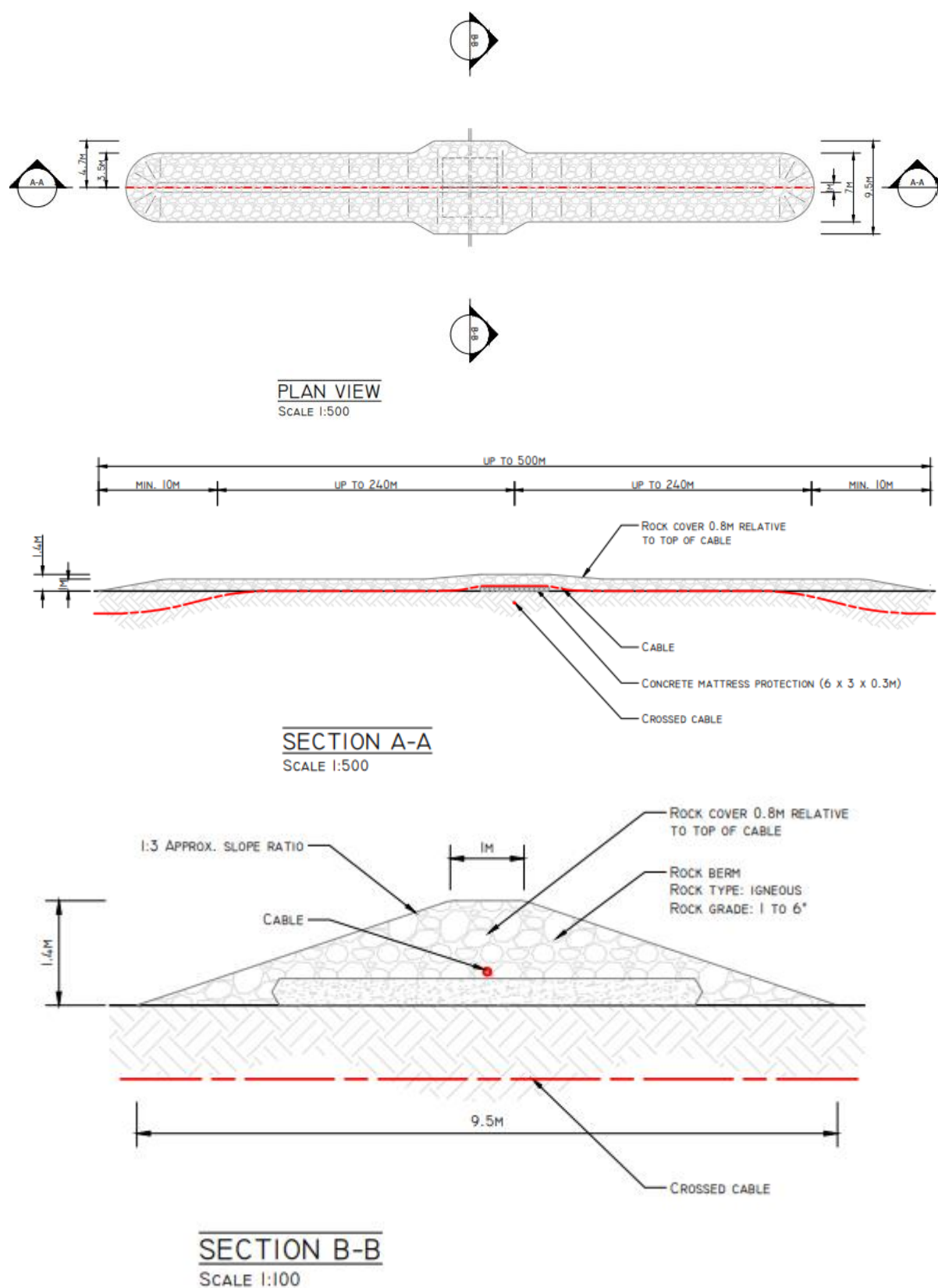
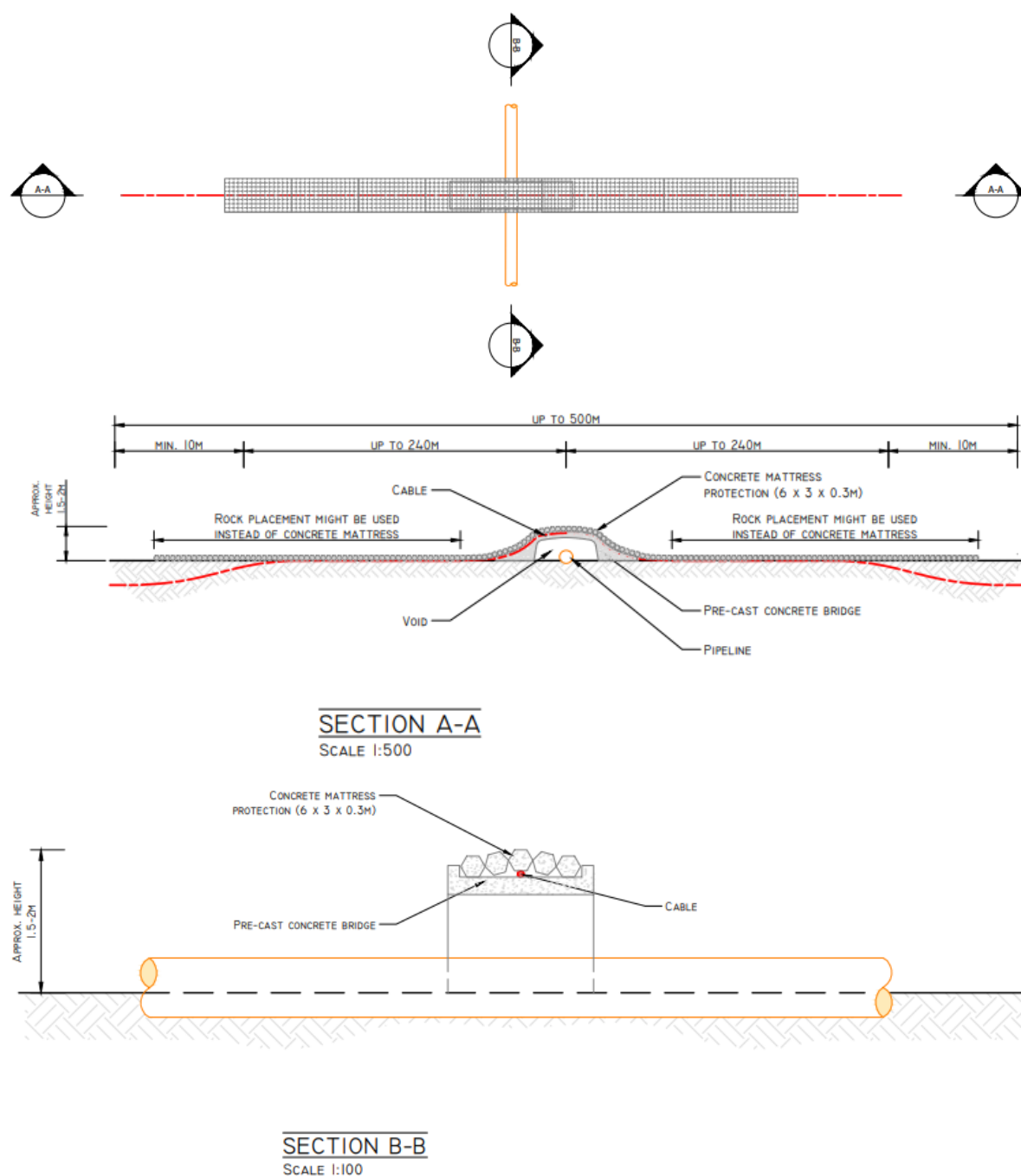


Figure 2-25: Representative cable crossing with mattresses and rock berm.





**Figure 2-26: Representative pipeline crossing with bridge.**

### Multiple Asset Crossings

For crossings of multiple assets in close proximity to each other (e.g., large offshore wind farms with multiple cables, or cable systems with more than one cable/bundle), a single integrated crossing structure may be used, resulting in the overall area of the crossing potentially being larger than that required for a single crossing.

#### 2.3.4.3 Cable Trenching

The primary protection method is to trench the cable along the majority of the Marine Installation Corridor, this is predominantly to protect the cables from external threats including potential fishing gear and anchor interactions. A Cable Burial Risk Assessment (CBRA) (Anatec Ltd, 2022) was undertaken to inform the development of the Marine Scheme. The CBRA confirmed a target depth of lowering of 1.5 m, where achievable, with a minimum depth of lowering of approximately 0.6 m for the submarine cables. Where the cables cannot be adequately protected by trenching, external cable protection will be deployed such as rock berms. Details of trenching depths, dimensions of trenches required, and wider areas of potential seabed disturbance are discussed in this chapter and summarised in Table 2-7.

The minimum target depth of lowering is anticipated to be achievable for the majority of the cable route, provided that the correct trenching tools are selected, which will depend on the seabed conditions present along the installation corridor. The choice of tool will be informed by the findings of the pre-installation surveys and micro-routeing requirements for the submarine cables and will be assessed to confirm suitability for the expected seabed sediment conditions prior to award of the installation contract.

There are four generic types of equipment for trenching the cables which may be deployed:

- Cable burial ploughs (displacement or non-displacement);
- Jet trenching (towed, free swimming or tracked);
- Mechanical trenchers (tracked); and
- MFE.

As discussed previously, the cables will be laid and trenched by the CLV simultaneously (Figure 2-18) or trenched in a separate operation (Figure 2-19).

