SSE – ED1 CABLE REPLACEMENT

MULL - COLL

Project Description – Mull - Coll

GO Reference : 3234-GO-O-TB-0003

REVISION	DATE	ISSUE DETAILS	PREPARED	CHECKED	APPROVED
01	20-04-2021	Issued for Review	MW	SW	CC
02	08-06-2021	Issued for Review	MW	JY	CC
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REVISION	SECTION	PAGES	BRIEF DESCRIPTION OF CHANGES	AUTHOR/S OF CHANGE
02	ALL	ALL	Updated based on comment sheet Project Description – Mull – Coll. No ref number provided.	MW
03	6.3		Additional Information added on Sea Earthing. New Section 6.3.	MW
04	ALL	ALL	SHEPD final edits	RB
05	Table 12 6.4.6.7		Updates to reflect inter-tidal burial information	RB

TABLE OF CONTENTS

Abbreviation and Definitions

The table below show a list of abbreviations and definitions used in this document:

List of Abbreviations and Definitions

Abbreviation	Definition
A/C	Alter Course
ADCP	Acoustic Doppler Current Profiler
AHC	Active Heave Compensation
AToN	Aid to Navigation
AWAC	Acoustic Wave and Current profiler
CBRA	Cable Burial Risk Assessment
C/L	Centreline
CLV	Cable Lay Vessel
CPSP	Cable Protection and Stabilisation Plan
CPT	Cone Penetration Test
CR	Client Representative
Cu	Copper
DGPS	Differential Global Positioning System
DP	Dynamic Positioning
DSE	Direct Shore End (position where vessel will site for pull-in operations)
DWA	Double Wire Armoured
FAT	Factory Acceptance Test
FLMAP	Fishing Liaison Mitigation Action Plan
FO	Fibre Optic
FOC	Fibre Optic Cable
GB	Gigabyte
GMG	Global Marine Group
GMSL	Global Marine Systems Ltd.
GPS	Global Positioning System
HDPE	High Density Poly Ethylene
HP	Horse Power
HV	High Voltage
HVAC	High Voltage Alternating Current
ID	Inner Diameter
IS	In-Service
ISM	International Safety Management

ISO	International Organization for Standardization
km	kilometre
kN	Kilo Newton
KP	Kilometre Point
kV	Kilo Volt
LAT	Lowest Astronomical Tide
LGP	Low Ground Pressure
LP	Landing Point
MBES	Multi-Beam Echosounder
MBR	Minimum Bend Radius
MCA	Maritime Coastguard Agency
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
msw	Meters Sea Water
nm	Nautical Mile
NTM	Notice to Mariners
OBS	On-Bottom Stability
OCMA	Oil Company Materials Association
OD	Outer Diameter
OHSAS	Occupational Health and Safety Assessment Series
OOS	Out of Service
OTDR	Optical Time Domain Reflectometer
PE	Poly-ethylene
PLGR	Pre-lay Grapnel Run
RB	Rock Bag
RHIB	Rigid Hulled Inflatable Boat
ROV	Remote Operated Vehicle
RPL	Route Position List
SDR	Standard Dimension Ratio
SHEPD	Scottish Hydro Electric Power Distributions
SIMOPS	Simultaneous Operations
SOLAS	Safety of Life at Sea
SSEN	Scottish and Southern Electricity Networks (SSE plc)
TDR	Time Domain Reflectometer
TJP	Transition Joint Pit / Terminal Junction Pit
TMS	Tether Management System
UAV	Unmanned Air Vehicle

UDL	Uniformly Distributed Load
UXO	Unexploded Ordnance
WD	Water Depth

1.0 Introduction and Background

1.1 Introduction

Scottish Hydro Electric Power Distributions (SHEPD) has contracted Global Marine Group to install a replacement 11kV circuit between Mull and Coll. Figure 1 outlines the location of the route in red.

