# SCOTTISH HYDRO ELECTRIC POWER DISTRIBUTION PLC

## Project Description

**Mainland Orkney to Shapinsay Distribution Cable Replacement**

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# DOCUMENT RELEASE FORM

## Scottish Hydro Electric Power Distribution plc

**P2663_R6269_Rev2**

Project Description

Mainland Orkney to Shapinsay Distribution Cable Replacement

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# GLOSSARY

**BS**
Basking Shark

**CDM**
Construction (Design and Management)

**CEMP**
Construction Environmental Management Plan

**CLV**
Cable Lay Vessel

**CR**
Client representation

**CPT**
Cone Penetration Test

**DP**
Dynamic Positioning

**DSV**
Dive Support Vessel

**DTS**
Desktop Study

**DWA**
Double Wired Armour

**EPS**
European Protected Species

**FLMAP**
Fisheries Liaison Mitigation Action Plan

**FO**
Fibre Optic

**GPS**
Global Positioning System

**HVAC**
High Voltage Alternating Current

**Kg**
Kilograms

**LAT**
Lowest Astronomical Tide

**MBES**
Multibeam Echosounder

**MEA**
Marine Environmental Appraisal

**MHWS**
Mean High Water Springs

**MLWS**
Mean Low Water Springs

**MM**
Millimetres

**NAVTEX**
Navigational telex

**NTM**
Notice to Mariners

**OBS**
On-Bottom Stability

**OCT**
Open Cut Trench

**OIC**
Ocean iQ

**OoS**
Out of Service

**PLGR**
Pre-Lay Grapnel Run

**ROV**
Remotely Operated Vehicle

**RPL**
Route Position List

**SEPA**
Scottish Environment Protection Agency

**SHEPD**
Scottish Hydro Electric Power Distribution plc

**SLD**
Straight Line Diagrams

**SSEN**
Scottish & Southern Electricity Networks

**SSS**
Side Scan Sonar

**TJP**
Transition joint pit

**UKHO**
United Kingdom Hydrographic Office

**USBL**
Ultra Short Baseline

**UXO**
Unexploded Ordnance

**WD**
Water Depth

**3D**
Three Dimensional

# 1. INTRODUCTION

## 1.1 Overview

Scottish and Southern Electricity Networks (SSEN) operating under licence as Scottish Hydro Electric Power Distribution plc (SHEPD) is responsible for monitoring and maintaining the efficiency and integrity of the subsea electricity cable networks which provide power supplies to 60 Scottish islands.

A single 33kV subsea electricity cable crosses The String and connects the islands of Mainland Orkney and Shapinsay to the electricity distribution network. The existing Orkney – Shapinsay cable has been identified as requiring replacement as part of the Electricity Distribution 2 Price Control Period which runs from 2023 – 2028.

The existing landfalls will not be reused for the new cable, instead new landfalls to the east on Orkney and the west on Shapinsay of the existing cable have been identified, and the new application corridor will cross the existing cable. The cable will be approximately 2.84km in length in total.

This project description sets out the methodology proposed to undertake the cable replacement works, as well as details on cable protection and deposits. No burial is planned to take place along the route due to a lack of sediment required to ensure safe coverage of the cable. The works are scheduled to take place from Summer 2024 to Winter 2025 (this is the period for which the Marine Licence has been requested), however the works will not be continual throughout this period. The estimated time period for each activity is presented below in Table 1-1, not including any weather downtime the project may experience.

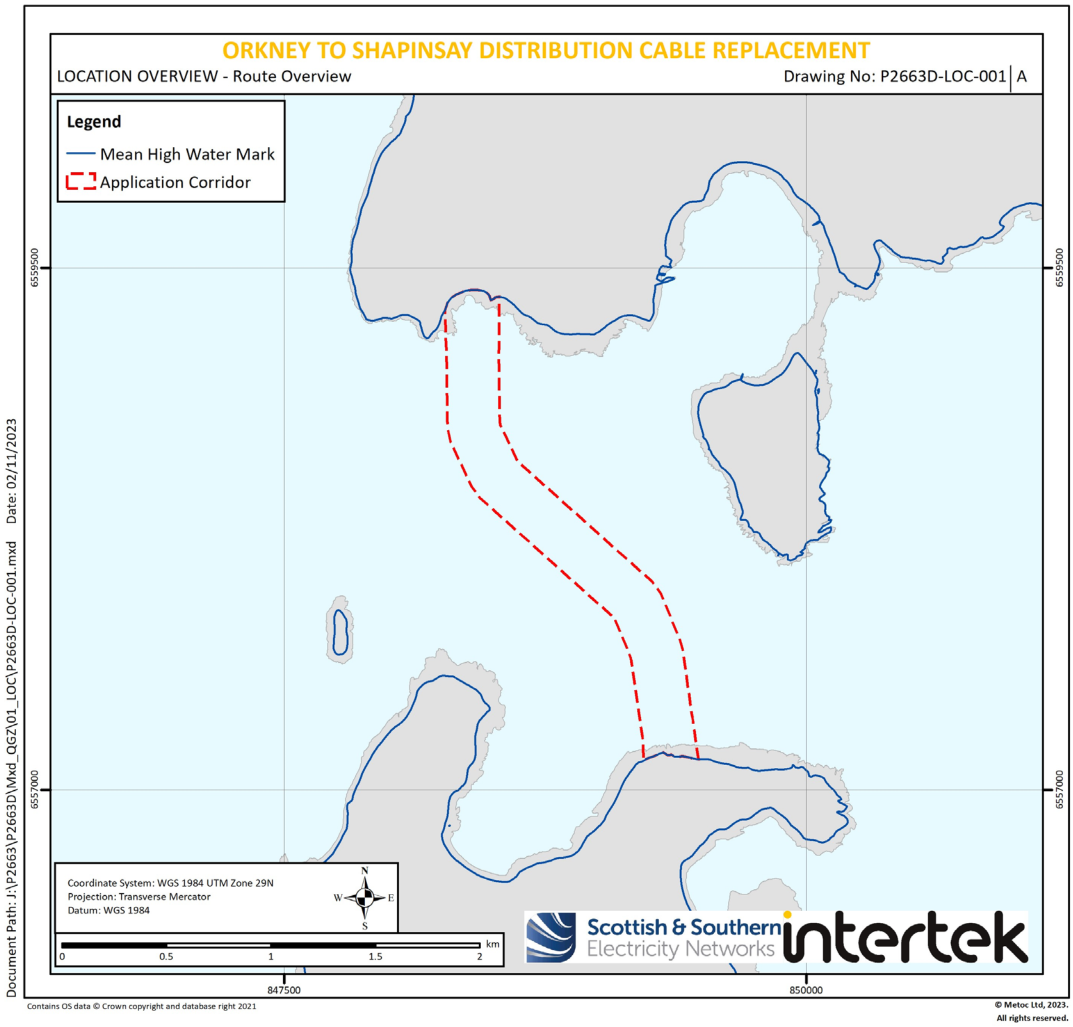
### Table 1-1 Estimated installation schedule (exclusive of weather downtime)

| Activity | Estimated time period (Days) |
|---|---|
| Route Clearance and pre-lay grapnel run (including boulder clearance, concrete mattress installation and pre-lay survey) | 7 days |
| Shore-end pull into Orkney and Shapinsay | 4 days |
| Cable burial (intertidal area only) | 14 days |
| Offshore cable lay | 3 days |
| Installation of protection and stabilisation measures, post lay inspections | 28 days |

## 1.2 Replacement cable corridor

The Application Corridor for the replacement cable is shown in red in Figure 1-1 (Drawing reference: P2663-LOC-001). The Application Corridor within which the cable will be installed is 250 meters (m) wide (+/- 125m either side of the route centreline). The Marine Licence Application is for installation of the cable within the boundary of this Application Corridor.

**Figure 1-1 Orkney to Shapinsay Cable Installation Application Corridor (P2663-LOC-001)**




### 1.2.2 Cable route design

OceanIQ (OiQ) were commissioned by SHEPD to undertake a Cable Route Desktop Study (DTS) (Report reference: 4063-GMSL-G-RD-0001). This study presents the potential risks to the replacement cable along the entire route, the alternative routes that have been considered and provides a summary of the perceived issues with each cable route with respect to engineering and installation of the cable. OiQ have developed Route Position List's (RPLs) and Straight-Line Diagrams (SLDs) that comprise the compound knowledge gained from data collected by SHEPD and OiQ research. The route has been designed to ensure cable security and prevent loss of service. The recommendations of the report concluded the following:

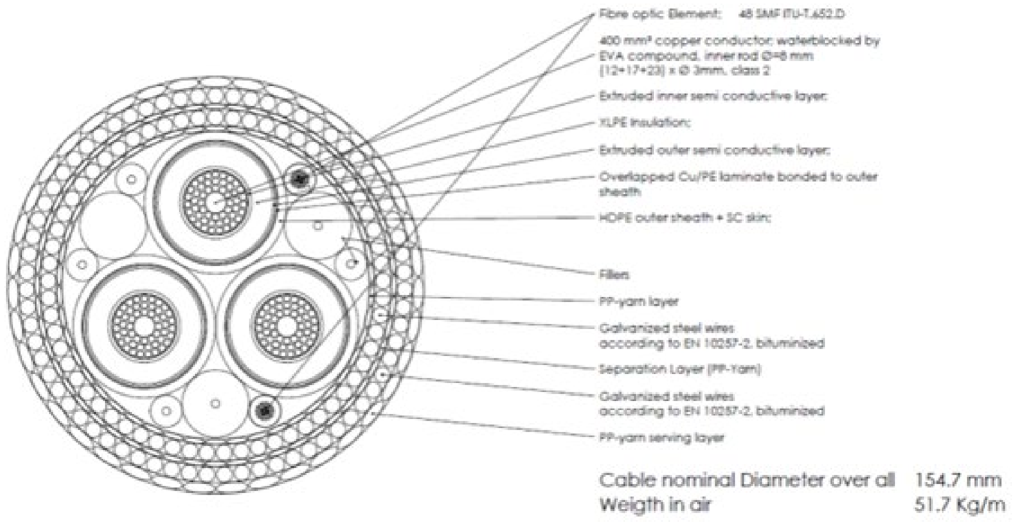
- Bury the cable to a target burial depth of 0.5m throughout its length where the seabed allows.
- Where the cable is unburied, apply additional protection and/or stabilisation measures to protect it from abrasion.
- Further investigation into suitable burial requirements should be carried out through a cable burial risk assessment (CBRA).
- Apply additional cable protection, such as mattresses and/or a polyurethane protection system at the crossing with the existing interconnector to prevent damage to either cable.