#### Cable Burial Ploughs

Ploughs are towed behind a CLV or a dedicated support vessel (e.g., an anchor handling tug) and some can be steered and controlled remotely from the surface via an umbilical cable. There are two types of cable ploughs: displacement ploughs (creating an open trench for the cable) and non-displacement ploughs (lowering the cable into the sediment; Figure 2-27). Non-displacement ploughs are towed either by the CLV or an auxiliary vessel following the CLV.



Figure 2-27: Modular cable plough.

The displacement plough creates an open 'V-shape' trench, and is towed behind an auxiliary vessel, which displaces the seabed material to either side of the trench. The disturbance swathe for the displacement plough is typically 10 m to 25 m, although the disturbed seabed footprint due to ploughing is between 2 m and 5 m. The remainder of the disturbed area is due to the action of the skids and the berms either side of the ploughed seabed. Displacement ploughs are often used to pre-trench a cable, with the cable and trench left either to naturally backfill, backfilled using MFE (see Section 2.3.4.3) or they may be backfilled with a relatively small amount of rock placement.

Non-displacement ploughs are typically used in simultaneous lay and trenching operations but may also be used during a post-lay trenching campaign. Their use removes the need for backfilling, in comparison to displacement ploughing. The disturbance swathe for the non-displacement plough is typically 8 m to 12 m, although the disturbed seabed footprint due to ploughing is approximately 1 m, the remainder comprising the skids and plough.

### Jet Trenchers

Jet trenchers may be self-propelled ROVs (Figure 2-28) or they may be towed sledges. Both use water jets to fluidise the seabed in front of, and around the cable, so that the cable sinks into the sediment under its own weight.



**Figure 2-28: Tracked jet trencher.**

In medium to coarse sands and in gravels, the reconsolidation of fluidised sediments is significantly faster than in fine sands and silts. The disturbance swathe for a jet trencher is typically 6 m to 10 m wide. The disturbed seabed footprint due to jet trenching is approximately 1 m, the remainder comprising the tracks.

Jet trenching is a viable technique in a wide range of sediments, although performance decreased with:

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

Systems can achieve burial in excess of 2 m in soft clays and fine sands, while in medium to coarse sands, the burial depth achieved depends on the grain size of the sediment (i.e., on the re-sedimentation velocity).

Any trench remaining after re-sedimentation is left to backfill naturally as a result of the natural movement of sediment on the seabed.

### **Mechanical Trenchers**

Mechanical trenchers are usually mounted on tracked vehicles and use saws, toothed wheels or chisels to cut a trench (Figure 2-29). They are effective in a range of sediments, including weathered softer bedrock and very soft sediment. However, they are less effective in certain types of rock (e.g., chalk with flints), large gravel, glacial till or boulder clays. The disturbance swathe for a mechanical trencher is 5 m to 15 m wide, although the disturbed sediment footprint due to mechanical trenching is 0.5 m to 1 m in width, the remainder comprising tracks.



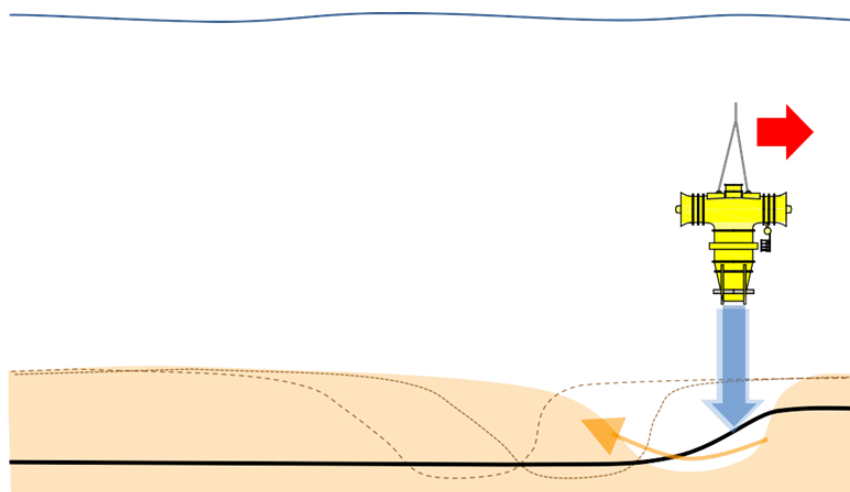
**Figure 2-29: Mechanical trencher.**

The mechanical trencher follows the cables that have been pre-laid on the seabed, collects them, keeping them clear of active trenching, before guiding the cables into the trench and backfilling sediment on top of the cable. The backfill material and suspended sediment stays in the direct area of the mechanical trencher and the backfilled trench.

### **Mass Flow Excavators**

MFE may be used for the excavation of the HDD exit pits, sandwave lowering, displacement plough backfill and/or burial of joints, as well as to increase the DOL in sections of the Marine Installation Corridor with medium to coarse sands, where achieved trenching depths using other methods may not meet the minimum depth of lowering. MFE uses low-pressure water to fluidise the seabed around the cable, allowing the cable to sink into the sediment under its own weight (Figure 2-30). The MFE is kept above the cable and thus mechanical impact on the cable is prevented. Additional cable length is required as the cable sinks and this is achieved via a horizontal 'S-shape' of the 'as-laid' position of the cable as well as in the vertical 'S-shape' of the seabed terrain.





**Figure 2-30: Progressing depression while lowering a cable using Mass Flow Excavation.**

In medium to coarse sand, MFE creates a depression with fluidised sediment as it moves over the cable. The majority of the fluidised sediment re-settles to the rear of the operation, thus backfilling the trench and covering cable. In fine sand and silt, MFE leaves behind an open trench with very little cover on the cable.

Turbidity within the water column as a result of MFE in medium to coarse sand is comparable to that of jet trenching. Suspended sediment stays in the direct area of the operations and either re-settles into the created depression or in its direct vicinity. The seabed footprint of MFE creates a depression up to 10 m wide

The use of MFE is anticipated to be required for up to 9 km in Scottish territorial waters for the pre-cut trench at the HDD exit pit and sandwave lowering, for up to 8.5 km on the Scottish offshore waters for sandwave lowering, for up to 5 km on the English offshore waters for sandwave lowering and up to 1.5 km in English territorial waters for the pre-cut trench at the HDD exit pit and possible lowering of the seabed in some limited areas within the vicinity of the English landfall, subject to further investigation during pre-installation surveys.

#### 2.3.4.4 Cable Protection Measures

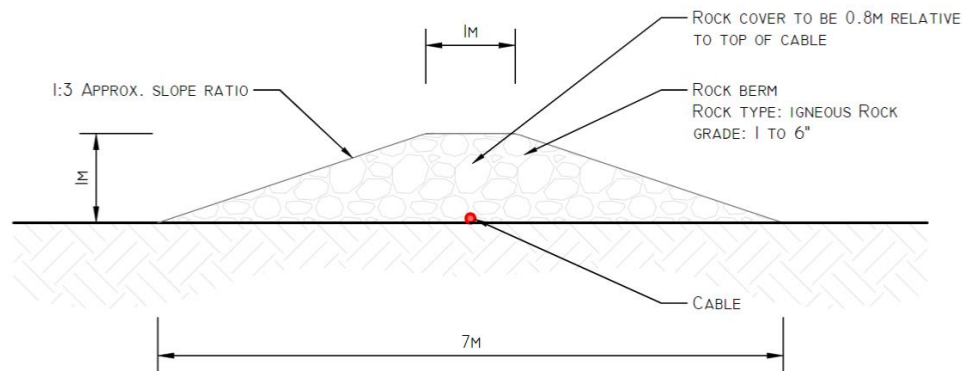
Additional cable protection will be required where the target depth of lowering using the methods outlined above cannot be achieved. The cable protection measure proposed for the Marine Scheme is the use of rock placement and/or the use of concrete mattresses (see Section 2.3.2.2 and Section 2.3.3.1 for details on where concrete mattresses will be used in the Marine Scheme).

Rock placement will be required in locations where the target depth of lowering cannot be achieved, at crossings, and potentially at the HDD exit pits. The requirement for rock placement will be minimised wherever possible and analysis of the potential to make modifications to the target depth of lowering, exact installation methodology and/or repeat trenching will be considered first, with remedial rock placement only installed as a last resort.

Rock berms provide a strong protective cover to protect the cables from external threats, such as potential interactions with other marine activities including anchoring and fishing and ensures stability of the cables, by shielding the cable from the currents. The size of the berm and grade (size) of rock required will depend on the current and wave loading conditions at the location where rock placement is required, but it is currently anticipated to be between 1" to 6". In shallow waters, the wave induced water action at the seabed is larger than in deeper waters, requiring larger graded rock. Rock will be igneous, clean with low fines.