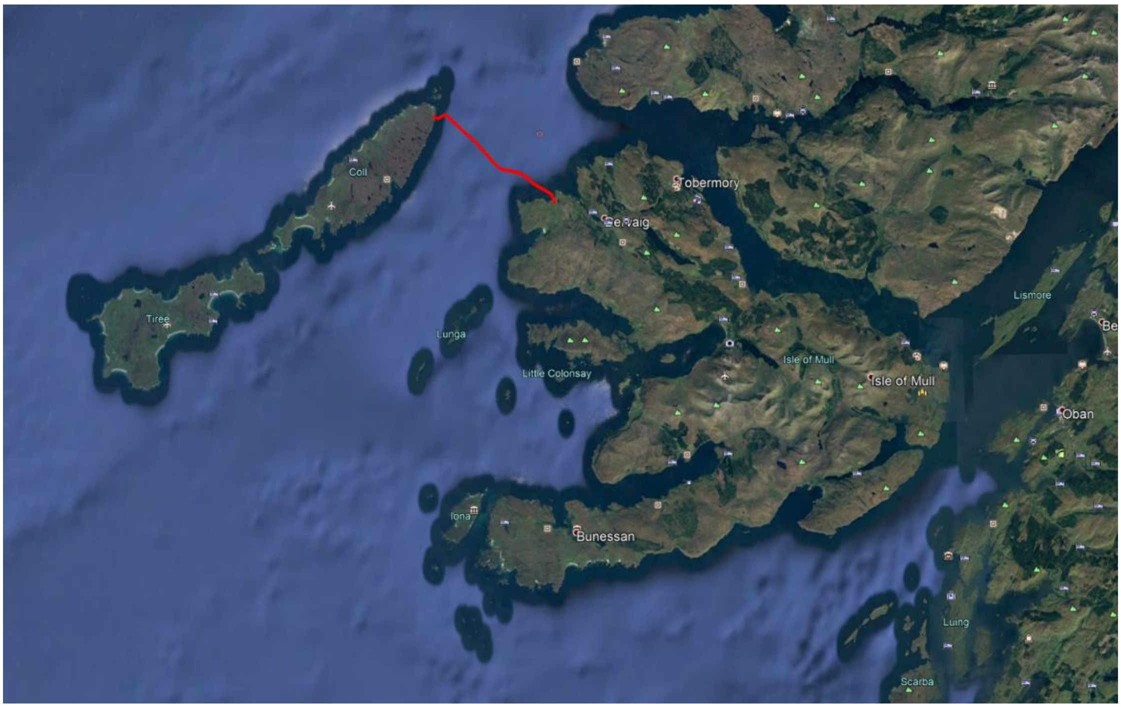


Figure 1: Route Overview

The existing 11kV circuit connects the Island of Coll to the wider power distribution network and has been identified as being at the end of its operational life. A project has been established to replace the existing circuit.

This operation now requires consent for the cable installation operations and as such a 500m corridor centred on the proposed RPL is being sought. Figure 2 shows the planned route in yellow with the 500m consent application corridor.