- When installing the cable through the banks at the landing points ensure that there is sufficient protection against further erosion by means of ducting or additional protection.
- Review the cable route and protection during and following the marine survey to optimise security, with particular attention to traces of ships anchoring from scars detected by side scan sonar.
- Ensure that the areas of sandwaves along the route are captured during the marine survey and compensated for by route engineering or deeper burial, if necessary, based on any temporal change compared to previous surveys.
- Undertake a marine offshore liaison program with fishing groups before, during and after installation to reduce the chances of damage to the cable.
- Perform marine survey and main cable lay during the annual good weather window from May to September.
- Carry out an environmental/screening exercise for the project and perform an otter survey prior to the commencement of works.
- Make sure that the installed cable is marked on navigation charts.

# 2. PROPOSED CABLE CONSTRUCTION

Electricity will be transmitted using High Voltage Alternating Current (HVAC) submarine cable technology. The typical cable structure is shown below in Figure 2-1.

### Figure 2-1 Typical XLPE HVAC submarine cable structure - cross sectional drawing




Source: Prysmian 2023

The subsea cable that is proposed for installation is a 33kV Prysmian 3x400mm$^2$ three core cable with three copper conductor that each have XLPE insulation, with two fibre optic (FO) cables, encased and protected with a double layer of steel wire armour. The proposed double wired armour (DWA) construction will provide the cable with additional mechanical protection and weight thus providing additional stability for the surface laid cable.

FOs are installed integral to the submarine cable for the purpose of cable condition monitoring, control and power system protection.

The subsea cable conductor cores specification and power rating has been selected through the assessment of historic demand on the existing network and with consideration given to future demand growth on the network.

A summary of the key mechanical properties of the replacement cable is provided in Table 2-1.

### Table 2-1 Proposed cable – key mechanical properties

| Cable Weight (in Air) kg/m | Cable Diameter (mm) |
|---|---|
| 51.7 | 154 |

Prior to installation, dynamic simulations using OrcaFlex or similar software will be run of the proposed installation methodology, taking into account the mechanical parameters shown in Table 2-1. The outputs of this analysis will be a set of operational weather parameters that the installation will adhere to.

An On Bottom Stability (OBS) assessment will be conducted to ascertain whether the cable will be stable on the seabed for its design life, and if not, what additional stability measures may be required.

# 3. SURVEY WORKS

## 3.1 Routing survey

Routing survey works were undertaken during August and September 2023 and included the following:

- Offshore geophysical survey.
- Offshore environmental survey.
- Nearshore geophysical survey.
- Landfall topographic survey.
- Intertidal ecological survey

The key outputs of the surveys were as follows:

- bathymetry;
- seabed features including debris, archaeology and areas of high mobility;
- third party pipelines and cables;
- locations of possible UXO;
- the composition of the top two meters of the seabed; and
- determine benthic habitats.

The survey works have informed selection of the Application Corridor. The data was used to engineer the route for this replacement cable. The survey works have also informed the environmental assessment provided in this Marine Environmental Appraisal (MEA) report (Report reference: P2663D1_R6253).

# 4. CABLE PROTECTION AND STABILISATION

## 4.1 Overview

SHEPD have compiled a deposits plan based on preliminary survey data acquired from the nearshore and offshore survey vessels, which is detailed in Table 4-1 below. This conservatively outlines the type and number of seabed deposits required for stabilisation and protection and is the basis of the assessment made in the MEA. The deposits will be placed where is considered most appropriate along the cable route. No burial is planned for any section of the cable due to a lack of sediment.

Engineering studies are ongoing which may alter the final quantity of deposits required and the information provided is therefore based upon worst-case scenarios. More information on the types of protection and stabilisation that could be utilised is provided in Section 5.2.7.

## 4.2 Cable protection and stabilisation

Table 4-1 conservatively outlines the type and number of seabed deposits needed for cable protection and stabilisation.

### Table 4-1 Cable protection and stabilisation

| Type of deposit/ removal | Deposits | | Removal | |
|---|---|---|---|---|
| | **Description** | **Quantity & Dimensions (metric)** | **Description** | **Quantity & Dimensions (metric)** |
| Cast Iron split pipe | Articulated cast iron shell design that interlocks around the cable and is fixed with bolted end clamps. This will be placed on either shore end of the cable where burial is not possible. | Dimensions:<br>Diameter: 260mm<br>Total length: 900m | N/A | N/A |
| | | Weight:<br>67.4kg/m | | |
| Uraduct | Polyurethane cable ducting to protect cable crossings from abrasive forces. | Dimensions:<br>Length: 220m | N/A | N/A |
| Concrete mattresses | Concrete mattresses may be required to stabilise the cable and/or manage cable crossings. | Quantity:<br>No. 8 | N/A | N/A |
| | | Dimensions:<br>Width: ~3m<br>Length: ~6m<br>Height: ~0.3m | | |
| | | Weight<br>8.75 T each | | |
| Rock bags<br>(below 8m LAT) | Rock bags may be required to stabilise the cable below 8m LAT so as not to reduce navigable water depth by more than 5%. | Quantity:<br>No. 34 | N/A | N/A |
| | | Dimensions:<br>Diameter: ~1.9m<br>Height: ~0.4m | | |
| | | Weight:<br>~2T each | | |
| Rock bags | | Quantity: | N/A | N/A |

| Type of deposit/ removal | Deposits | | Removal | |
|---|---|---|---|---|
| | Description | Quantity & Dimensions (metric) | Description | Quantity & Dimensions (metric) |
| (below 14m LAT) | Rock bags may be required to stabilise the cable below 14m LAT so as not to reduce navigable depth by more than 5%. | No. 52<br>Dimensions:<br>Diameter: ~ 3.0m<br>Height: ~0.7m<br>Weight:<br>~8T each | | |
| Clump weight | Clump weights provide extra stabilisation where any may be required. | Quantity:<br>No. 8<br>Dimensions:<br>Diameter: 1m<br>Height: 0.5m<br>Weight:<br>~300kg each | N/A | N/A |
| Earthing clump weight | Concrete clump weight to stabilise earthing wires. | Quantity:<br>No. 16<br>Dimensions:<br>Diameter: 0.5m<br>Height: 0.5m<br>Weight:<br>Up to 60kg each | N/A | N/A |
| Rock anchors | Stainless steel threaded rod, plus bolt fixing and marine grade resin to provide additional stabilization if required | Quantity:<br>No. 20<br>Dimensions:<br>Diameter: ~0.02m<br>Height: 0.3m<br>Weight:<br>40kg | N/A | N/A |

# 5. PROJECT DESCRIPTION

## 5.1 Proposed route

The proposed replacement cable route has been assessed from an engineering perspective in a number of desktop study reports. These include the Cable Route DTS (OiQ Report reference: 4063-GMSL-G-RD-0001), Mainland Orkney to Shapinsay Desk Study Report (ERM Report Reference: 0646770), various marine survey reports, and fisheries considerations outlined as part of the Fisheries Liaison Mitigation Action Plan (FLMAP) North Coast and Orkney. The final route engineering will be subject to ongoing studies prior to installation.

The location of the replacement cable Application Corridor in relation to the existing cable is shown in Figure 5-1 (Drawing reference: P2663-LOC-004). The cable routing decisions taken as part of the development of the route are outlined in Table 5-1.

### 5.1.1 Route decision making process

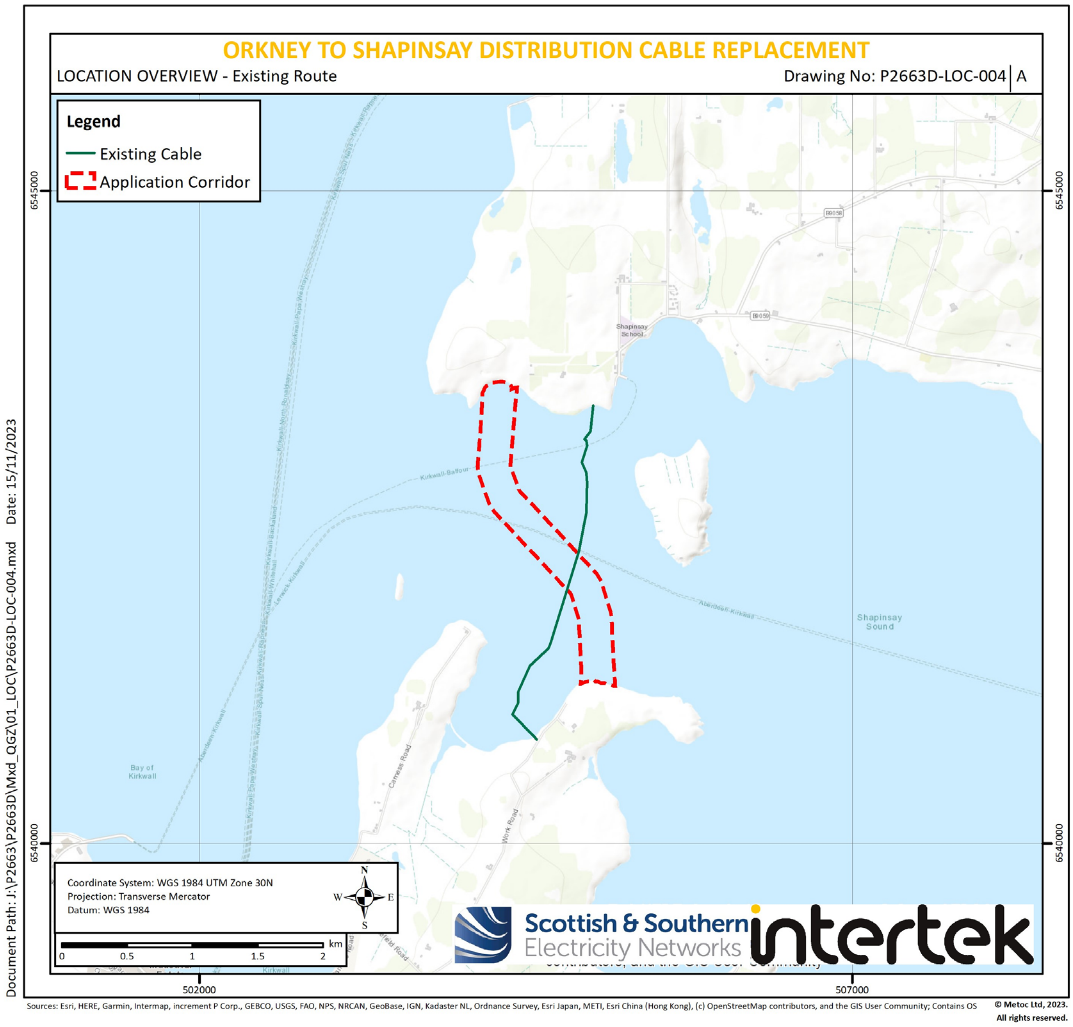
**Table 5-1 Key Route Engineering**

| Stage | Date | Description |
|---|---|---|
| Desktop Study (prior to route survey) | July 2023 | Preliminary RPL based on existing SSEN data and publicly available data |
| Post route survey | Q3 2023 | Collection of geophysical data based on desktop study RPL and indicative installation corridor |
| Final design | Q1 2024 | RPL for cable installation |

### 5.1.2 Route description

The proposed Application Corridor lies between Mainland Orkney and Shapinsay as shown in Figure 5-1, with the existing operational cable also shown.