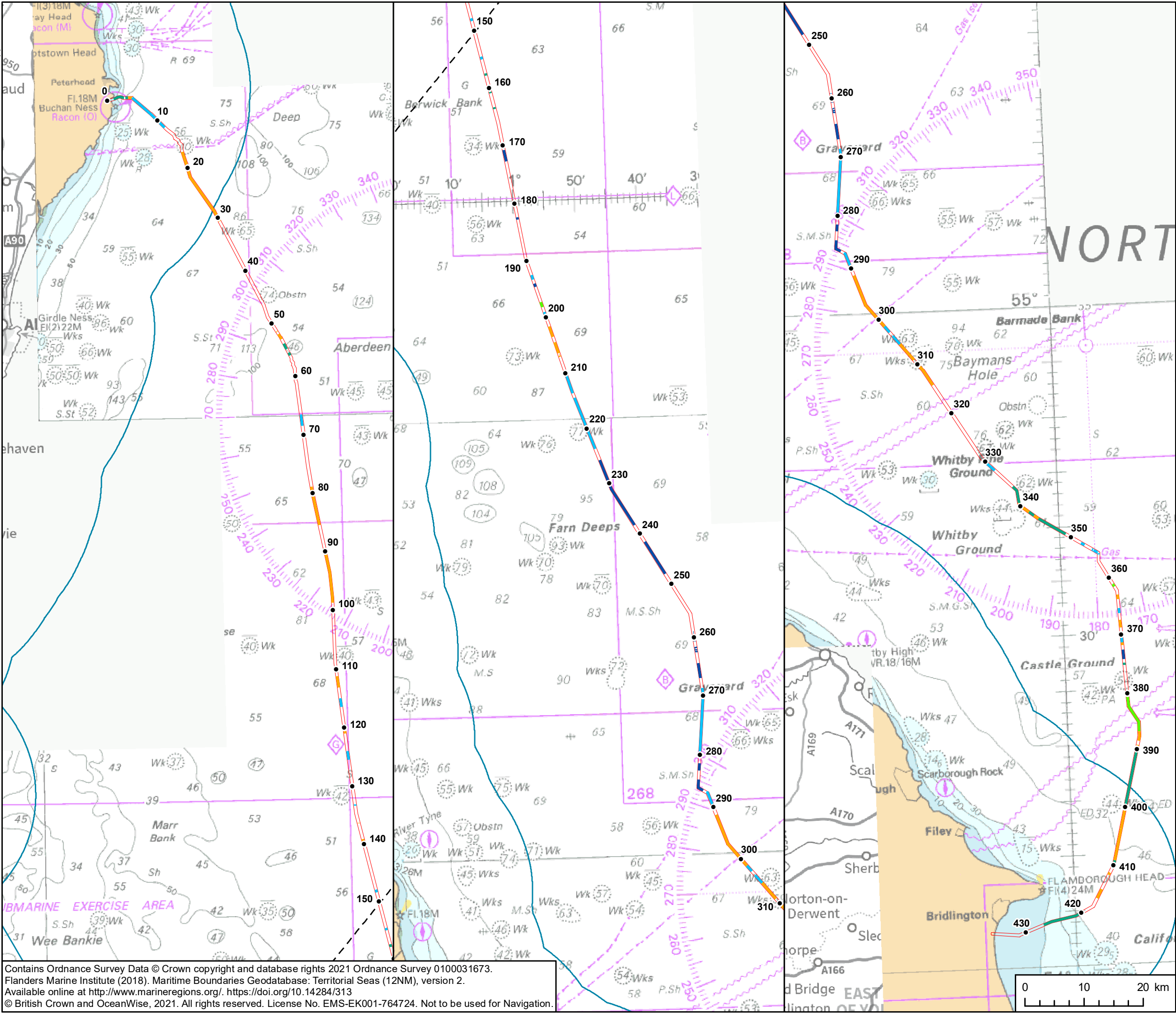
Where rock placement is required to protect an exposed or shallow buried cable, the height and width of these berms will be kept to a practical and safe minimum, typically a height of up to 1 m, with a width of up to 7 m. The berms will be designed to reduce snagging risk in so far as is practicable, with 1:3 slopes and flat crests in line with industry guidance. A representative rock berm is shown in Figure 2-31.

Up to approximately 154 km of rock berm is anticipated to be required for the protection of the each of the cables, including crossings, joints, and landfall protection (as shown on Figure 2-32). This includes up to approximately 15 km of the additional rock berm which has been allocated for remedial activities following installation of the cable and could be placed anywhere within the Marine Installation Corridor. The length of remedial rock berm has been calculated based on the likelihood of achieving the minimum depth of lowering calculated for each section of the route, considering the available trenching tools and perceived ground conditions. These calculations are considered conservative and based on worst-case assumptions.



**Figure 2-31: Representative rock berm.**

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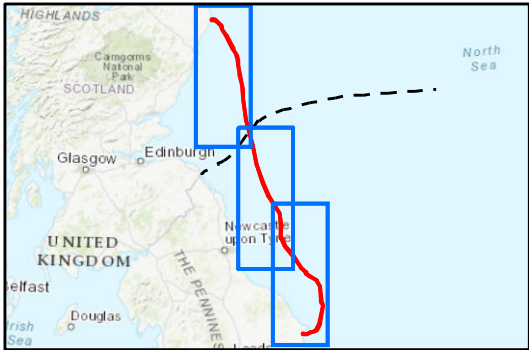


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Flanders Marine Institute (2018). Maritime Boundaries Geodatabase: Territorial Seas (12NM), version 2.  
Available online at <http://www.marineregions.org/>. <https://doi.org/10.14284/313>  
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Coordinate System: ETRS 1989 UTM Zone 30N

PROJECT  
**Eastern Green Link 2**

- KEY
- Marine Installation Corridor
  - Kilometre Point (KP)
  - UK Territorial Sea Limit
  - Scottish/English Water Border
  - Indicative Rock Placement Location \*
  - Category 1 - 3%
  - Category 2 - 25%
  - Category 3 - 50%
  - Category 4 - 75%
  - Category 5 - 100%

\* Categories are the percentage length of each zone where rock placement may be anticipated



TITLE  
**Figure 2-32  
Planned Rock Placement Locations  
within the Marine Installation Corridor**

REFERENCE  
SEGL2\_M\_EAR\_2-32\_v2\_20220614

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### 2.3.4.5 Summary of Submarine Cable Installation Parameters

Key submarine cable installation activities aspects and parameters are summarised below in Table 2-7. It should be noted that if the displacement plough is used along the cable route within the parameters provided below, this would be instead of non-displacement methods, not in addition to.

**Table 2-7: Summary of submarine cable installation activities aspects and parameters.**

Aspect	Maximum Zone of Influence	Scottish Waters		English Waters	
		Territorial Waters	Offshore Waters	Offshore Waters	Territorial Waters
Trenching - Displacement plough	Width of disturbance per trench is 10 m to 25 m. The actual disturbed seabed footprint due to ploughing is 2 m to 5 m, the remainder comprising the skids and berms either side of the ploughed seabed.	14.2 km *	25 km *	30 km *	47.3 km *
Trenching – all tools except displacement ploughs.	Width of disturbance per trench is: <ul style="list-style-type: none"> <li>Ploughs – 8 m to 12 m.</li> <li>Jet trenchers – up to 10 m</li> <li>Mechanical trenchers – 8 m to 15 m</li> </ul>	28.4 km *	121.8 km *	246.3 km *	38.7 km *
MFE	Seabed footprint up to 10 m in width.	9 km for pre-cut trench at HDD exit pits and sandwave lowering	8.5 km for sandwave lowering	5 km for sandwave lowering	1.5 km for pre-cut trench at HDD exit pits and sandwave lowering
Cable laying	Simultaneous cable lay and trenching	1 km maximum vessel separation.			
		0.5 km to 5 km per day. Rate of progress.			
	Surface lay followed by post-lay trenching	Up to 7 km per day for CLV, with trenching progressing more slowly			
Cable jointing	Distance between joints	50 km to 100 km. Distance dependent on amount of cable carried by CLV or CLB. Up to nine joints per cable.			
Cable protection using rock placement	Protection of breakouts following excavation of exit pits	9,000 m <sup>3</sup>	Not required.		9,000 m <sup>3</sup>
	Anticipated that up to 24 assets to be crossed.	6	Not required.	18	Not required.
	Pipeline crossing seabed area affected. Total of 28,500 m <sup>2</sup> per pole along Marine Installation Corridor. Crossings up to 500 m in length, width varies between 7 m and 12 m, up to 1.9 m high. Footprint of approximately 4,750 m <sup>2</sup> of rock placement per crossing per pole.	Two pipeline crossings anticipated. 9,500 m <sup>2</sup> of seabed area affected.	Not required.	Four pipeline crossings anticipated. 19,000 m <sup>2</sup> of seabed area affected.	Not required.
	Cable crossing seabed area affected. Total of 73,800 m <sup>2</sup> per pole along Marine Installation Corridor. Crossings up to 500 m in length, width varies between 7 m and 9.4 m, up to 1.4 m high. Footprint of approximately 4,100 m <sup>2</sup> of rock placement per crossing per pole.	Four cable crossings anticipated. 16,400 m <sup>2</sup> of seabed area affected.	Not required.	Fourteen cable crossings anticipated. 57,400 m <sup>2</sup> of seabed area affected.	Not required.
	Rock placement along Marine Installation Corridor per pole. Approximately 141.3 km of rock placement anticipated including 15 km of remedial rock placement (excluding crossings).	15.2 km	25.2 km	76.6 km	20.4 km

Aspect	Maximum Zone of Influence	Scottish Waters		English Waters	
		Territorial Waters	Offshore Waters	Offshore Waters	Territorial Waters
	Rock placement along Marine Installation Corridor per pole (excluding crossings). Berms assumed to be 7 m wide.	113,843 m <sup>2</sup>	190,988 m <sup>2</sup>	574,943 m <sup>2</sup>	153,277 m <sup>2</sup>
* To be multiplied by two if cables trenched separately)					

### 2.3.5 Interim and As-Built Surveys

During the Installation Phase, interim surveys will be performed after each trenching operation to determine if trenching is sufficient and to identify areas requiring remedial activities such as additional trenching passes or rock placement.

Once the cables are fully installed and protected, an “as-built” survey will be undertaken to confirm the positions of the cables and associated protection measures. The “as-built” surveys will form the baseline for further monitoring during the Operation and Maintenance Phase as described in Section 2.4.1.

## 2.4 Operation and Maintenance Phase

### 2.4.1 Monitoring Surveys

During the Operation and Maintenance Phase, surveys will be undertaken to monitor the condition of the cables. These surveys will determine the seabed level which will allow the cable trenching to be assessed. Monitoring survey methods are anticipated to include ROV and geophysical survey techniques.