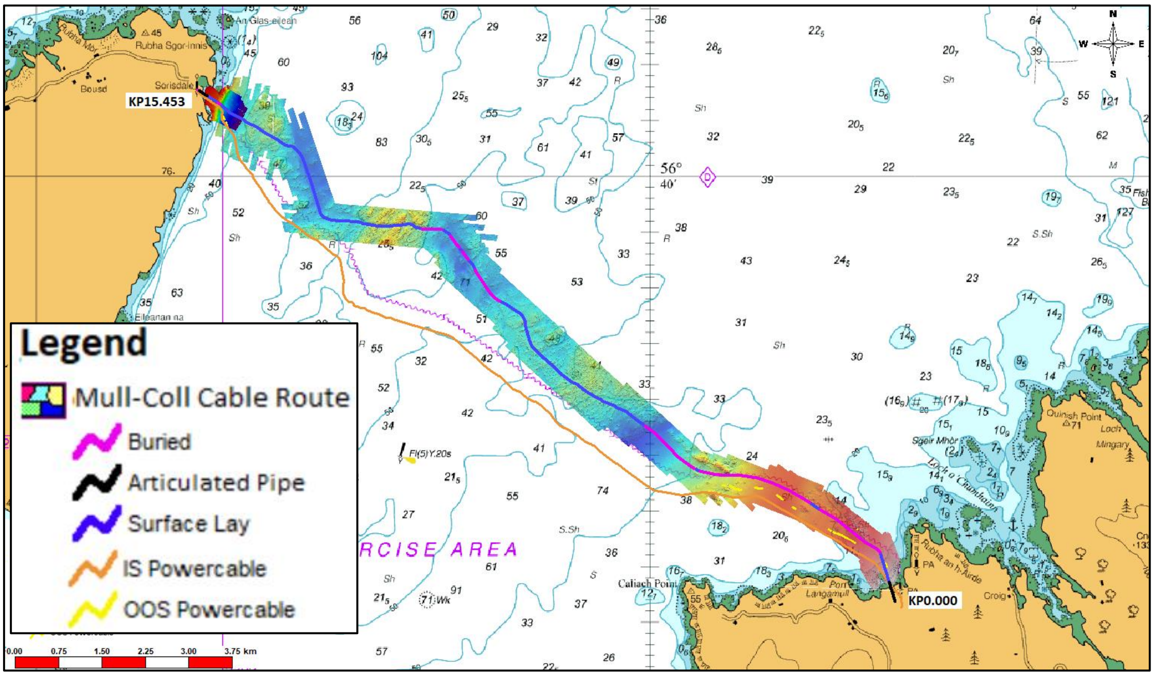


Figure 2: Mull - Coll Existing Routes

1.2 Overview of Scope of Work

The scope of work for the Cable Replacement Includes:

- Pre-Installation Surveys
- Landfall establishment
- Cable Installation
- Cable Protection and Stabilisation
- Post-Installation Surveys
- Landfall re-instatement

1.3 Project Key Dates

Table 1: M-C Operational Durations provides an overview of the anticipated durations for various stages of the project.

Mull-Coll – Task Durations	
Onshore Works	30 days
Offshore Works	36 days
Nearshore Works	14 days
Cable Pull-In	11 days
Re-instatement	7 days

Table 1: M-C Operational Durations

2.0 Pre-Installation Survey Works

Pre-installation survey works were undertaken from January to March 2021 and were split into marine and land based survey campaigns.

2.1 Marine Operations

The following were conducted as part of the marine surveys:

- High Resolution Geophysical Area Survey
- UXO Survey
- Geotechnical Survey
- Environmental Survey

The surveys required that the following equipment be mobilised:

Equipment used for Marine survey	
"MV Seeker" & "MV Valkyrie" 12m Inshore Survey Vessels 	"Fugro Frontier" 53m Offshore Survey vessel 
Multibeam echosounder	Side scan sonar
Sub-bottom profiler	Magnetometers (multiple)
Vibro Corer (3m)	CPT Rig (3m)
Grab Sampler	Subsea Camera

Table 2: Equipment used in Marine Survey

The Inshore vessels investigated a 500m wide geophysical survey corridor (+/- 250m of the RPL C/L) which couldn't be covered by the offshore vessel due to shallow water depths. The extent of the inshore survey was from close to the Mean Low Water Springs (MLWS) mark to the deeper waters where the Offshore vessel can safely access, approximately the 40m LAT contour.

The entire marine route was covered by a dedicated UXO survey, a 50m wide survey corridor (+/- 25m of the RPL C/L) from beach to beach. Again, the offshore vessel covered the operations in depths greater than 40m LAT.

Geotechnical sampling was conducted at areas of interest identified from the geophysical survey in order to assess where burial could potentially be achieved.