## Figure 5-1 Recommended route and current operating cable

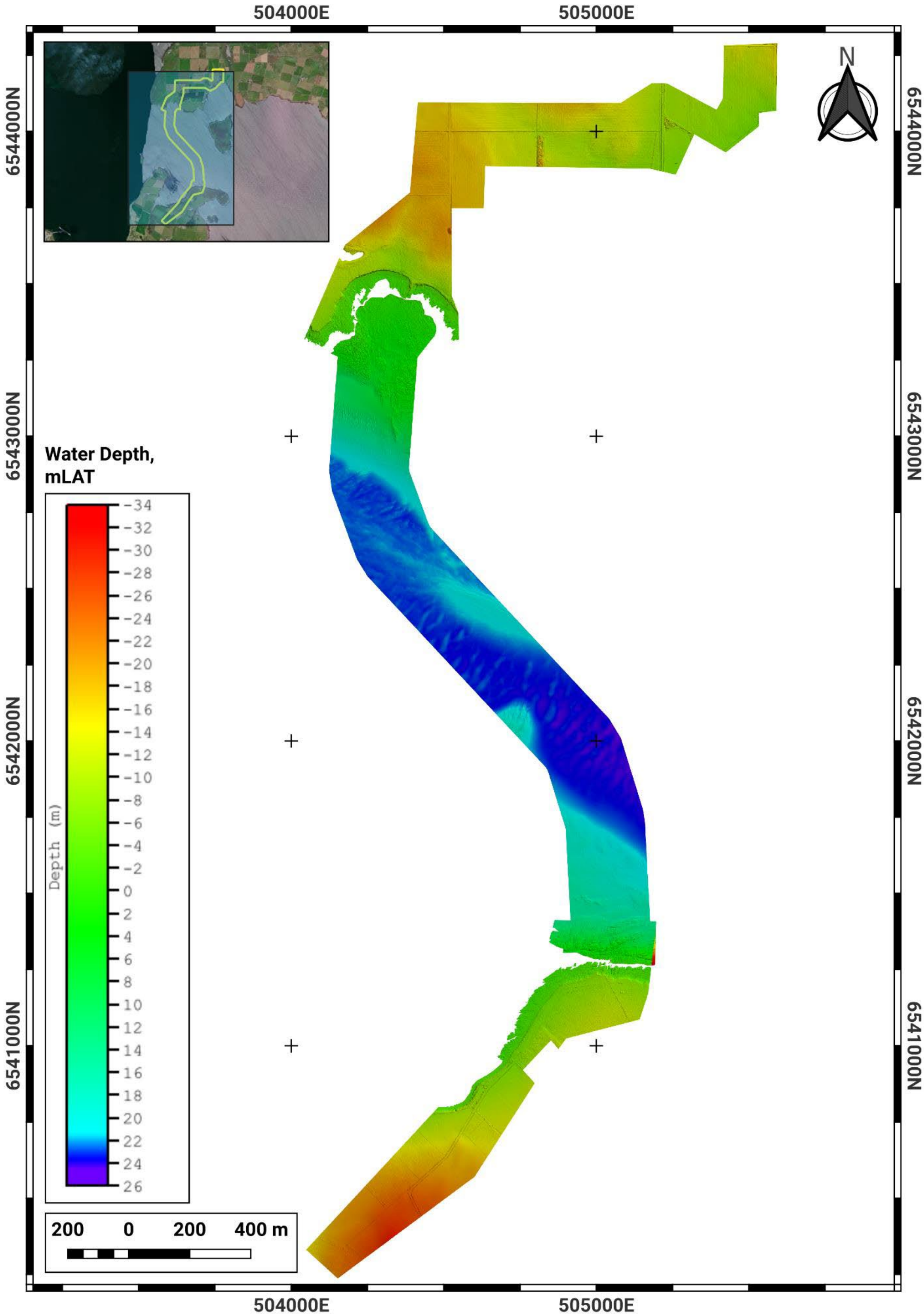



The survey corridor for the replacement cable covered an area of approximately 0.6km$^2$, consisting of a corridor 2,400m long by 250m wide. The survey corridor was selected to avoid key seabed features and to maximise the amount of survey data available to inform route engineering decisions.

A bathymetric overview of The String is presented in Figure 5-2. Where possible the cable route has been optimised to allow for efficient installation, the least disruption possible to the operational cable, and to avoid bedforms and a large sandbank in the channel where possible.

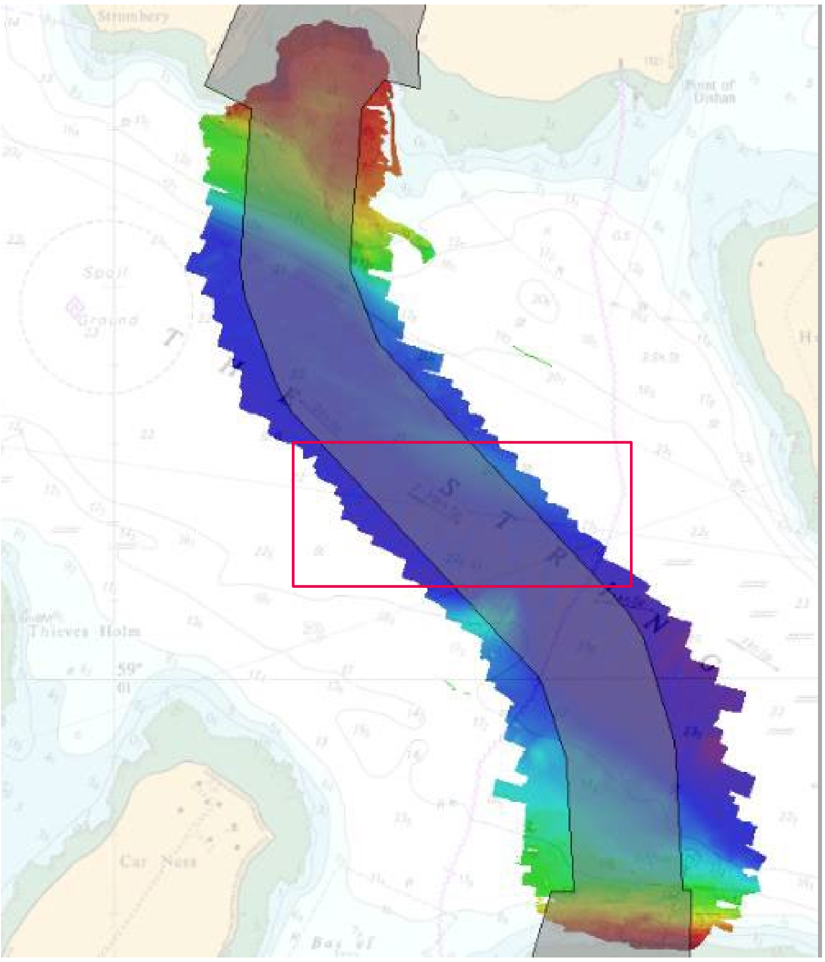
A geophysical survey was undertaken in Summer 2023 by ‘Spectrum Geosurvey’. A Norbit Winghead B51S (400kHz) multi-beam echosounder (MBES) was used to survey the Application Corridor. A lack of coherent acoustic signal below the seabed in shallow areas due to dense kelp beds prevented complete interpretation of the seabed in shallow areas. Changes to current velocities in The String also resulted in sand wave migration during the survey period and Figure 5-3shows the location of this migration in the bathymetric data. Figure 5-4 and Figure 5-5 show further detail of the area marked by the red box in Figure 5-3.