It is anticipated that surveys will be undertaken every one to two years following completion of the Installation Phase. The results of the initial surveys will be used to determine the frequency of future surveys and identify areas requiring more regular surveys based on the potential natural and anthropogenic threats to the cables.

Requirements for surveys of third-party assets such as cable crossings will be agreed as part of any required crossing agreements made with asset owners, may affect the frequency and nature of monitoring surveys. Furthermore, new or changed third-party activity in proximity to the cable throughout the life of the Project may also require the survey frequency to be reviewed.

### 2.4.2 Cable Maintenance

The cable system is designed to avoid the need for routine maintenance and therefore no planned maintenance work is anticipated for the cables or their infrastructure during the lifetime of the Marine Scheme.

However, monitoring surveys may identify the need for preventative maintenance to increase the external protection (e.g., in highly localised areas of mobile seabed risking exposure of the cable over time). This may involve the use of methods to increase DOL (such as jet trenching or MFE, see Section 2.3.4.3 or use of rock placement or concrete mattresses (see Section 2.3.4.4) to provide additional protection to the cables.

The methods and scale of materials anticipated to be required during the Operation and Maintenance Phase fall within the parameters of impacts assessed by this appraisal for the Installation Phase.

### 2.4.3 Submarine Cable Repairs

Repairs to submarine cables that have been designed, manufactured, installed and protected correctly are not common. Situations where a repair may be required include:

- Internal faults: mechanical or electrical faults within the cable due to a design or manufacturing error or defect; and

- External faults: including third-party damage from anchor strikes, towed fishing gear or other third-party works.

A suitable vessel may need several months to complete the repair work, which may include:

- Find location and extent of fault on cable;
- Loading of spare cable to the repair vessel and transiting to site;
- Cutting of damaged section using divers or ROV and recovery of ends to the repair vessel;
- Replacement and jointing of the damaged section;
- Lowering of new repaired section and joints to the seabed; and
- Protection of cable repair.

## 2.5 Decommissioning Phase

In the years leading up to the end of the Marine Scheme's operational life, the options for decommissioning will be evaluated through integrated environmental, technical and economic assessments. The objective in undertaking these assessments will be to minimise the short and long-term effects on the environment, whilst ensuring that the sea is safe for others to navigate. The level of decommissioning will be based upon the regulations, best practices and available technology at the time of decommissioning.

It is acknowledged that current methods for the recovery and disposal of redundant cables are often difficult, expensive and potentially harmful to the environment. The Applicants will retain liability for any residual cable sections, should it be determined that they be left in-situ, in perpetuity or as agreed with Crown Estate Scotland and Marine Scotland (in Scottish waters) and The Crown Estate and MMO (in English waters). An Out of Service Deed will be entered into by the Applicants as required.

The principal options for decommissioning include:

- Leaving the cable buried in-situ;
- Leaving the cable buried in-situ and provide additional protection;
- Remove sections of cable that present a risk; or
- Remove the entire cable.

### 2.5.1 Leaving Cables Buried In-situ

Should the recommendations of the environmental and economic assessments be to leave the cable in situ, the approach taken will be determined by the burial status of the cable. This itself, will be determined based on the mobility of the seabed and/or cable over the design life as indicated by operational monitoring surveys (see Section 2.4.1). Any mattresses and rock placement materials will also be left in situ.

Prior to decommissioning, a contingency plan will be developed for resolving the potential issue of cables becoming exposed post-decommissioning should it be determined for the cables to remain in-situ.

### 2.5.2 Removal of Cables

Cable removal, either in sections or as a single whole, involves removing the cable from the seabed and reeling it onto a carousel on cable recovery vessel deck, for transfer and disposal. The strength of the sediments and depth of burial will dictate whether it is likely to be feasible to pull the cable out the seabed in sections or whether prior removal of material burying the cable is required. If overburden is required to be removed, MFE will be used to expose a short section of cable or a grapnel will be used to bring the cable to the surface.

Once the cable is exposed, the cable may be "peeled out" if forces are not too excessive and a gripper attached to the cable to lift the cable end to the cable recovery vessel. Cable recovery could then



proceed directly. Alternatively, a cable under-roller could be used. This device would be connected to a vessel using a steel wire and drawn along beneath the cable for its full length, raising the cable to the seabed level.

Both methods would ensure that the cable end is recovered back on to the cable recovery vessel with cable recovery then commencing for the full cable length. Alternatively, lengths of recovered cable could be cut into sections 10 m to 16 m in length and stored in skips or open containers onboard the vessel for later disposal through appropriate routes for material reuse, recycling or disposal on land.

During decommissioning, the waste generated must be handled, stored and disposed of according to waste management legislation and environmental best practices. The waste hierarchy will be considered, which rank the disposal options in order of most-favoured and least-favoured; prevent, re-use, recycle, other recovery and disposal.

Prior to decommissioning, a contingency plan will be developed for resolving the potential issue of cables becoming exposed post-decommissioning should it be determined for the sections of the cables to remain in-situ. Once operations are complete, the route would be surveyed to ensure that all cable had been removed, it is considered likely that any concrete mattresses or rock placement materials would be left in situ.

### 2.5.3 Decommissioning Programme

The decommissioning programme is expected to be similar to that of the Installation Phase and involve similar vessels and timescales. No post-decommissioning monitoring of the seabed is proposed by the Marine Scheme at this stage.

## 2.6 Emissions

There are several emissions which may occur during the Installation and Operation and Maintenance and Decommissioning Phases of the Marine Scheme. These emissions include:

- Electric and magnetic fields (EMF);
- Heat; and
- Underwater sound.

### 2.6.1 Electric and Magnetic Fields

Electric and magnetic fields (EMF) are generated when electrically charged particles are accelerated. EMF occurs naturally in the marine environment and may be defined as follows:

- Magnetic Field: Both bundled and non-bundled HVDC cables in a bi-pole<sup>7</sup> arrangement are currently being considered for the Marine Scheme. When HVDC cables are installed in a bi-pole arrangement the strength of the magnetic field produced by the cable will depend on the current flowing in the cables, the separation of the cables and the distance from the cables;
- Electric Field (E field): The cables themselves emit no external electric field as the E field is contained within the metallic outer sheath of the cable; and
- Induced Electric Field (iE field): iE field are induced in the sea water as it passes through the geo-magnetic field. The strength of these fields is dependent on the geo-magnetic field strength and sea water chemistry, viscosity, its flow velocity and direction to the direction of the geo-magnetic field.

Naturally occurring induced electric fields also occur and for the North Sea have been measured at 35  $\mu\text{V/m}$  (Pals et al., 1982). Given the background EMF levels, the induced electric fields could range between 24.5  $\mu\text{V/m}$  and 61.3  $\mu\text{V/m}$  (Tripp, 2016). However, the strength of the electric field in the sea varies continuously because of the varying speeds and directions of the water flow that are consequences of the tides and weather conditions, but it is essentially a static field.

<sup>7</sup> Biopole cable arrangements have two conductors, one is positive and the other negative to the earth. This contrasts with a monopole cable which has a single conductor of negative polarity.

An EMF Assessment has been undertaken for the Marine Scheme and is provided in Appendix 2.2.

### 2.6.1.1 Magnetic Fields

Both bundled and non-bundled bipole systems are being considered for the Marine Scheme. Table 2-8 shows assumed operating conditions for the two options in consideration, while Table 2-9 shows the maximum calculated field at a trenching depth of 1 m. Figure 2-33 shows the magnetic field with and without geo-magnetic field at the seabed for an unbundled cable design at maximum current load.

For the separated cables, the magnetic field resulted in a combined field slightly above the background level at 20 m from the cable. The bundled cable had significantly lower magnetic fields due to cancellation of the magnetic fields between poles. EMF from a bundles cable reduced to a background geomagnetic field around 20 m from the cable, having only a very localised effect.

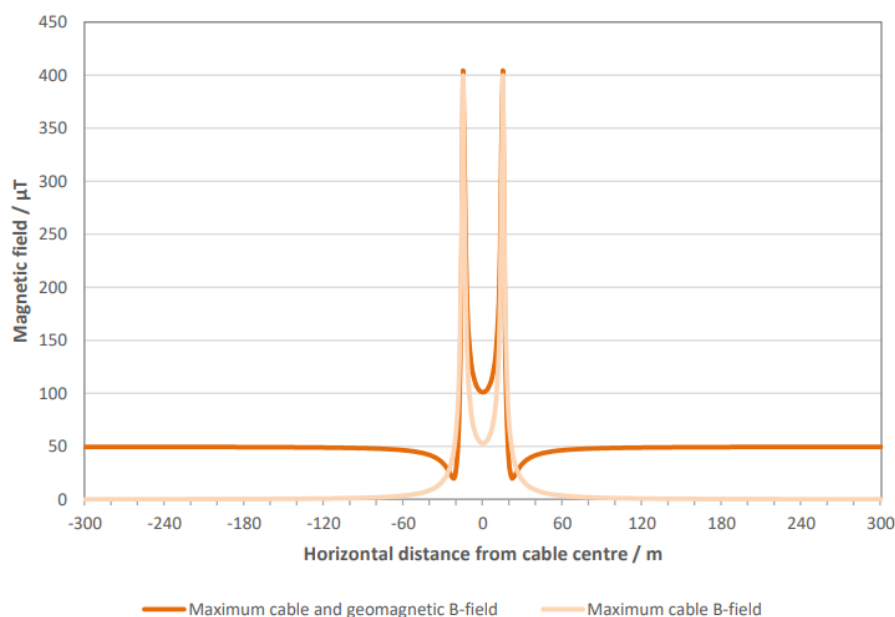
**Table 2-8: Operating conditions for cable design options.**

Cable Configuration	No. of cables	Power per cable	Current per cable	Voltage
Bundled bipole (0.2 m separation)	2	1 GW	2000A	550kV
Bipole (30 m separation)	2	1 GW	2000A	550kV

**Table 2-9: Maximum total magnetic field from the cables and geo-magnetic field for increasing vertical distance from the seabed and maximum current load.**

Distance from cable	Maximum cable and geomagnetic field ( $\mu\text{T}$ )					
	Seabed	0.5 m	1 m	5 m	10 m	20 m
Bundled bipole (0.2 m separation)	126.8	83.69	68.68	51.7	50.3	49.88
Bipole (30 m separation)	404.4	273.2	212.7	102.8	82.99	66.82

Assumed natural geomagnetic field: magnitude 49.715  $\mu\text{T}$ , dip 68.679°



**Figure 2-33: Magnetic field with and without geo-magnetic field at the seabed for an unbundled cable design.**

### 2.6.1.2 Induced Electrical Fields Associated with Submarine Cables

The magnetic field produced by the cable decreases with distance from the cables. The movement of the sea, as a result of tidal currents, through the magnetic field results in a small localised electric field being produced, the induced electric field (iE), although the cable shielding will restrict the transmission of electric fields. A background electric field will also be present in the sea due to the geo-magnetic field and localised magnetic anomalies.