The environmental survey required an environmental specialist's review and assessment of the results of the geophysical data acquired as part of the selected cable route. As a result of this analysis any sites which identified the potential for the presence of habitats of sensitive or conservation interest were then selected for further drop-down video/stills imagery to verify the findings.

2.2 Land Based Operations

- Topographic
- UXO
- Geotechnical
- Environmental (Intertidal)

A traditional topographical (levels) survey was undertaken at all the landing sites. The corridor was defined as being +/- 125m from the proposed centre line and runs from MLWS to 200m behind the TJP.

Hand-held shallow geotechnical sampling was also undertaken along the profile of the cable on the beach/landing, at 25m intervals. This took the form of penetration tests to a depth of 3m or refusal using an auger, with no physical sample removed from the beach.

A 50m wide UXO survey (+/- 25m of the RPL C/L) was undertaken to complete the coverage from the closest approach of the nearshore vessel to 50m beyond the Transition Joint Pit (TJP), or inland to a safe location where overhead cables exist. This survey was conducted using a drone (UAV) solution and suspended magnetometers.

A shore/intertidal environmental survey was conducted during daylight hours at low water springs (or as close as possible). The survey was conducted by a shore walk with GPS and hand-held measuring quadrats, used to map all intertidal/beach habitats and quantify the benthic habitats, biotopes and any potential "Annex 1" habitats. Photographs were collected of representative quadrats.

2.3 Environmental data gathering

In addition to the Offshore and Land based surveys described above, environmental data was gathered using an Acoustic Doppler Current Profiler (ADCP).

One ADCP was deployed along the route for a minimum of 28days in order to gather current and wave data for the site. This data is required to perform on-bottom stability assessment for the cable and therefore allowed a further detailed engineering assessment of the cable protection methods and quantities required along the route. At the time of preparing the Marine Licence Application these studies are ongoing.