## Figure 5-2 Bathymetric map of the Application Corridor




Source: Spectrum, 2023

**Figure 5-3 Sand wave migration in The String**

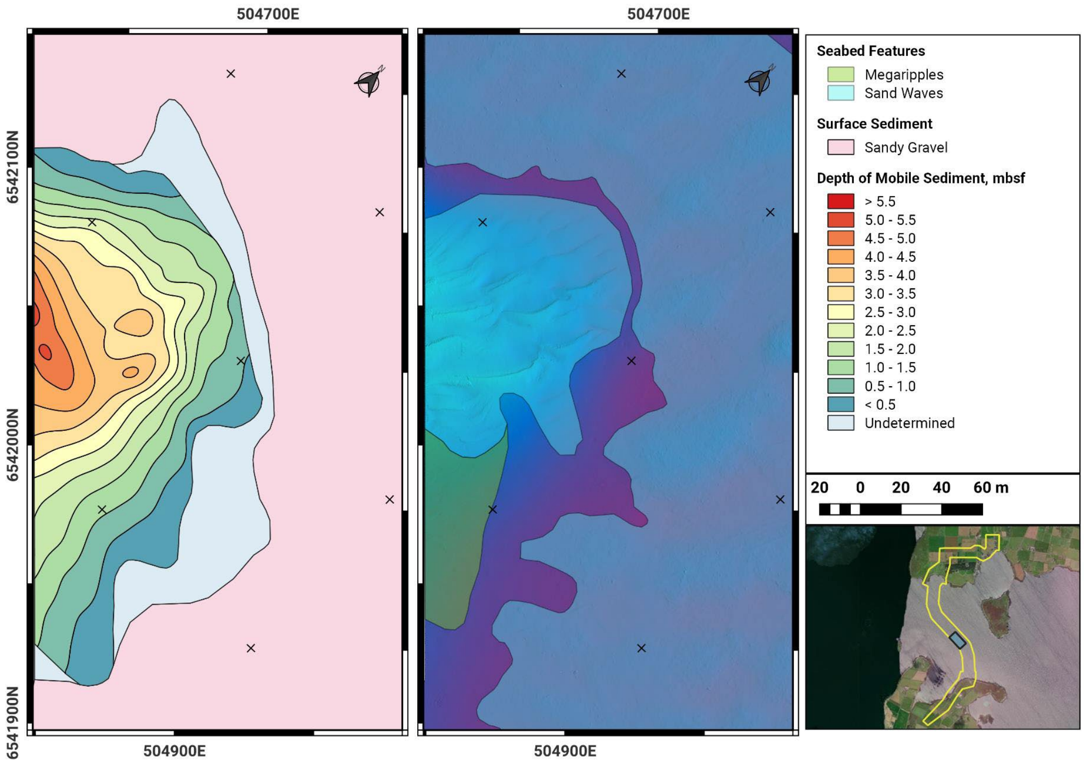


Source: Spectrum, 2023

The cable route will be located within the boundary of the Application Corridor and commences at the Transition Joint Pit (TJP) (59° 0.6196' N, 002° 54.7839' W), located on the beach at the Head of Work, Orkney 600m northeast of the landfall of the existing cable. The cable runs along the beach and nearshore area and across the seabed in The String before entering the beach at Twi Ness, Shapinsay and continuing to the TJP (59° 01.9396' N, 002° 55.4905' W). The route TJP to TJP is described in a south to north direction.

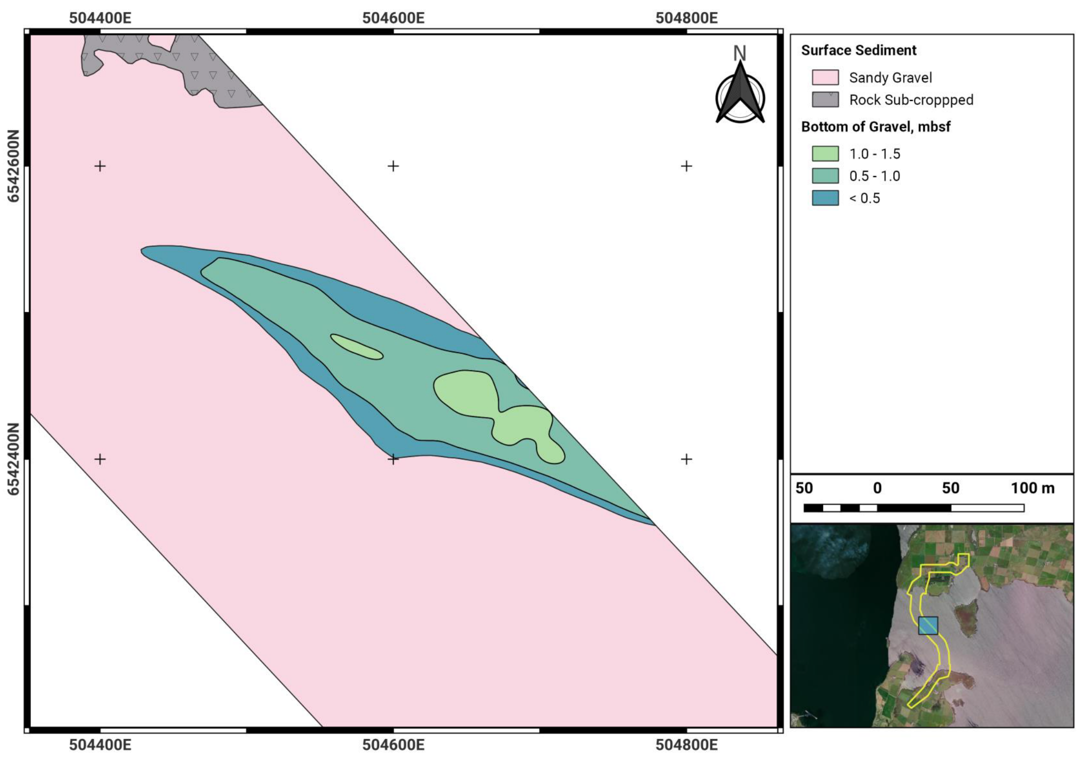
Commencing at the TJP in a grassy area at the back of the beach at the Head of Work, Orkney, the cable route will cross a grassy slope to enter the beach and cross through a gully between rock formations to reach the intertidal area. The intertidal and nearshore area sediment transitions from rock outcrop to a coarse gravelly sand, with boulder fields offshore from the outcrops which the cable will pass through. The cable route then crosses an unknown cable and the existing Orkney – Shapinsay cable and continues in a north-west direction. The cable route continues offshore, and has been routed to avoid a mobile sand unit (resulting in a cluster of sandwaves and megaripples observed to have moved during survey operations, Figure 5-4) and gravel mound (up to 1.5m thick at some points, Figure 5-5) where possible.

## Figure 5-4 Mobile gravelly sand formation in the centre of the Application Corridor




Source: Spectrum, 2023

## Figure 5-5 Gravel mound observed in the centre of the Application Corridor




Source: Spectrum, 2023

The route continues north through an area of sandy gravel before reaching a band of sub-cropping rock in the nearshore area of Shapinsay, of which the cable route avoids as much as possible (particularly formations visible at low tide). Megaripples are present in the area of gravelly sand beyond the rock, alongside maerl beds, which the cable route crosses before making landfall at Shapinsay. The route avoids outcropping rock on the shoreline and crosses the beach to the banks at the back of the beach where the cable will be pulled through a duct and terminate at the TJP.

### 5.1.3 Proposed Orkney Landing Site

It is planned to utilise a new landing site (600m northeast of the existing landing) at the beach located east of the Bay of Carness and north of the Head of Work, Orkney. The existing landfall cannot be reused for the new cable due to the presence of a fish farm and the existing cable, so the new site was selected based on an area with breaks in the rock outcrops to allow the cable to be installed between.

A site visit to the new landing site was undertaken by OiQ in March 2023 and the following points were outlined in the Site Visit Report:

- The access route to the beach is via slope which may need to be graded to allow construction equipment to safely reach the area;
- Other access to the beach is restricted by the presence of banks; and
- There is no existing cable or pipeline infrastructure at the landfall.

The TJP has been positioned to protect the installation from coastal erosion. As a result, the site is the most achievable for installation from an engineering perspective. Another advantage of this site is the nature of the marine approach, with close access for a cable lay vessel allowing for a direct shore end to be used to land the cable. Figure 5-6 and Figure 5-7 show the Orkney landfall location, taken during the OiQ site visit in March 2023.

**Figure 5-6 Orkney new landing site looking seawards**


Figure 5-6 shows the view offshore from the beach at the new landing site, with an example cable route included. As discussed, the route would be located in a gully between two rock formations.

### Figure 5-7 Orkney new landing site looking landwards


Figure 5-7 shows the view from the new landing location looking landwards towards the onshore route to the TJP with an indicative cable route. The proposed access ramp is also marked.

**Figure 5-8 Orkney proposed TJP location**

Figure 5-8 shows the proposed location of the new TJP at the new Orkney landfall.

### 5.1.4 Proposed Shapinsay landing site

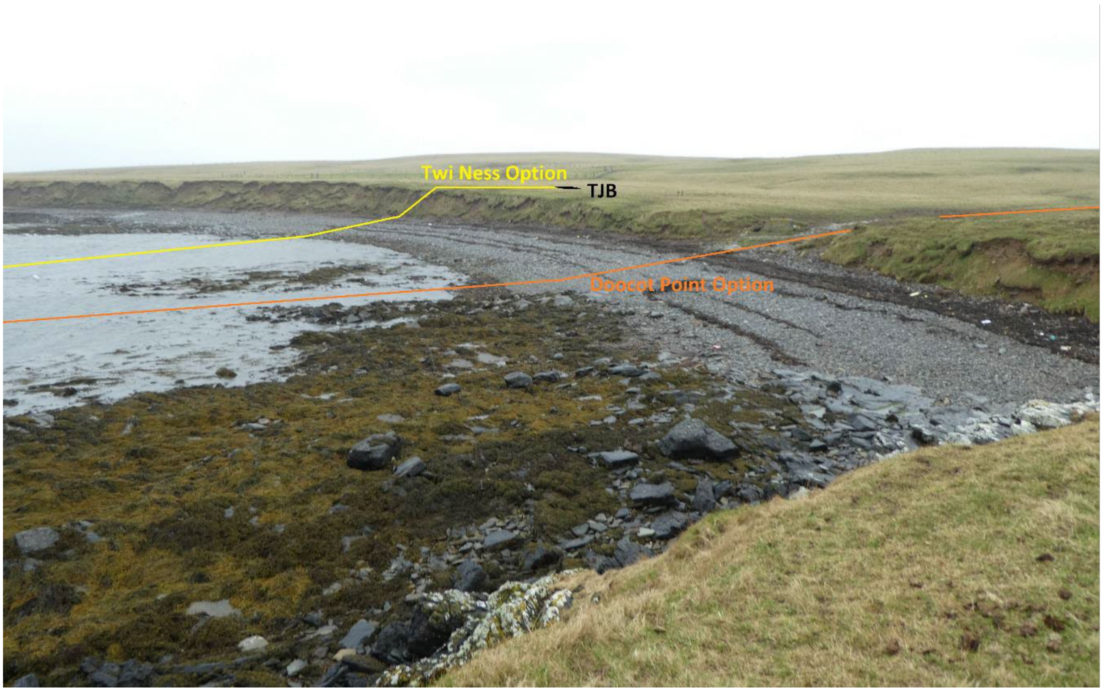
The Shapinsay landing site will also utilise a new landing site as the previous site cannot be used due to landowner constraints. The new landing is in close proximity to the original due to its location as the most western point easily accessible from offshore that will avoid existing pipeline infrastructure onshore. This site was also visited by OiQ in June 2023, during which the following considerations for selecting this site were identified:

- Banks are located along the back of the beach, which may require the cable to pass through a duct to reach the TJP;
- The location of the TJP has been selected behind the banks to reduce the risk of erosion and flooding;
- A water pipe runs along the beach to feed a cattle standpipe, but the selected landing location should avoid this; and
- Vehicles will need to cross cattle fields to reach the landing point, which is located to the east of the landing point where the banks fall to meet the beach.