The convention for calculating induced electric fields applied to comparable projects including Basslink, BritNed HVDC and Western Link connections is:

$$\text{Induced electric field (pV/m)} = \text{Velocity (m/s)} \times \text{Magnetic field (pT)}$$

The induced electric field for both bundled and non-bundled approaches to cable arrangement for the Marine Scheme, under a range of tidal velocities is shown in Table 2-10.

Analysis of tidal currents from shipboard current profiler data in the North Sea shows tidal currents to range between 0.10 m/s and 0.68 m/s (Videnes, 2018). Conservatively, this suggests maximum iE generated by tidal currents to be 303.30  $\mu\text{V/m}$  at the seabed (i.e., the value for a separated cables with a tidal current speed of 0.75 m/s). The iE expected is further reduced by the trenching to a target depth of lowering of approximately 1.5 m and the placement of external protection, which would result in an iE of approximately 159  $\mu\text{V/m}$ .

**Table 2-10: Induced electric field using the calculated magnetic fields for a range of tidal velocities at increasing vertical distances from the cables.**

	Tidal velocity	Induced electric field ( $\mu\text{V/m}$ )		
		0.1 m/s	0.3 m/s	0.75 m/s
<b>Bundled bipole (0.2 m)</b>	Seabed	12.68	38.04	95.10
	0.5 m	8.37	25.11	62.77
	1 m	6.87	20.60	51.51
	5 m	5.18	15.54	38.84
	10 m	5.03	15.10	37.75
	20 m	4.99	14.96	37.41
<b>Bipole 30 m separation</b>	Seabed	40.44	121.32	303.30
	0.5 m	27.32	81.96	204.90
	1 m	21.27	63.81	159.53
	5 m	10.28	30.84	77.10
	10 m	8.30	24.90	62.24
	20 m	6.68	20.05	50.12

### 2.6.1.3 Magnetic Compass Deviation

A Compass Deviation Assessment was undertaken for the Marine Scheme (see Appendix 2.1). In a bipole arrangement, the magnetic fields produced by the cables will depend on the current flowing in the cables, the separation of the cables and the distance from the cables. A bi-pole system, such as that proposed for the Marine Scheme, will result in the cancellation of the magnetic fields when the cables are in close proximity, however, in separate trenches they will act more like single cables with reduced field cancellation, representing the worst-case which this appraisal is based upon.

The magnetic fields from the cables will combine with the Earth's magnetic field and can cause a magnetic compass to indicate north in a different direction to the magnetic north pole, referred to as compass deviation. Current advice from the Maritime and Coastguard Agency states that they would be willing to accept a three-degree deviation for 95% of the length of the Marine Scheme and for the remaining 5%, no more than five-degrees of deviation.

The Compass Deviation Assessment was undertaken using the worst-case scenario of two cables in separate trenches 30 m apart operating at 2000 A per cable. Bathymetry data collected in 2021 was used to confirm the cables' orientation and water depths, which will all impact the extent a compass is



deviated from the Earth's magnetic north pole. The Compass Deviation Assessment confirmed that using the worst-case scenario, 15.7% of the Marine Scheme has less than three-degree deviation and 52.1% has less than five-degree deviation.

It is possible to reduce these deviation effects however, and further assessment will be undertaken following appointment of the installation contractor and once detailed design of the cable routes within the Marine Installation Corridor has been undertaken.

The detailed engineering design will aim to optimise cable configuration to minimise compass deviation across the Marine Scheme.

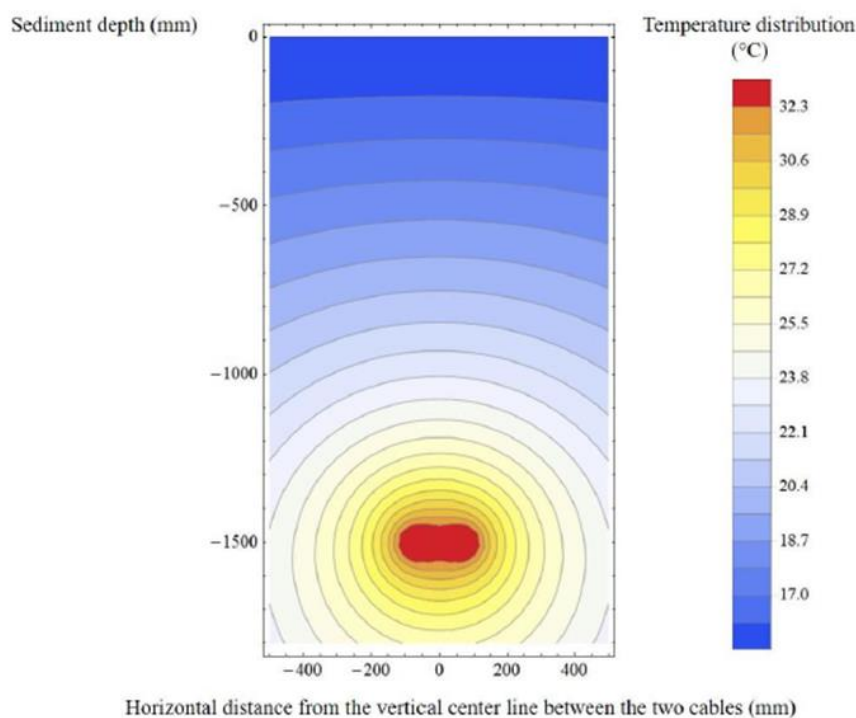
## 2.6.2 Heat

The process by which submarine power cables and other imperfect conductors generate heat is termed resistive heating. It is caused by energy loss as electric current flows and leads to the heating of the cable surface and warming of the surrounding environment.

The use of high voltages minimises heat losses and resultant environmental warming effects because current loads are relatively small. Additionally, HVDC systems result in comparatively less heat loss to the environment for a given transmission rate than AC cables (OSPAR, 2009) such that relatively smaller environmental heating effects would be expected for a given power transmission.

Where submarine power cables are buried, the surrounding sediment may be heated but cables, whether buried or not, have negligible capability to heat the overlying water column because of the very high heat capacity of water.

For the purposes of this appraisal, Figure 2-34 provides an indicative temperature distribution profile for bundled cables trenched to a depth of 1.5 m, as a worst case, where the ambient seabed maximum temperature has been assumed to be 15°C. Figure 2-34 suggests that where the minimum depth of lowering of approximately 0.6 m is achieved, the temperature increase at the seabed surface is expected to be approximately 5°C. For unbundled cables, the heat profile of each individual cable at the surface may be lower but the affected area will be around two cables rather than one.



**Figure 2-34: Temperature distribution in the vicinity of a bundled pair of 1800 mm<sup>2</sup> Cu SPLE cables operated at +/-515 kV.**

## 2.6.3 Underwater Sound

The predominant noise generating activities during the Marine Scheme are:

- Geophysical survey equipment (e.g., multi-beam echo sounder (MBES), sidescan sonar (SSS), sub-bottom profiler SBP) and ultra short baseline (USBL) acoustic positioning;
- Cable trenching, mechanical cutting and MFE;
- Placement of rock protection or concrete mattresses;
- Vessels using DP; and
- Support vessels (non-DP).

These activities will occur during the Installation, the Operation and Maintenance and Decommissioning Phases of the Marine Scheme.

The activities include examples of both impulsive and non-impulsive (or continuous) sound sources. Impulsive sound, such as that generated by geophysical survey equipment, is characterised by short duration pulses (<1 second), these sounds have a broadband bandwidth have a rapid rise and decay period with a high peak pressure. In contrast non-impulsive sound, such as generated by vessel movements and dynamic positioning, do not have rapid rise and decay times or a high peak pressure.

### 2.6.3.1 Background Noise Context

Underwater sound produced by the Marine Scheme must be considered against a background of noise produced by other human activities in the area, and in particular, shipping. These ships include merchant vessels, tankers and ferries, fishing vessels and offshore industry support vessels (Chapter 13: Shipping and Navigation). The number of vessel tracks within 10 km of the Marine Installation Corridor ranged between 3,234 and 4,230 per month. Thus, the number of vessels involved in the Marine Scheme phases identified above, will make a very minor contribution to the overall baseline vessel activity.

Underwater sound in the North Sea is dominated by shipping sounds. Total underwater sound levels, from both shipping and natural sound range from 105 dB to 130 dB re 1  $\mu$ Pa Sound Pressure Level (SPL) and are significantly higher than natural noise levels (Joint Monitoring Programme for Ambient Noise North Sea, 2022). Ambient underwater sound is higher in the southern part of the North Sea, including in the Humber region and towards the English Channel.