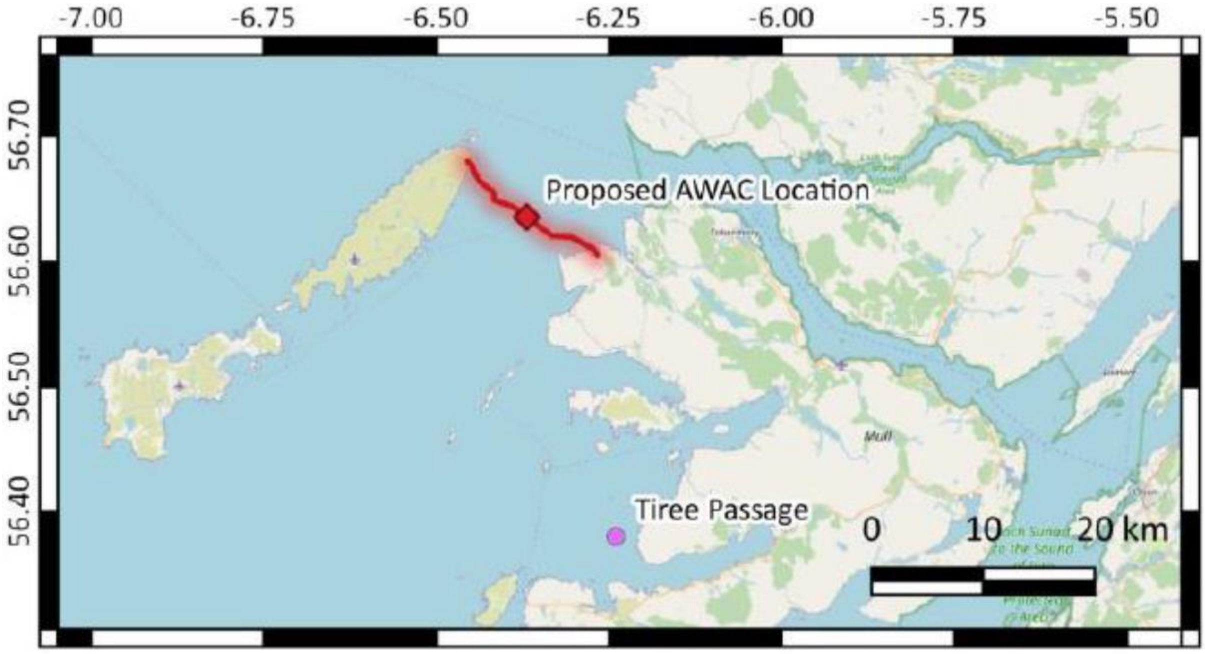


Figure 3: ADCP Deployment Location – Mull - Coll

Figure 4: Example of ADCP deployed inside protection frame

3.0 Cable Information and Load Out

3.1 Cable Construction

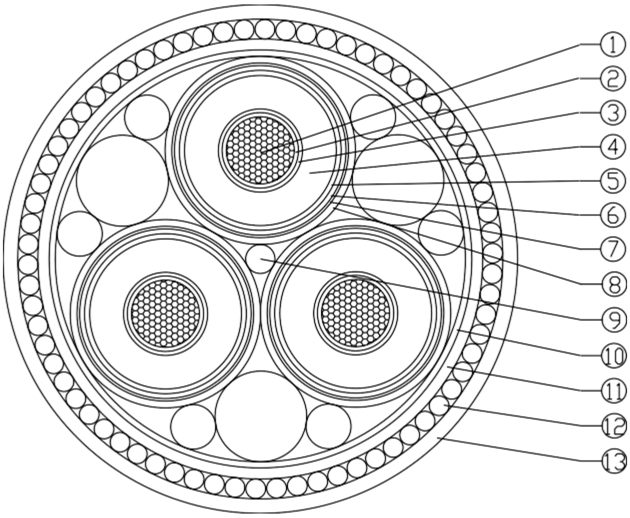
The cable to be installed will be a High Voltage Alternating Current (HVAC) submarine cable.

SHEPD will free-issue the cable conforming to the requirements in Table 3: Cable Specification.

TYPE	LENGTH (km)	DIAMETER (mm)	MBR (m)	Cable weight in air (kg/m)
3x95mm2 – SWA 11kV	16.5	103	2.5m (installation)	13.7

Table 3: Cable Specification

A cross section of the cable is provided in Figure 5: 3x95mm2 Cu 11kV power cable cross-section below:



1 - Copper round stranded compacted class 2 according to BS EN 60228 of nominal cross-section equal to 95 sq.mm, longitudinally water sealed.
2 - Semiconductive waterblocking tape (s) applied helically with overlap.
3 - Conductor non-metallic extruded screen: Extruded semiconducting compound with nominal thickness of 0.7 mm.
4 - Insulation: XLPE water-tree retardant type GP8 according to BS 6622, which satisfies the two years long duration test according to HD 605 Test No 5.4.15 (without 5.4.15.3.4.c)), of 3.4 mm min average thickness.
5 - Core non-metallic extruded screen: Extruded semiconducting compound firmly bonded to the insulation with nominal thickness of 0.8 mm. 6 - Semiconductive waterblocking tape(s) applied helically with overlap.
7 - Metallic screen and radial watertightness:
Cu/PE laminated tape of 0.2 mm copper nominal thickness, bonded to LLDPE sheath, longitudinally applied with overlap.
8 - Sheath: LLDPE of 1.6 mm min average thickness. Sheath colour: Black
9 - Non-hygroscopic fillers at the interstices between cores in order to give the cable a circular cross-section. 10 - Binding tape (one or two at manufacturer's option) helically applied with overlap.
11 - One layer of polypropylene yarns of approximate thickness of 1 mm.
12 - Armour consisting of one layer of helically applied bitumen compounded galvanized round steel wires of grade 34, class A, 6.0±0.09 mm diameter, according to EN 10257-2.
13 - Two layers of polypropylene yarns with total approximate thickness of 3.0 mm. Over the inner (first) layer bitumen is applied. Over the outer (Second) layer no bitumen is applied, but after winding of cable some bitumen will be transferred to the outer layer too.