The new landing site represents the most practical engineering solution as the existing landfall is unavailable for reuse. A further advantage of the site is the nature of the marine approach with close access for a cable lay vessel allowing for a direct shore end to be used to land the cable through a gap in the surrounding rocks in the nearshore area.

An alternative landfall site, named Doocot Point, was also visited during the landfall site. As it is located on the same beach, the location has been identified in the images provided from the site visit (Figure 5-9 and Figure 5-10).

### Figure 5-9 Twi Ness and alternative landfall site




The rocky areas, gaps in which the cable will need to pass through, can be seen in Figure 5-9, along with indicative cable routes for both the preferred and alternative landfalls and the new TJP location for the Twi Ness landing.

**Figure 5-10 Twi Ness landing point looking seaward**

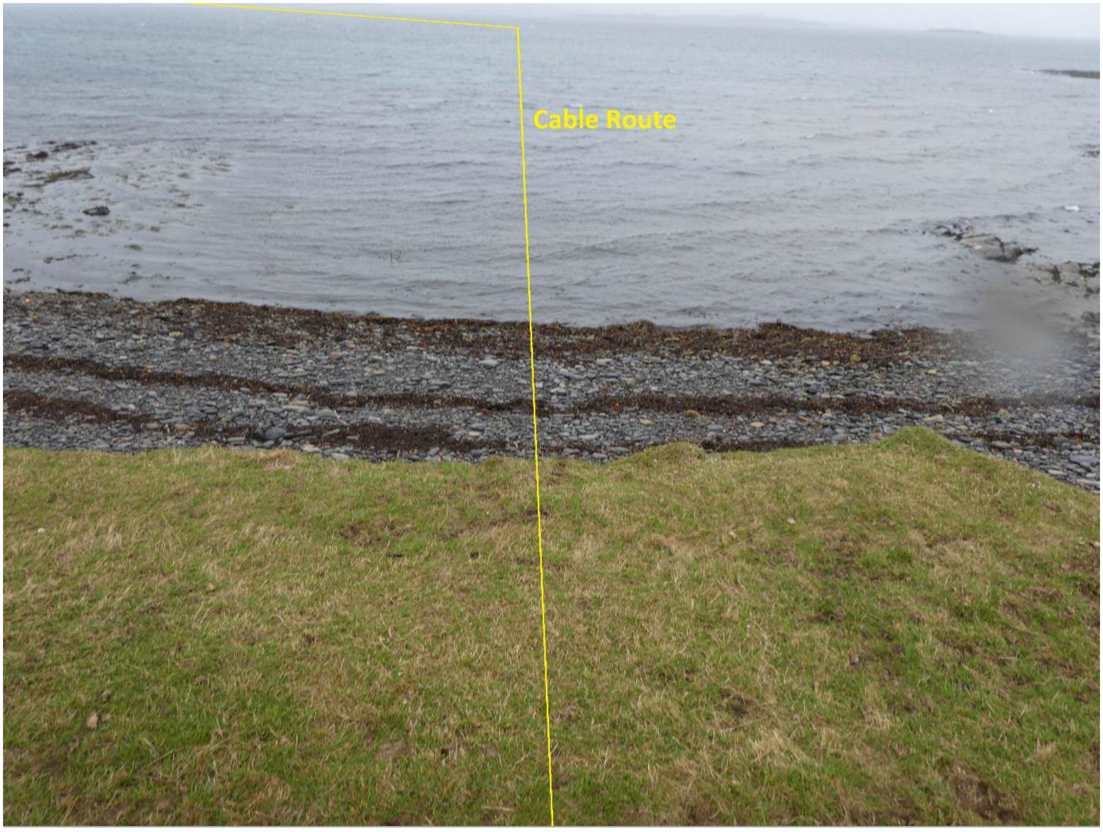



Figure 5-10 the view looking seaward from the Twi Ness new TJP location on top of the bank. An indicative cable route is also shown.

## 5.2 Proposed installation method

An indicative installation methodology is outlined below. The final methodology will be engineered following the results of the route survey operations and on completion of the OBS assessment. The indicative methodology is intended to give an overview of the options available to the cable installation contractor and has been used to inform the environmental assessment provided in MEA, so that the worst-case impact scenarios of the installation have been considered.

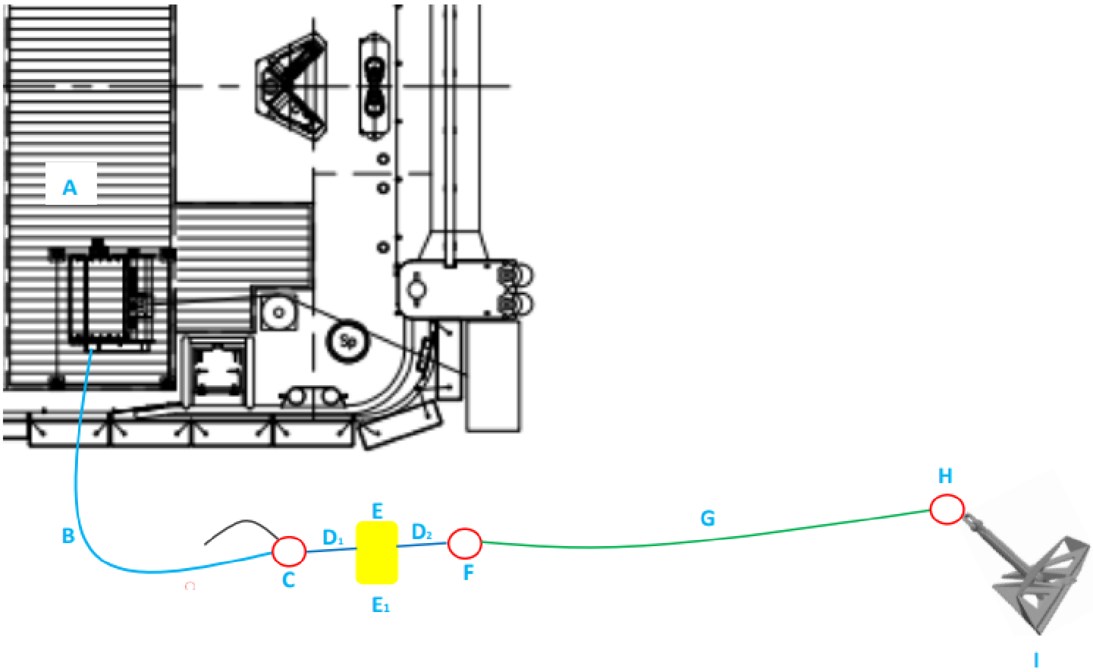
Vessels and equipment proposed to be utilised during the installation are summarised in the subsequent sections. All equipment used will be within the requirements set out within the European Protected Species (EPS) and Basking Shark (BS) Licences provided for the works.

### 5.2.1 Vessels

Table 5-2 below provides an overview of the types of vessels that will be deployed during the installation of the cable, these vary from Cable Lay Vessels (CLV), Dive Support Vessels (DSV) and other support vessels. These specific vessels or vessels with similar specifications will be used in the installation of the replacement cable.

The DSV will be positioned using up to two spud legs up to 10m LAT, with the potential for a 4-point mooring spread to be used between 10m – 18m LAT in up to two locations at the Head of Work end of the cable. There is the potential for the mooring spread to be left in place between working days, marked with surface buoys and lights, however this will be subject to approval from the Orkney Harbour Authority. A diagram of the mooring spread is included in Figure 5-11.

### Figure 5-11 Lay of temporary moorings for 4-point spread




| ID | Item | Description |
|---|---|---|
| A | Dromec – Hydraulic Anchor Winch | HPA – 15000 - O |
| B | Winch Wire | 300m length, 35x7 Steel Core, 24mm Diameter, 574Kn MBL |
| C | Shackle | 25t Safety Pin Bow Shackle |
| D | Pendant wire | 18m Length, 36x6 Galvanised, 36mm diameter, 816.6Kn MBL, 540mm Machined Spliced soft eye each end. |
| E | Can Buoy | Fifth Class Buoy, 1220mm Dia with channel for pendant wire. |
| $E_1$ | Buoy Light | Iso, Y, 2s. Solar Powered lights. |
| F | Shackle | 25t Safety Pin Bow Shackle |
| G | Studlink Chain | 54m Length, 30mm Diameter, 513kn MBL |
| H | Shackle | FS50 Joining Shackle |
| I | Delta Flipper Anchor | 2T Delta Flipper |
| J | Rope Tail / Recovery Strop | 25mm x 4m recovery rope, 127 Kn MBL |

Source: Briggs Marine 2024

### Table 5-2 Installation Vessels

| Name of Vessel | Type of Vessel | Vessel Specification | Positioning System/ Spud diameter | Working limits |
|---|---|---|---|---|
| MV Elektron | Cable Lay Vessel (CLV) | GT – **3,438**<br>DL – **87m**<br>DB – **18m** | DP 2 | <10m |
| Forth Guardsmen | Landing craft | GT – **654**<br>DL – **50m**<br>DB – **14.6m** | DP2 | <10m |
| Olympic Delta | Boulder Removal Vessel | GT – **5,395**<br>DL – **92.55m**<br>DB – **19m** | DP 2 | <10m |
| Forth Jouster | Dive Support Vessel (DSV) | GT – **167**<br>DL – **26m**<br>DB – **11.5m** | 610 mm with spiked tip | <13m |
| Forth Warrior | Dive Support Vessel (DSV) | GT – **296**<br>DL – **27m**<br>DB – **12m** | 610 mm with spiked tip | <13m |
| Celtic Guardian | Other Support Vessel | GT – **9.5**<br>DL – **13.9m**<br>DB – **4.3m** | N/A | 0.7m |

GT- Gross tonnage – DL – Dimension Length – DB – Dimension Beam

### 5.2.2 Installation monitoring

Touch down monitoring of the cable will be conducted to confirm the position of the cable as it is laid, using an ROV or a cable fish. The ROV will be deployed from the cable lay vessel (CLV) or a separate support vessel that will be present during the installation.