### 2.6.3.2 HDD

Sound measurements made during a generic HDD operation, in shallow riverine water, recorded in the absence of vessel noise showed a maximum unweighted Sound Pressure Level (SPL) of 129.5 dB re 1  $\mu$ Pa (Nedwell et al., 2012).

### 2.6.3.3 Geophysical Survey

Table 2-11 provides typical acoustic properties associated with the survey techniques that may be required during geophysical surveys.

**Table 2-11: Acoustic properties of indicative survey equipment.**

Sound Source	Example equipment	Frequency (kHz)	Maximum Sound Source Level (SPL <sub>PEAK</sub> dB re 1 $\mu$ Pa @1m)
Multibeam echo sounder (MBES)	Kongsberg Maritime EM 2040 Dual Rx system	170 – 450	221
Side scan sonar (SSS)	Edgetech FS4200 SP (300-600kHz dual frequency)	300 - 600	210
Sub-bottom profiler (SBP)	Innomar SES-2000, Edgetech Chirp & Applied Acoustics 201 boomer	0.5 – 12	238

Sound Source	Example equipment	Frequency (kHz)	Maximum Sound Source Level (SPL <sub>PEAK</sub> dB re 1 µPa @1m)
	Innomar Medium 100	100	238
Ultra-short baseline (USBL)	Kongsberg HiPAP 502	21 - 31	207

### 2.6.3.4 Cable Laying Activities

The cable installation will comprise, as a worst-case, two installation vessels (one laying the cable and one trenching the cable). These offshore vessels will be moving at a rate of 0.5 km to 5 km per day, but if separate lay/trenching is conducted progress is up to 7 km/day, on a 24-hour basis, therefore noise generated at any one location will be transient and temporary. However, at joint locations, the installation vessels could be stationary for approximately one week. Whilst it is not possible at this stage to specify the exact joint locations, it is anticipated that they will be some distance offshore. It has been estimated that up to 9 offshore joint locations will be required for the Marine Scheme.

A study undertaken by Nedwell et al. (2003) recorded noise emissions during the installation of the submarine cable associated with the North Hoyle Offshore Wind Farm. Levels were recorded at a range of 160 m from trenching activities with hydrophones at 2 m depth (necessary because activities were being undertaken in very shallow water). The SPL was recorded at 123 dB 1 m Pa, with trenching noise found to be a mixture of broadband noise, tonal machinery noise and transients (assumed associated with rock breakage). It was noted that the noise was highly variable, depending on the physical properties of the area of seabed. Analysis of the data indicated that if a transmission loss of 22 log (R) is assumed, a Source Level of 178 dB re 1 µPa @ 1 m results. The above measurements are comparable to the stated source noise level for dredging activity in Richardson et al (1995) of between 172 and 185 dB re 1 µPa @ 1 m and in OSPAR (2009) of between 171 and 189 dB (peak) re 1 µPa @ 1 m.

### 2.6.3.5 Rock Placement

In studies of noise generated by rock placement, it was noted that it was possible to faintly hear rocks falling through the fall pipe to the seabed, but the underwater sound was dominated by the sound of dynamic thrusters of the vessel (Nedwell et al., 2012). SVT Engineering Consultants (2010) estimated source noise levels were expected to be in the region of 120 dB re 1 µPa @ 1 m. An earlier study by Nedwell et al (2003) estimated that the expected noise levels for rock placement and similar activities was approximately 177 dB re 1 µPa @ 1 m. This is broadly comparable with cable laying activities.

### 2.6.3.6 Vessel Sound

Vessels operating under dynamic positioning (DP) to maintain station using thrusters can create cavitating bubbles which can implode with high acoustic energy in the water. Cavitation can cause damage to impeller and tunnel materials and also lead to the propagation of underwater sound in the marine environment. The source sound levels and sound characteristics will depend on the exact vessel being used, however quoted sound levels range between 177 and 197 dB re 1 µPa @ 1 m and frequencies lie towards the lower end of the spectrum at 3 kHz and below (AT&T, 2008; Lawson et al., 2001; Talisman Energy, 2006).

Project support vessels, in the small to medium size range (up to ~ 100 m long) not be operating on DP, are likely to produce broadband non-impulsive sound in a range between 160 dB re 1 µPa @ 1 m (tug/barge assumed equivalent to a guard vessel) and 180 dB re 1 µPa @ 1m (supply ship) (Richardson et al., 1995; OSPAR commission, 2009).

## 2.7 Marine Project Scheme Zone of Influence

The zone of influence (Zoi), i.e., the spatial extent, over which the Marine Scheme is predicted to have a potential impact on the receiving environment, has been established based on activities specific Zoi as detailed below. The Zoi is based on the worst-case assumptions as presented in Table 2-12.



**Table 2-12: Summary of Zone of Influence for the Marine Scheme.**

Aspect	Description	Maximum Zone of Influence	Scottish Waters		English Waters	
			Territorial Waters	Offshore Waters	Offshore Waters	Territorial Waters
Marine Installation Corridor	Width	500 m	500 m			
	Length	Total length of 436 km	28.4 km	121.8 km	246.3 km	38.7 km
Cable installation trenches	Number	Up to two trenches	2			
	Depth of lowering	Minimum depth of lowering approximately 0.6 m. Target depth of lowering of approximately 1.5 m.	0.6 m to 1.5 m			
	Width	Width dependent on trenching tool utilised	1 m to 6 m			
	Disturbed area	Up to 25 m per trench, depending on trenching tool.	25 m wide per trench			
	Separation between trenches	30 m maximum separation	30 m			
HVDC cables	Configuration	One cable per pole	Bi-pole			
	Number	2 HVDC cables	2			
	Joints	Up to nine joints per cable, with one every 50 km to 100 km. Up to 18 joints in total in nine broad locations (with exact joint numbers and locations dictated by installed cable lengths along the route and cable carrying capacity of the CLV or CLB).	18			
	Operating voltage	525 kV	525 kV			
	Transmission capacity	2 GW for the Marine Scheme	2 GW			
	Diameter	Two cables of up to 150 mm in diameter	140 mm to 150 mm			
FO cable	Number	One FO cable will be installed alongside on of the HVDC cables	1			
	Joints	Up to nine joints per cable, with one every 50 km to 100 km. Up to 9 joints in total which will be co-located with the HVDC cable joints.	9			
	Diameter	One cable of up to 30 mm in diameter	20 mm to 30 mm			
Route preparation	Use of boulder plough or grab to remove boulders.	Where required, across a swathe of 10 m to 25 m per cable trench.	21.6 km *	30.3 km *	85.4 km *	29.9 km *

Aspect	Description	Maximum Zone of Influence	Scottish Waters		English Waters	
			Territorial Waters	Offshore Waters	Offshore Waters	Territorial Waters
	PLGR	Corridor of 1 m to 3 m per cable trench.	28.4 km *	121.8 km *	246.3 km *	38.7 km *
	Sandwave lowering	Footprint depends on density of seabed sediments. May be up to 10 m in width in loosely packed sands, but typically less than 6 m.	9 km *	8.5 km *	5 km *	1.5 km *
	Sea trials	Corridor of 10 m to 15 m within Marine Installation Corridor	2 km	5 km	5 km	3 km
Crossing preparation	Concrete mattresses	Area up to 18 m <sup>2</sup> (6 m x 3 m). Up to 0.3 m thick. Weigh up to 9.1 tonnes. Number provided per pole.	42 *	None anticipated	108 *	None anticipated
	Separator system	Use would be subject to crossing agreement. Number provided per pole.	0.7 km *		1.8 km *	
	Pre-cast concrete bridge		3*		6*	
		Rock placement	See below.			
Landfall Installation	Completed boreholes	Boreholes up to 1.5 km in length and 660 mm in diameter.	Up to 4	Not applicable	Up to 4	
	Aborted boreholes		Up to 2		Up to 2	
	HDD exit pit excavation	Area of the seabed directly affected by works associated with the excavation of exit pits at each landfall (including equipment spread). Depth of lowering is expected to be 1 m to 3 m.	5,000 m <sup>2</sup>		5,000 m <sup>2</sup>	
		Temporary concrete mattresses used to protect borehole breakout within the exit pit prior to cable pull in. Each mattress covers 18 m <sup>2</sup> .	24		24	
	Pre trenching at landfalls to facilitate cable pull in.	Area of the seabed directly affected by works associated with the excavation pre-cut trenches at each landfall.	5,000 m <sup>2</sup>		5,000 m <sup>2</sup>	
	Drilling fluid losses	2,000 m <sup>3</sup> of drilling fluids and 80 m <sup>3</sup> of solids (drill cuttings) to be discharged into the marine environment per borehole.	12,000 m <sup>3</sup> of drilling fluids and 480 m <sup>3</sup> of solids.		12,000 m <sup>3</sup> of drilling fluids and 480 m <sup>3</sup> of solids.	
	Breakout point protection after installation of cable ducts	Anticipated that ducts and cables (within HDD exit pits and pre-cut trenches) will be buried using MFE or diver operated equipment or backfilled using rock placement. Concrete mattresses may be used as temporary protection at six per duct.	10,000 m <sup>2</sup> 24 concrete mattresses See below for rock protection		10,000 m <sup>2</sup> 24 concrete mattresses See below for rock protection	