Figure 5: 3x95mm2 Cu 11kV power cable cross-section

4.0 Vessel and Equipment Specifications

Global Marine operates a fleet of vessels that are regulated under SOLAS and which are all required to comply with the ISM Code. Global Marine's Safety Management System ensures compliance with mandatory fleet rules and regulations and that applicable codes, guidelines and standards recommended by Administrations, Classification Societies and maritime industry organisations are met appropriately.

During the immediate lead-up to the project Global Marine will issue the Notice to Mariners and complete updates to the Kingfisher Fortnightly Bulletin.

4.1 Cable Lay Vessel (CLV)

The Global Symphony, or similar, will be the main Cable Lay Vessel (CLV) of this project.

Figure 6: Global Symphony

The vessel is equipped with a McGregor Hydramarine "Active Boost" 150T AHC knuckle-boom crane capable of subsea lifts at 150Te in single fall mode down to 3,000m as well as two FCV3000 Work Class ROVs located within ROV garages of the vessel superstructure.

ITEM	DESCRIPTION
Type	DP Class 2
Gross Tonnage	11,324te
Dimension – Length (a/o)	130.2m
Dimension – Beam	24m
Draft	7.5m
PoB (Max.)	105

Table 4: Global Symphony Characteristics

Figure 7: Global Symphony Back Deck

4.2 FCV3000 Work Class ROV

The FCV3000 is a capable 3000msw rated modern work class ROV. The ROV will be used for Touch Down Monitoring (TDM) throughout cable lay operations as well as any subsea intervention works and post lay survey.

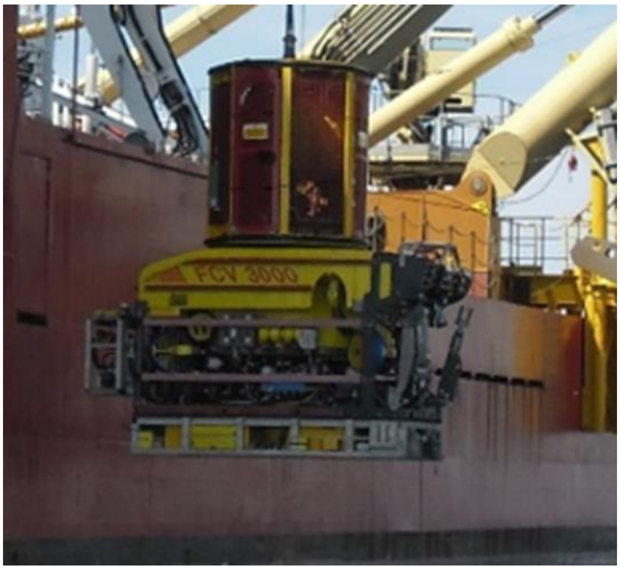


Figure 8: FCV3000 Deployment

ITEM	DESCRIPTION
Type	FCV3000 (150HP)
Length	3.3m
Height	1.7m (exc. TMS)
Width	1.7m (exc. TMS)
Weight	4.1te (inc. 400kg payload)

Table 5: FCV3000 Specifications

4.3 Cable Protection and Stabilisation Installation Vessel

Upon completion of the cable installation campaign, there may be a requirement to install some cable protection. This may include a combination of concrete mattresses and rock bags. Details of these methods are described in Section 5.1 and Section 6.4.6 below. The final quantity of protection and stabilisation to install will dictate the type of vessel that may be used.

It is likely that the bulk of the installation will take place form a DP Class 2 vessel. Specifications of this vessel would be comparable to that of the Global Symphony as described in Section 4.1 above.