### 5.2.3 Seabed preperation

#### 5.2.3.1 Pre-lay survey

Prior to lay operations commencing, a pre-lay survey may be conducted, this will be undertaken using a work class ROV. The objective of the survey is to:

- Identify and investigate possible debris; and
- Identify any obstructions on the proposed route including the presence of boulders which may impede the safe installation of the cable.

A summary of the survey equipment that may be used during the pre-lay survey is outlined in Table 5-3.

### Table 5-3 Examples of proposed survey equipment

| System / Survey Equipment | Description |
|---|---|
| **Geophysical** | |
| Ultra-Short Baseline (USBL) | USBL systems are used to determine the position of subsea survey items, including Remotely Operated Vehicles (ROVs), towed devices, grab samplers, etc. This involves the emission of sound from a vessel- mounted transducer to a subsea transponder, thereby introducing sound into the marine environment. A USBL system consists of a transducer, which is mounted on the vessel and a transponder attached to the ROV. The transducer transmits acoustics through the water and the transponder sends a response which is detected by the transducer. The USBL calculates the bearing and time taken for the transmissions to be completed and thus the position of the subsea equipment is determined. These systems can either be used continuously or intermittently through the operation they are supporting. |
| Multi-beam echosounder (MBES) | Multi-beam echo-sounders are used to obtain detailed 3-dimensional (3D) maps of the seafloor which show water depths. They measure water depth by recording the two-way travel time of a high frequency pulse emitted by a transducer. The beams produce a fanned arc composed of individual beams (also known as a swathe). Multi-beam echo-sounders can, typically, carry out 200 or more simultaneous measurements. |
| Sidescan Sonar (SSS) | Side-scan sonar is used to generate an accurate image of the seabed, which may include 3D imagery. An acoustic beam is used to obtain an accurate image of a narrow area of seabed to either side of the instrument by measuring the amplitude of back-scattered return signals. The instrument can either be towed behind a ship at a specified depth or mounted on to a ROV. The frequencies used by side-scan sonar are generally very high and outside of the main hearing range of all marine species (NMFS, 2018). The higher frequency systems provide higher resolution but shorter-range measurements. |
| **Seabed Imagery** | |
| Hi-Resolution Camera | An ROV mounted camera will be utilised to acquire imagery of the cable and adjacent seabed. |

Source: SSEN, 2022

#### 5.2.3.2 Boulder removal

Boulders may be removed using a “grab” tool deployed from a support vessel with suitable crane, as shown below in Figure 5-12. This will be dependent on the results of the boulder removal assessment which will be done during the route engineering.

If debris or an obstruction cannot be removed from the planned route, the offshore surveyors will micro-route around the debris/obstruction in consultation with the onboard Client Representative (CR). Any micro-routing will always remain within the licenced installation corridor.

Although the cable route will be engineered to avoid as many boulders as practical, a hydraulic operated grab may be required to remove any boulders that may impede the safe installation of the cable (Figure 5-12). This system will be operated via a crane on the vessel from the surface and deployed using a boulder removal vessel such as the DSS Olympic Delta (Figure 5-13) or a similar support vessel. An ROV will assist in the positioning of this tool. The grab will move the boulder away from the installation area.

Debris identified and removed along the route will be disposed of as outlined in the marine Construction Environmental Management Plan (CEMP).

**Figure 5-12 Example of boulder grab**

Source: SSEN, 2023

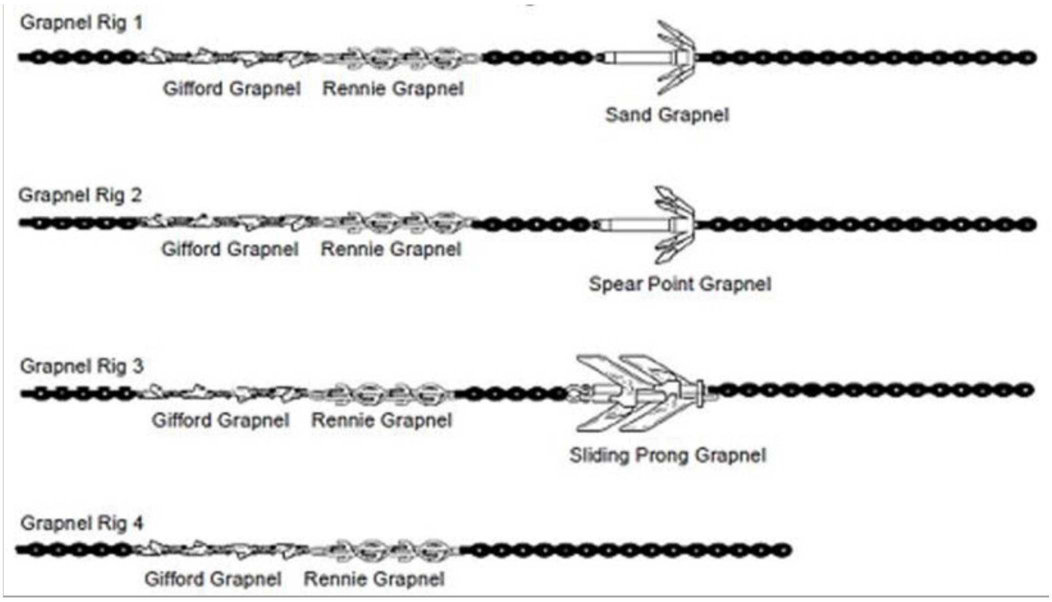
**Figure 5-13 An example vessel used for boulder removal, crossing and stabilisation operations (DSS Olympic Delta)**

Source: SSEN, 2023

#### 5.2.3.3 Pre-lay grapnel run (PLGR)

Any obstructions or debris which cannot be avoided will be removed, if possible. A PLGR may be undertaken to remove debris from the proposed installation corridor. A PLGR may be required to remove debris for example cables, chains, wires, ropes, and fishing gear. Therefore, it is expected that this activity will be completed prior to the cable installation activities to ensure that the installation corridor remains free of debris prior to installation. A typical grapnel train is shown below in Figure 5-14 and Figure 5-15. Multiple PLGR's both end to end or perpendicular to the route may be required within the licenced installation corridor to remove debris. Where OOS cables have been cleared the cut ends will be secured with clump weights if required to prevent cable movement.

Figure 5-14 Grapnel train (typical example)




Source: SSEN, 2022

Figure 5-15 Example of grapnel and chain at stern roller of vessel

Source: SSEN, 2022

### 5.2.4 Landfall preparation

The landfall areas will be prepared with the following tasks undertaken:

- Site setup, including fencing, signage, welfare units etc;
- Site walk-over;
- Nearshore visual survey;
- Excavation works along landfall cable route (above MHWS at TJP to MLWS); and
- Cable pull-in preparation, including cable rollers, quadrants winches etc.

#### 5.2.4.1 Access to site

Personnel can access the Orkney site via Work Road from Kirkwall (a single track road with no passing places), then a tarmacked farm track located past the water treatment works to the TJP location. Access to the beach is available via a grassy slope at the back of the beach which may need to be graded to allow access for construction equipment.

Access to Shapinsay is available via ferry, and the landing point is located 900m from the ferry landing. It can be reached via a single track road with no passing places north of the Balfour Castle estate or via a road and farm tracks further north which increase the journey to 2.3km. The banks at the back of the beach are reached by crossing 300m of a cattle field which is likely to become boggy when wet. Access to the beach is located east of the landing point, where the banks drop to meet the beach.

#### 5.2.4.2 Site compound

For the onshore engineering works a base will be established which will also act as a local site management office for the works. It shall comprise of, but is not limited to, the following:

- Suitable office accommodation, including space for: site briefing/training, electrical supply internet and telephone connectivity (where applicable and signal is available);
- Lay-down areas designed to take the biggest loads likely to be delivered to site;
- Secure storage areas for all required materials, with segregation of material in line with Safety Data Sheets (SDS) requirements
- Compound lighting where work is required to be undertaken in low light levels, directional lighting will be used on shore end, to minimise light disturbance;
- An area designated for waste and waste recycling skips, with clear signs to indicate the waste segregation requirements of each container or skip; and
- All onshore operations and facilities will be covered by an onshore CEMP.

The site shall have a traffic management plan to maintain safety of traffic entering and exiting the compound. It should be noted that traffic at the local site compounds shall be light and minimal throughout, with the heaviest traffic during set up and tear down of the compound.