Aspect	Description	Maximum Zone of Influence	Scottish Waters		English Waters	
			Territorial Waters	Offshore Waters	Offshore Waters	Territorial Waters
	Nearshore vessels	Area of seabed disturbance for jack-up barges as a result of spud cans	200 m <sup>2</sup>			200 m <sup>2</sup>
		Area of seabed disturbance for CLB. Each anchor up to 2 m in length and deployed up to 800 m from CLB within Marine Installation Corridor.	32 m <sup>2</sup> at each anchored work location			32 m <sup>2</sup> at each anchored work location
		Area of seabed disturbance for back-hoe dredger, which maintain position via anchors or spud can.	100 m <sup>2</sup> at each exit pit location			100 m <sup>2</sup> at each exit pit location
Cable trenching	Displacement plough	Corridor of disturbance swathe per trench is 10 m to 25 m wide. The actual disturbed seabed footprint due to ploughing is 2 m to 5 m, the remainder comprising the skids and berms either side of the ploughed seabed. If the displacement plough is used along the cable route within the parameters provided below, this would be instead of non-displacement methods, not in addition to.	14.2 km *	25 km *	30 km *	47.3 km *
	Non-displacement plough	Corridor of disturbance per trench is: <ul style="list-style-type: none"> <li>• Ploughs – 8 m to 12 m.</li> <li>• Jet trenchers – up to 10 m</li> <li>• Mechanical trenchers – 8 m to 15 m</li> </ul>	28.4 km *	121.8 km *	246.3 km *	38.7 km *
	MFE	Seabed footprint up to 10 m in width.	9 km * for pre-cut trench at HDD exit pits and sandwave lowering	8.5 * km for sandwave lowering	5 km * for sandwave lowering	1.5 km * for pre-cut trench at HDD exit pits and sandwave lowering
Cable laying	Simultaneous cable lay and trenching	1 km indicative vessel separation.	Rate of progress of 0.5 km to 5 km per day.			
	Surface lay followed by post-lay trenching	Spatially and temporally separated.	Rate of progress of up to 7 km per day for CLV, with trenching progressing more slowly			
Cable protection using rock placement	Protection of break outs within exit pits	Protection of breakouts following excavation of exit pits within footprint of exit pits and pre-cut trench	9,000 m <sup>3</sup>	Not required.		9,000 m <sup>3</sup>
	Third-party assets to be crossed	Anticipated that up to 24 assets to be crossed.	6	Not required.	18	Not required.



Aspect	Description	Maximum Zone of Influence	Scottish Waters		English Waters	
			Territorial Waters	Offshore Waters	Offshore Waters	Territorial Waters
	Third-party assets to be crossed	Pipeline crossing seabed area affected. Total of 28,500 m <sup>2</sup> per pole along Marine Installation Corridor. Crossings up to 500 m in length, width varies between 7 m and 12 m, up to 1.9 m high. Footprint of approximately 4,750 m <sup>2</sup> of rock placement per crossing per pole.	Two pipeline crossings anticipated. 9,500 m <sup>2</sup> of seabed area affected.	Not required.	Four pipeline crossings anticipated. 19,000 m <sup>2</sup> of seabed area affected.	Not required.
		Cable crossing seabed area affected. Total of 73,800 m <sup>2</sup> per pole along Marine Installation Corridor. Crossings up to 500 m in length, width varies between 7 m and 9.4 m, up to 1.4 m high. Footprint of approximately 4,100 m <sup>2</sup> of rock placement per crossing per pole.	Four cable crossings anticipated. 16,400 m <sup>2</sup> of seabed area affected.	Not required.	Fourteen cable crossings anticipated. 57,400 m <sup>2</sup> of seabed area affected.	Not required.
	External protection	Rock placement along Marine Installation Corridor per pole. Approximately 141.3 km of rock placement anticipated including 15 km of remedial rock placement (excluding crossings).	15.2 km	25.2 km	76.6 km	20.4 km
		Rock placement along Marine Installation Corridor per pole (excluding crossings). Berms assumed to be 7 m wide.	113,843 m <sup>2</sup>	190,988 m <sup>2</sup>	574,943 m <sup>2</sup>	153,277 m <sup>2</sup>
* multiplied by two if cables trenched separately)						

## 2.8 Embedded Mitigation

The design of the Marine Scheme has facilitated mitigation, with potentially significant effects avoided or minimised as far as reasonably practicable through the design process. A summary of the mitigation considered embedded in the design of the Marine Scheme is provided below in Table 2-13.

**Table 2-13: Summary of embedded mitigation.**

Activity / Issue	Embedded mitigation commitment
<b>All phases</b>	
Ecological mitigation	<p>Given the potential for injury from the use of SBP, mitigation measures recommended in the JNCC 2017 guidelines for minimising the risk of injury to marine mammals from geophysical surveys (JNCC, 2017) will be adopted during SBP operations; and</p> <p>All vessels will comply with the following codes to protect ecological receptors:</p> <ul style="list-style-type: none"> <li>• The Scottish Marine Wildlife Watching Code (SMWWC) (available from: <a href="https://www.nature.scot/sites/default/files/2017-06/Publication%202017%20-%20The%20Scottish%20Marine%20Wildlife%20Watching%20Code%20SMWWC%20-%20Part%201%20-%20April%202017%20%28A2263518%29.pdf">https://www.nature.scot/sites/default/files/2017-06/Publication%202017%20-%20The%20Scottish%20Marine%20Wildlife%20Watching%20Code%20SMWWC%20-%20Part%201%20-%20April%202017%20%28A2263518%29.pdf</a>); and</li> <li>• The Basking Shark Code of Conduct (available from: <a href="https://www.sharktrust.org/Handlers/Download.ashx?IDMF=6137b1a1-8518-4327-9922-7b280acb8336">https://www.sharktrust.org/Handlers/Download.ashx?IDMF=6137b1a1-8518-4327-9922-7b280acb8336</a>).</li> </ul>
Notifications	<p>Notifications of the Marine Scheme will be made; this shall include:</p> <ul style="list-style-type: none"> <li>• Notice(s) to Mariners (including Kingfisher Bulletins), Radio Navigational Warnings, NAVTEX and/or broadcast warnings will be issued prior to the commencement of installation works, to include the following as a minimum: <ul style="list-style-type: none"> <li>– Notifications to the Northern Lighthouse Board, Trinity House, the Maritime and Coastguard Agency and relevant harbour and port authorities;</li> <li>– Regular vessel operators (e.g., ferry operators);</li> <li>– The Ministry of Defence (MoD) will be notified prior to commencement of Installation Phase activities within Military Practice and Exercise Areas;</li> </ul> </li> <li>• Appropriate notification will be provided to advise beachgoers and those using the area for recreation in the close vicinity of each landfall;</li> <li>• Other marine energy infrastructure operators to confirm operation dates and otherwise rationalise activity schedules, as required; and</li> <li>• Regular consultation will be made with third-party infrastructure asset owners to notify them of any activities associated with the Marine Scheme and avoid spatial and temporal interactions between vessels.</li> </ul>

Activity / Issue	Embedded mitigation commitment
Marine Scheme vessel requirements	<ul style="list-style-type: none"> <li>• All vessels will follow the International Regulations for Preventing Collisions at Sea 1972 (COLREGS) and International Convention for the Safety of Life at Sea 1974 (SOLAS);</li> <li>• All vessels will be in compliance with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations and will therefore be equipped with waste disposal facilities onboard. The discharging of contaminants is not permitted within 12 nm from the coast to preserve bathing waters;</li> <li>• Control measures and shipboard oil pollution emergency plans (SOPEP) will be in place and adhered to under MARPOL Annex I requirements for all vessels;</li> <li>• Ballast water discharges from all vessels will be managed under International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention);</li> <li>• All vessels will adhere to the IMO guidelines for the control and management of ships' biofouling to minimise the transfer of invasive aquatic species (Biofouling Guidelines) (resolution MEPC.207(62));</li> <li>• Where possible, vessels will operate with dynamic positioning which will minimise anchor disturbance on the seabed;</li> <li>• All vessels will display appropriate lights and shapes;</li> <li>• All applicable vessels will broadcast their status on AIS at all times;</li> <li>• All vessels will follow Port bylaws and General Directions, including VTS communications from ports (Peterhead);</li> <li>• Guard vessels will use RADAR with Automatic RADAR Plotting Aid (ARPA) to monitor vessel activity and predict possible interactions, will be employed to work alongside the installation vessel(s) during installation and maintenance work (which will also minimise anchor disturbance on the seabed);</li> <li>• A temporary 500 m Recommended Clearance Zone will be established around all vessels associated with the works;</li> <li>• Piloting of large vessels when entering or leaving Peterhead Harbour Area;</li> <li>• Limits to wave height / wind speed conditions for operations / activities will be followed by all vessels; and</li> <li>• Lighting on-board the vessels will be kept to the minimum level required to ensure safe operations and directed towards working areas. This will minimise disturbance to seabird species.</li> </ul>
Recommendations to third-party vessels	<p>It is advised that third-party vessel operators follow the longstanding maritime guidance regarding the avoidance of demersal trawling (and anchoring) in the vicinity of submarine cables. This guidance includes:</p> <ul style="list-style-type: none"> <li>• The Mariner's Handbook (P100) 12th Edition (UKHO, 2020);</li> <li>• All Admiralty charts; and</li> <li>• The recent Marine Guidance Note (MGN) 661 published by the Maritime and Coastguard Agency (MCA).</li> </ul>
Installation Phase	
Route selection	<p>The Marine Installation Corridor has been selected to optimise the balance of environmental, technical, commercial and financial considerations, such as avoiding designated sites, known archaeological sites, recreational activities, key fishing grounds and third-party infrastructure as far as possible.</p>
Pre-installation surveys	<p>Pre-installation surveys will inform detailed engineering and cable installation planning. They will focus on collection of detailed information within the preferred route for each of the cables, all within the Marine Installation Corridor. They will confirm the absence or presence of any new obstructions or significant changes to seabed conditions and bathymetry, and also help to inform detailed unexploded ordnance (UXO) assessment. Survey methods may include:</p> <ul style="list-style-type: none"> <li>• Geophysical survey including multibeam and single beam echo sounders, side scan sonar (SSS), and sub-bottom profiler (SBP);</li> <li>• Magnetometer/gradiometer to identify magnetic anomalies and metallic targets;</li> <li>• Visual methods including drop down video or remotely operated vehicle (ROV); and</li> <li>• Geotechnical investigations such as vibrocore and cone penetration test (CPT).</li> </ul>