For locations where a DP Class 2 vessel cannot access due to water depth restrictions, a Multicat vessel would be used. Details of such a vessel can be found in Section 4.12 below.

4.4 Rock Placement Vessel

Rock placement may also be used to protect the cable and in such cases a rock placement campaign may be considered using a DP2 vessel.

The below vessel is an example of a Fall Pipe Vessel that could be used.

Figure 9: FPV Flintstone

ITEM	DESCRIPTION
Type	DP Class 2
Gross Tonnage	21,710te
Dimension – Length (a/o)	154.6m
Dimension – Beam	32.2m
Draft (fully loaded)	7.74m

Table 6: FPV Specifications

The above example is a Fall Pipe Vessel capable of accurately placing rock in water depths up to 2000m. The FPV carried rock within its high capacity hoppers and is able to place these on the seabed in order to protect cable from subsea activity. The Fall pipe is manoeuvred similar to an ROV is and can track the cable position cable tracking systems to ensure that the rock placement is accurate.

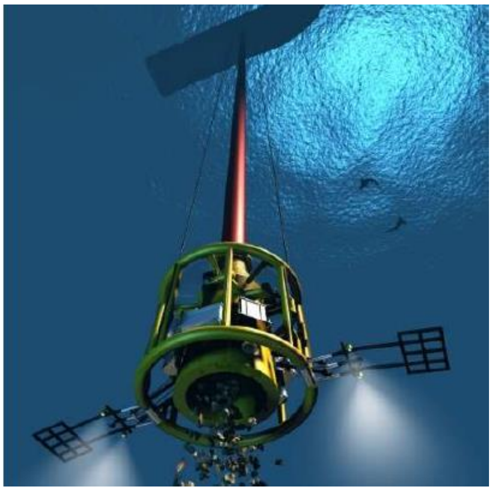


Figure 10: Fall Pipe

4.5 Onshore installation and Excavation

The excavation works at the TJP and landfall will be carried out with the aid of a 13Te LGP tracked excavator.

Figure 11: Example 13te LGP Excavator

4.6 Tracked Winch

Pull-Ins will be performed using a tracked 10Te constant tension capstan winch which has an electronic cable recording device which can be downloaded as evidence of the cable pull tensions. The winch will self-tracked into place to ensure the allowable over pull is considered. The winch will be anchored back using certified anchor chains and pinned anchor blocks.

Figure 12: Tracked 10Te Bull Wheel Winch

4.7 Quadrant and Beach Rollers

Various cable quadrants will be used on the beach along with pipe cradle lifters to securely handle the cable to shore and into the excavated trench.