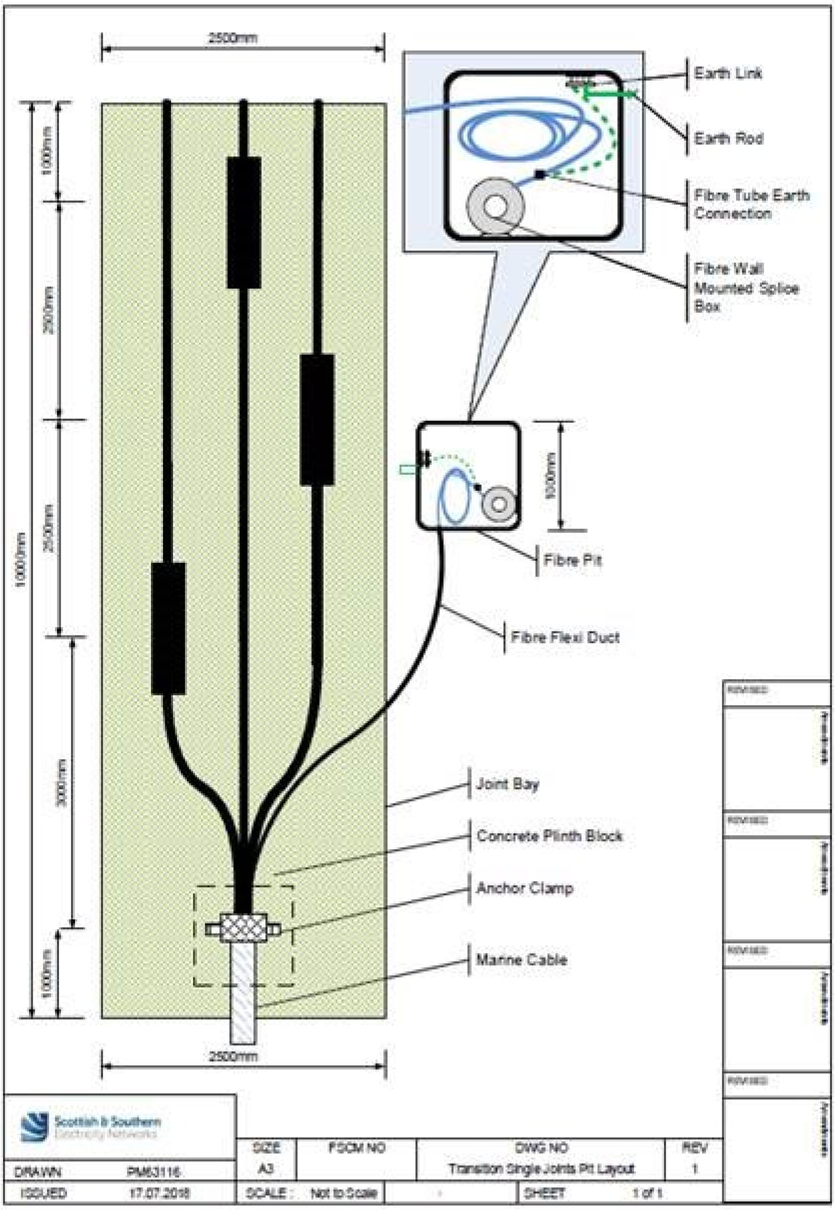
The site compound will be secured from the public by means of Heras fencing where applicable and or pedestrian walkways, all relevant site signage and warning signs will be posted where necessary to ensure site safety and public safety.

All responsible methods will be employed to mitigate environmental damage and in particular spill kits (120L bins) and machine nappy pads to catch leaks and drips on site. The compound shall comply with the environmental requirements for all activities impacting protected or sensitive habitat or species. The site will also be compliant with the Construction (Design and Management) (CDM) Regulations requirements.

#### 5.2.4.3 Transition joint pit (TJP)

The TJP will be the location where the subsea cable is split out into its individual cores and terminated to a land cable. The TJP at each landfall are located above MHWS and will utilise a sea earth. As the Marine Licence Application Corridor only covers up to MHWS details on the TJP are only included in this report to provide further information on the Project. Figure 5-16 outlines the TJP plan for both landfalls on Orkney and Shapinsay.

**Figure 5-16 SSEN provided TJP plan**




## 5.2.5 Intertidal cable installation

### 5.2.5.1 Open cut trench

At both landfalls, the cable will be buried within the intertidal area using an Open Cut Trench (OCT) (Figure 5-17) method, from the MHWS to MLWS. Each landfall will have two trenches excavated, one trench will be for the subsea cable and armour earth, while the other trench is for a fibre optic cable earth.

This will be undertaken using the following equipment:

- 1 x 20tn and 1 x 8tn excavators (complete with rock pecker attachment, for areas of bedrock),

The trenches will be approximately 1m in width, and the target depth of the trench will be approximately 800mm from ground level to the top of the cable. However, this is subject to ground conditions at the landfall such as the soil stability and the nature of subsurface sediments. Excavators complete with rock pecker attachment, will be utilised to reach the depths required to bury the cable in the intertidal zones of each landfall. Split pipe will be used to protect the cable within the intertidal trench, as well as potentially on sections of the trench route where burial depth cannot be viably achieved.

Each landfall's OCT will require a 20m corridor width to conduct the works, 20m will be sufficient space to operate the excavator and temporarily store the excavated material. The length of the intertidal excavation sites will be 19m and 10m at Orkney and Shapinsay, respectively. Once the trenching activities are completed, the excavated material will be backfilled into the trench, returning the intertidal area to pre-works conditions.

**Figure 5-17 Example OCT**


Source: SSEN, 2022

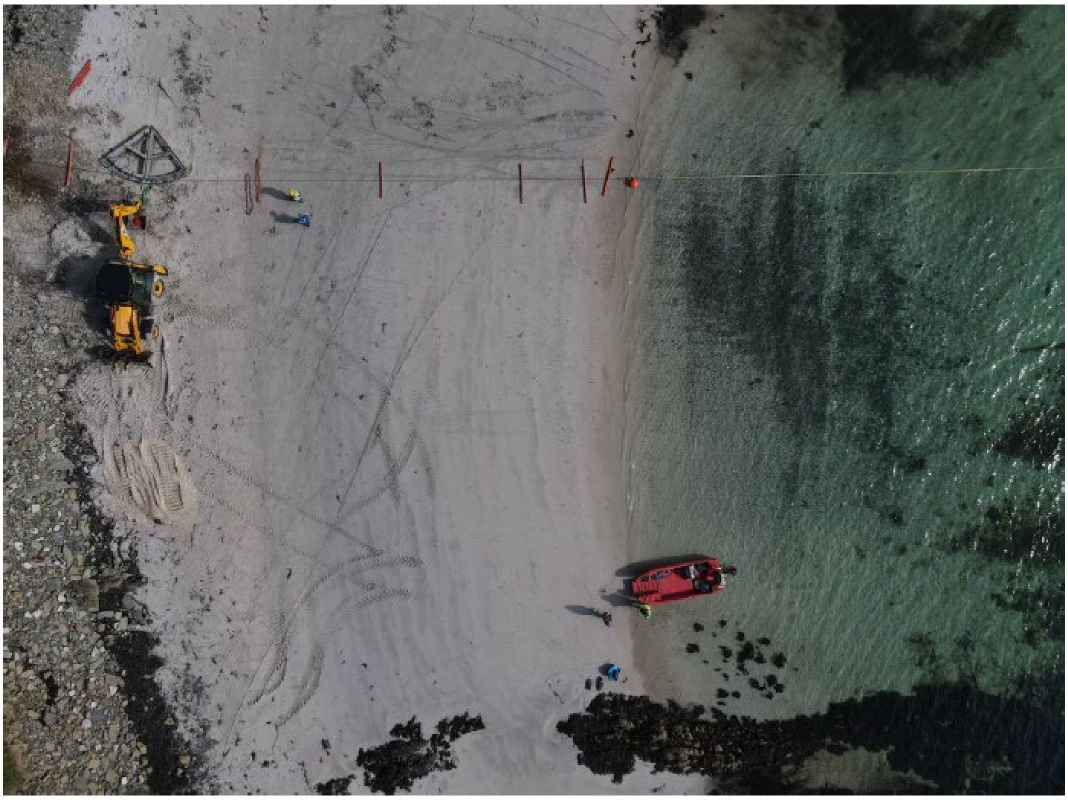
### 5.2.5.2 Intertidal cable pull in

Cables will be pulled onto land using two winches, this will be on a rising tide along with a combination of rollers (Figure 5-18) and quadrants (Figure 5-19). This equipment will allow the cable to be safely pulled ashore without any damage, rollers will be used to support the flow of the cable as it's pulled in using the winches and the quadrants are used to ensure that the cable is pulled into the intertidal area, in the correct alignment. Anchor plates will hold the rollers and quadrants in place while the process of the pull in takes place, these anchor plates will be buried at first and then removed once the cable has been fully pulled ashore.

**Figure 5-18 Example images of rollers**

Source: SSEN, 2022

**Figure 5-19 Example of rollers and quadrants**



Source: SSEN 2022

### 5.2.6 Marine cable installation

The following installation method is based on that utilised during previous 100% surface laid cable installations that SHEPD have undertaken. This has been used as the basis for the present MEA.

#### 5.2.6.1 First end pull in

The CLV will position at the first end pull-in site (Orkney based on current plans), generally stationed at the 10m water depth (WD) contour (this is dependent on the vessel's draft). Deck handling equipment will be used to direct the cable to the over-boarding chute. An example of a CLV which may be used during the installation is displayed in Figure 5-20 below.

**Figure 5-20 An example CLV**


Source: Vessel finder, 2023

A messenger line will be taken from the CLV via small support craft to the shore. This will be connected to the shore winch line at MLWS. The small support craft will then pull back the mooring line and pull-in winch wire from the shore to the CLV where it will be connected to the cable end. The shore end winch will commence pulling in the cable with buoyancy units attached onto the cable as it leaves the vessel to 'float' the cable ashore. The cable will be secured at the TJP and surface swimmers will gradually remove the buoyancy units, completing the first end pull-in operations.

#### 5.2.6.2 Cable lay operations

Following successful completion of the first end pull in the CLV will commence laying the cable on the seabed from the first end to the second end; a smaller support vessel may be used in the shallower shore locations. DSV, nearshore and guard vessel may also be required during cable lay operations.

The cable will be surface laid from MLWS to MLWS as the majority of the installation corridor does not have good burial potential.

During cable lay operations, the vessel crew will monitor the lay to ensure the cable is laid within the consented installation corridor and that the mechanical parameters of the cable are adhered to. A cable fish or ROV may be used for Touch Down Monitoring (TDM) during installation, which contains a camera and USBL system to ensure accurate images of the installation are sent to the crew on the CLV for assessment.

During these operations, the vessel structure may be outside the licenced corridor however all deposits will be installed within the allocated boundary. Vessel movements will be notified by Notices to Mariners (NtM) issued via Orkney Harbour Authority to inform other sea users as outlined in the FLMAP.

#### 5.2.6.3 Second end pull in

Once the cable is laid across the seabed, the vessel will either manoeuvre off the RPL and float the cable off the vessel or remain in position on the RPL and pay out cable into a floated omega bight. This is to allow the cable to be cut at the required length prior to pulling the cable into the second end landing point at Shapinsay (based on current plans).

The bight may be outside of the cable installation corridor whilst in the water column at certain points during deployment, however final installed position will be within the boundary of the licenced area. The supporting FLMAP and MEA references the notifications issued to sea users to inform which activities are taking place. Navigational broadcasts will be issued via Navigational telex (NAVTEX) and NTMs distributed by Orkney Harbour Authority.