Activity / Issue	Embedded mitigation commitment
Micro-routeing / detailed design post-consent	<p>Detailed route development and micro-routeing will be undertaken within the Marine Installation Corridor, informed by pre-installation evaluation of site-specific survey data to avoid or minimise localised engineering and environmental constraints. This will include minimising the footprint as much as possible;</p> <p>Navigational features such as charted or known anchorages, maintained channel depths and prohibited regions will be avoided;</p> <p>Changes to the sedimentary and metocean environments will be minimised by careful route selection and the use of appropriate burial techniques and cable protection methods such as fall pipes for the laying of rock placement;</p> <p>Cable configuration will be optimised to minimise EMF during detailed design;</p> <p>Reduction in charted water depth to LAT will be limited to less than 5% where possible; and</p> <p>A Cable Burial and Protection Plan will be submitted to include detailed micro-routeing, trenching methods and external protection measures for the final design of the Marine Scheme prior to commencement of Installation Phase activities.</p>
Construction Environmental Management Plan (CEMP)	<p>Prior to cable installation activities commencing, a CEMP, including an Emergency Spill Response Plan (ESRP), Waste Management Plan, Marine Mammal Management Plan, Marine Non-Native Species (MNNS) Plan, Fisheries Liaison and Co-existence Plan (FLCP)<sup>8</sup> will be developed and agreed with relevant stakeholders in accordance with the coastal and marine environment site guide; and</p> <p>A commitment will be included with the CEMP and implemented via the SMWWC, to ensure that transiting vessels move at low speeds allowing any rafts of birds to disperse naturally well in advance of an approaching vessel. This will minimise the energy expended and avoid unnecessary flushing, which is especially important during the immediate post breeding dispersal periods of auks from early July to mid-September.</p>
Commercial fisheries mitigation	<p>A Fisheries Liaison Officer (FLO) will be appointed for the Installation Phase. Good practice guidance on the approach to fisheries liaison and mitigation (e.g., FLOWW, 2014; 2015 as relevant to cable projects) shall be implemented as far as possible; and</p> <p>A procedure for the claim of loss of/or damage to fishing gear will be developed.</p>
Written Scheme of Investigation and Protocol for Archaeological Discoveries	<p>A Written Scheme of Investigation (WSI) and Protocol for Archaeological Discoveries (PAD) will be in place for any archaeological discoveries. This will include any recommended Archaeological Exclusion Zones and a PAD for reporting and investigating unexpected archaeological discoveries encountered during installation activities, with a Retained Archaeologist providing guidance and advising industry staff on the implementation of the PAD. The PAD provides a mechanism to comply with the MSA 1995, including notification of the Receiver of Wreck, and accords with the Code of Practice for Seabed Developers (JNAPC, 2006). The PAD also makes provision for the implementation of temporary exclusion zones around areas of possible archaeological interest, for prompt archaeological advice, and, if necessary, for archaeological inspection of important features prior to further activities in the vicinity.</p>
24-hour cable installation	<p>Installation will be a 24-hour operation where viable to minimise overall installation time, maximise use of fair-weather windows, and take advantage of vessel and equipment availability.</p>
Securing of Out of Service cables	<p>The ends of any out of service (OOS) cables cut will be secured to the seabed in accordance with International Cable Protection Committee recommendations or reburied.</p>
Landfall installation	<p>Horizontal Directional Drilling (HDD) will be used at both landfalls for the installation of the cables in the transition zone between the Onshore Schemes and the Marine Scheme which avoids any works in the intertidal environment; and</p> <p>This will keep sediment disturbance to a minimum, minimising the use of cable protection measures inshore of the 11 m depth contour at Sandford Bay and the 5 m depth contour at Fraisthorpe Sands. This avoids direct impacts on sensitive coastal and intertidal habitats and features.</p>

<sup>8</sup> Note that this will be a single document that will perform the role of other fisheries liaison plans, for instance, a Fisheries Management and Mitigation Strategy.



Activity / Issue	Embedded mitigation commitment
Drilling fluids	<p>Drilling fluids for HDD operations will be biologically inert and selected from the OSPAR List of Substances/Preparations Used and Discharged Offshore which are Considered to Pose Little or No Risk to the Environment (PLONOR);</p> <p>During drilling, drilling fluids will be recycled, treated, and reused as far as possible, and any waste drilling fluid will be transported offsite for treatment and disposal; and</p> <p>Losses of drilling fluids are unavoidable; however they will be minimised insofar as practicable through the implementation of industry best practice for example, clearing runs or reducing the volume of drilling fluids in the borehole prior to breakout to the marine environment.</p>
Third-party cable crossings	<p>Each cable crossing will be designed in detail in accordance with the International Cable Protection Committee recommendations;</p> <p>Proximity and Crossing Agreements will be agreed with third-party infrastructure owners. The Crossing Agreement describes the rights and responsibilities of the parties and also the design of the crossing. Crossing design will be in line with industry standards, using procedures and techniques agreed with the cable and pipeline owners; and</p> <p>Proximity agreements describe the approach to works close to, but not crossing third party assets, to ensure safety and manage interactions between the two projects.</p>
Cable protection	<p>Cables will be trenched to a minimum depth of lowering of approximately 0.6 m, with a target depth of lowering of approximately 1.5 m; and</p> <p>The use of external protection will be limited to areas where cables cannot be trenched to the minimum depth of lowering, at crossings with third-party infrastructure and in some limited areas at both landfalls (as required).</p>
Rock placement	<p>Berms will be designed to reduce snagging risk in so far as is practicable, with 1:3 slopes and flat crests in line with industry guidance;</p> <p>Rock utilised in berms will be igneous, clean with low fines; and</p> <p>A vessel able to undertake a targeted placement method will be used, such as one fitted with a flexible fall pipe.</p>
Interim and as-built surveys and reporting	<p>Undertaking of interim and as-built surveys to confirm the trenching status of the cables, identify potential seabed hazards associated with installation, and, where appropriate and practicable, undertaking of rectification works;</p> <p>As-built locations of cables and associated external protection will be supplied to UKHO and Kingfisher for inclusion in Admiralty and KIS-ORCA charts, respectively; and</p> <p>As built details, including the locations, nature and extent of rock berms shall also be shared with relevant fisheries stakeholders.</p>
<b>Operation and Maintenance Phase</b>	
Monitoring Surveys	<p>Routine surveys and inspections of the submarine cables and associated protection measures will be conducted through the lifetime of the project, to ensure they remain in good condition, and adequately protected.</p>
No planned routine maintenance work	<p>Following installation, the cable system is designed to minimise scheduled maintenance and no routine maintenance work is planned on the cables or their infrastructure during the lifetime of the Marine Scheme.</p>
Submarine cable repairs	<p>In the event that cable exposures are identified during the operational phase of the Marine Scheme, the location of these will be shared with fisheries stakeholders and where appropriate, additional temporary measures put in place (e.g., marker buoys, use of guard vessels, etc.), until a repair or remediation can be implemented</p>
<b>Decommissioning Phase</b>	
Options for decommissioning	<p>Options for decommissioning will be evaluated in both environmental and economic assessments, taking account of the regulations, best practices and available technology at the time of decommissioning.</p>

## 2.9 References

- Anatec. (2021). *Eastern Link Lot 1 Cable Burial Risk Assessment*.
- AT&T. (2008). *AT&T Asia America Gateway Project Draft EIR. Section 4.10 - Noise*. Retrieved 02 19, 2022, from <https://ceqanet.opr.ca.gov/2007111029/2>
- Genesis. (2011). *Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. Document J71656-Final Report-G2*. Retrieved 02 19, 2022, from <https://www.semanticscholar.org/paper/Review-and-Assessment-of-Underwater-Sound-Produced-IRECTIVE/52b808718275e5203637ed083942fff8502adba9>
- Joint Monitoring Programme for Ambient Noise North Sea. (2022). *Joint Monitoring Programme for Ambient Noise North Sea*. Retrieved from <https://keep.eu/projects/19154/Joint-Monitoring-Programme--EN/>
- Nedwell, J., Brooker, A., & Barham, R. (2012). *Assessment of underwater noise during the installation of export power cables at the Beatrice Offshore Windfarm*. Subacoustech Environmental.
- Nedwell, J., Langworthy, J., & Howell, D. (2003). *Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore windfarms, and comparison with background noise*.
- OSPAR. (2009). *Assessment of the Environmental Impact of Cables. OSPAR Commission 437/2009. 19pp*.
- Pals, N., Peters, R., & Schoenhage, A. (1982). Local geo-electric fields at the bottom of the sea and their relevance for electrosensitive fish. *Netherlands Journal of Zoology*, 479–494.
- Richardson, W., Greene, C., Malme, C., & Thomson, D. (1995). *Marine mammals and noise*. San Diego: Academic Press.
- Ross, D. (1993). On ocean underwater ambient noise. *Acoustics Bulletin*, 18, 5-8.
- Tripp. (2016). *Offshore assessment of induced electric and magnetic fields of Viking Link HDVC. Environmental Engineering Note. National GridEEN/295/ NOTE2016*.
- UK Government. (2020, October). *New Plans to Make UK World Leader in Green Energy*. Retrieved from Prime Minister's Office Press Release: <https://www.gov.uk/government/news/new-plans-to-make-uk-world-leader-in-green-energy>