As per the First end, buoyancy units will be attached to the cable as it is being paid out to float the cable ashore.

Once the cable is floated out into a bight, a messenger wire will be sent ashore from the CLV on a support craft. The messenger wire will be connected to the to the shore winch which will then be pulled back to the CLV and connected to the cable end. The cable will then be pulled into the Second end landing point. Surface swimmers will then gradually remove the buoyancy units allowing the cable to come to rest on the sea floor. The shore winch will pull in any slack to complete installation operations.

### 5.2.7 Cable protection methods

This section outlines the envelope of all potential marine cable stabilisation and protection methods for which consent is being sought.

Upon completion of the OBS Assessment for the Orkney to Shapinsay route it will be possible to better identify the quantities of cable protection and stabilisation to be employed along the route.

Split pipes and Sea Earths will be utilised to provide protection for the replacement cable. Worst case scenario quantities, dimensions and weight for each protection method is provided in Table 4-1 in Section 4.2, and is the basis of the assessment made in the MEA.

#### 5.2.7.1 Split pipe (articulated pipe)

The cable protection strategy includes the installation of cast-iron articulated pipe. Generally, this is installed following the cable pull-in operations by divers or from the CLV during lay, or by a combination of both methods. This protects and helps stabilise the cable in the nearshore and intertidal section of the cable route.

See the cable protection and stabilisation plan detailed in Table 4-1 for the length of anticipated articulated pipe installation.

#### 5.2.7.2 Sea Earths

Sea Earths will also be installed to provide protection from surges and lightning strikes to the electrical circuit. It is expected that two earthing cables will be required at each shore end using stainless steel. One cable will earth the armour of the HVAC cable system, while the other provides an earth for the fibre optic armour (integral to the HVAC cable system).

At the intertidal zone, the earth wire will be installed in a separate trench with a minimum separation of 10m. The working corridor will be 20m either side of each trench (10m either side of the cable). This will still be inside the consented corridor as defined by SHEPD. The excavator will be utilised, so the trench will be excavated using the same method employed for the subsea cable, as detailed in Section 5.4.1. Below MLWS sea earths will be surface laid, concrete clump weights may be used to anchor the sea earths at intervals/at their termination subsea.

#### 5.2.7.3 Concrete Mattresses

A work class ROV operated mattress frame will be utilised for the installation of concrete mattresses at the crossing locations. If shallow water mattress installation is required, a Multicat type vessel will carry out the installation in shallow water. During the installation in shallow water, the Mulitcat will hold position using spud legs to position the mattresses along the route of the existing cable.

#### 5.2.7.4 Rock bags

The cable protection strategy may include the installation of rock bags onto the cable to provide stability. The rock bags will be stored on the vessel and lifted into position using the vessel's crane. The vessel's ROV monitors the installation and detaches the crane wire from the rock bag once in position.

Where practicable, the rock bags will be filled with stone local to the installation site. The rock bags may be installed as soon as the cable is laid by a separate vessel to the cable lay vessel. Simultaneous Operations (SIMOPS) between the two vessels will be managed in the planning phase as well as the offshore phase via implementation of a SIMOPS plan. Each vessel will be named in the NtM as required in the supporting FLMAP.

#### 5.2.7.5 Uraduct

Uraduct is a synthetic cable protection system which encases the cable in polyurethane ducting to protect it from abrasive forces at crossing locations. It can be used as an alternative to traditional concrete mattresses, or in conjunction with them.

#### 5.2.7.6 Rock anchors

Rock anchors are made from stainless steel threaded rod, plus bolt fixing and marine grade resin and may be placed in areas where additional stabilisation of the cable is required.

#### 5.2.7.7 Clump weights

Clump weights are made from concrete, steel or iron and may be used for additional stabilisation of the cable where required.

### 5.2.8 As-built survey and site reinstatement

Installation data will be compiled to confirm the as-built positions and to ensure that the design and licence requirements have been met. This will record the as-installed position of the cable from TJP to TJP and the deposits utilised to stabilise and/or protect the cable given (i.e. rock bags, mattresses, articulated pipe etc.). The landfall sites will also be reinstated as agreed with landowners. The replacement cable will subsequently be electrically jointed to the land HV infrastructure. The routing and installation of the land HV infrastructure is not covered as part of this Project Description which supports the marine licence application.

Details of the as-built locations of the cable and associated protection measures will be provided to the UK Hydrographic Office and the Kingfisher Information Service for inclusion on Admiralty Charts, and Offshore Renewable and Cable Awareness Charts respectively.

# REFERENCES

1 Briggs Marine (2024) Method Statement - Forth Warrior.

2 Spectrum Geosurvey (2023). Processing and Interpretive Report - Orkney to Shapinsay.

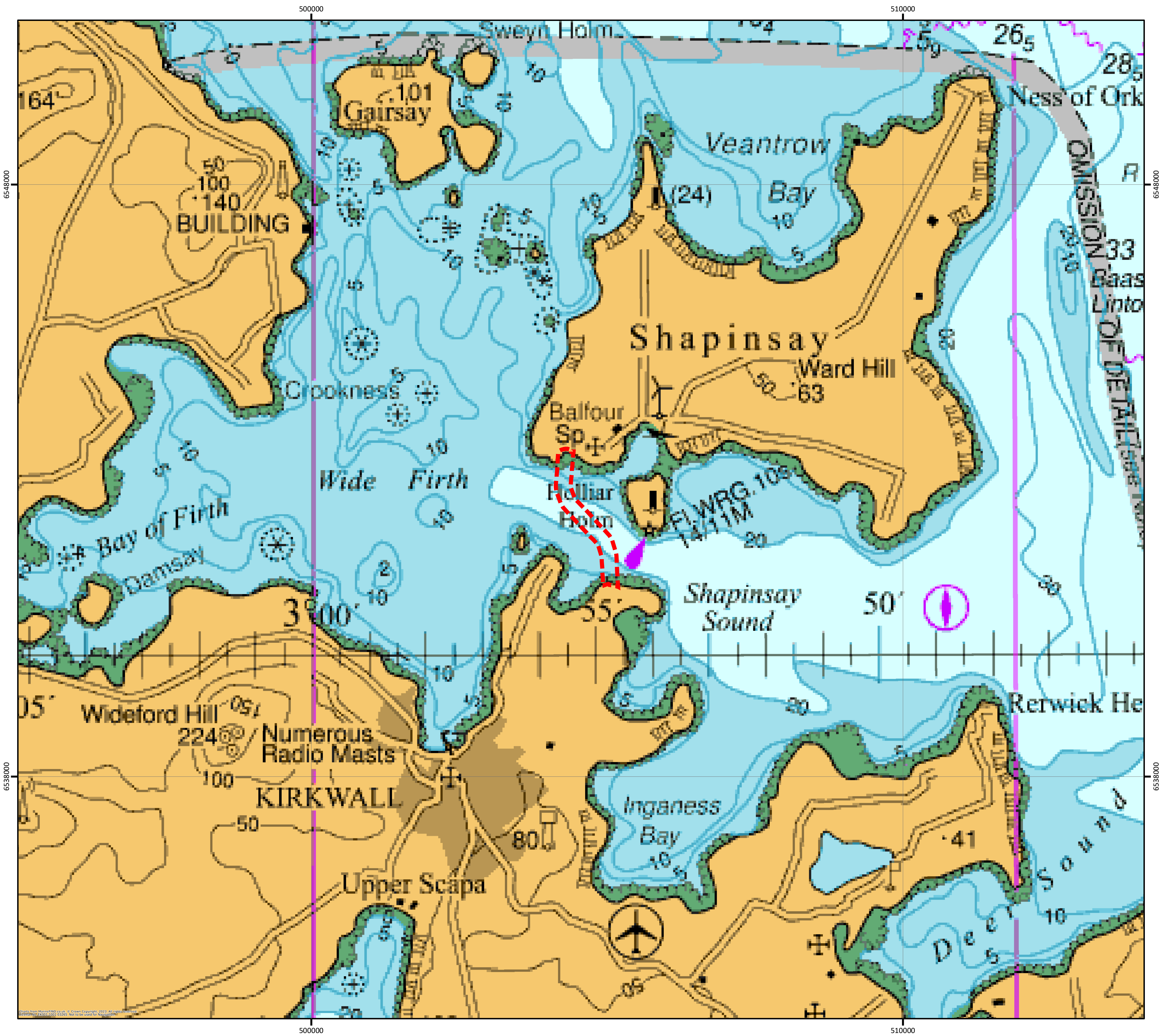
3 SSEN (2018). Transition Single Joint Pits layout. SSEN.

4 SSEN (2022). Site Visit Report Islay - Jura. rep. SSEN.

Vessel Finder (2022). MV Elektron CLV, Vessel Finder. Available at: https://www.vesselfinder.com/vessels/details/9386811 [Accessed December 2023]

# APPENDIX A

## Overview Map



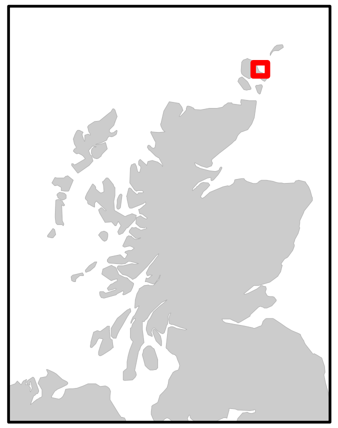

# ORKNEY TO SHAPINSAY DISTRIBUTION CABLE REPLACEMENT

**LOCATION OVERVIEW**
**Route Overview**

| Drawing No: P2663D-LOC-003 | A |
|---|---|

**Legend**

Application Corridor



NOTE: Not to be used for Navigation

| | |
|---|---|
| Date | 15 November 2023 |
| Coordinate System | WGS 1984 UTM Zone 30N |
| Projection | Transverse Mercator |
| Datum | WGS 1984 |
| Data Source | MarineFIND; ESRI |
| File Reference | J:\P2663\P2663D\Mxd_QGZ\01_LOC\P2663D-LOC-003.mxd |
| Created By | Oliver Bula |
| Reviewed By | Lewis Castle |
| Approved By | Vicky Fisk |

Scottish & Southern Electricity Networks

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