Figure 13: Example of the Beach Quadrant Layout during pull-in

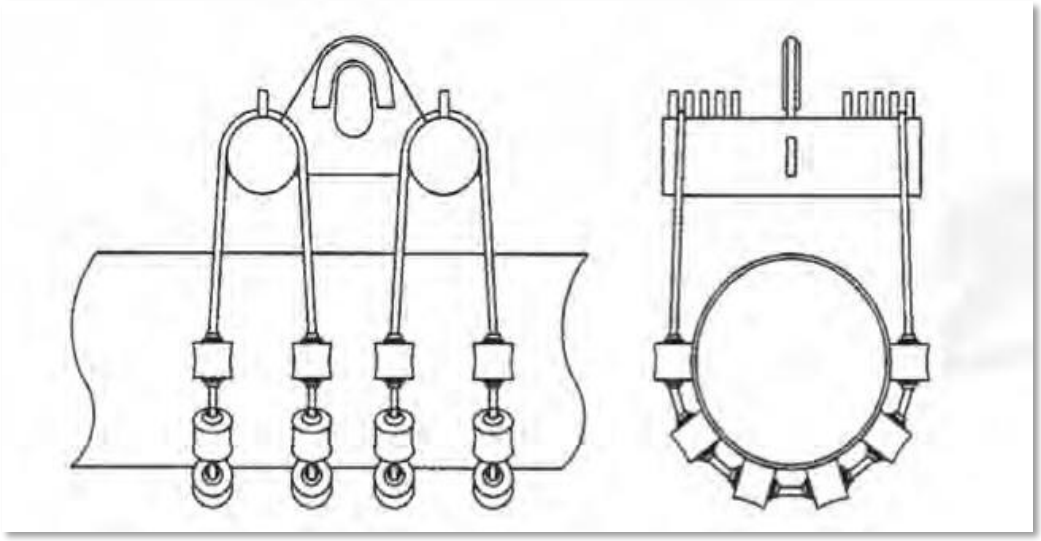


Figure 14: Pipe Cradle Lifter

4.8 Cable Bollard

A survey team will accurately mark out the onshore cable pull-in route and positions of the cable handling equipment such as bollards, excavator, rollers, quadrants and skid steer winch.

The Bollard Roller shall be positioned on the RPL at the Landfall and will ensure that pull-in alignment is maintained.

An excavator with sheave block shall be in position adjacent to the Bollard Roller to ensure a smooth cable transition from floating to shore/ onshore roller. Divers shall also remove cable buoyancy from the cable prior to the cable reaching the Bollard Roller.

Figure 15: Bollard Roller

4.9 Survey / ROV and Safety Boats

Safety Boat 'Delta 9151' or similar would be used to transfer the pull-in wire from shore to shore or from shore to MLV, where applicable.

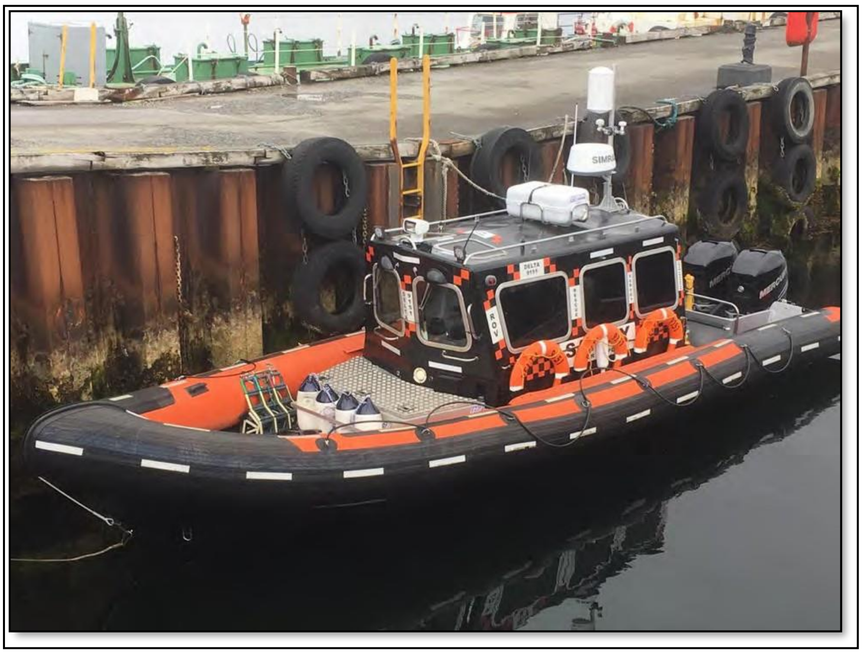


Figure 16: Delta 9151 Safety Boat

ITEM	DESCRIPTION
Type	RHIB
Category	MCA Cat 3 (20 miles)
Dimension – Length (a/o)	9.151m
Dimension – Beam	2.75m
Draft	0.5m
Top Speed	50 knts
PoB (Max.)	2 crew + 6 pax.

Table 7: General Specification of Delta 9151 Safety Boat

4.10 Work Boat – Speedbird One

Work Boat 'Speedbird One' or similar would perform Safety Boat, Diver and project and cable support works.

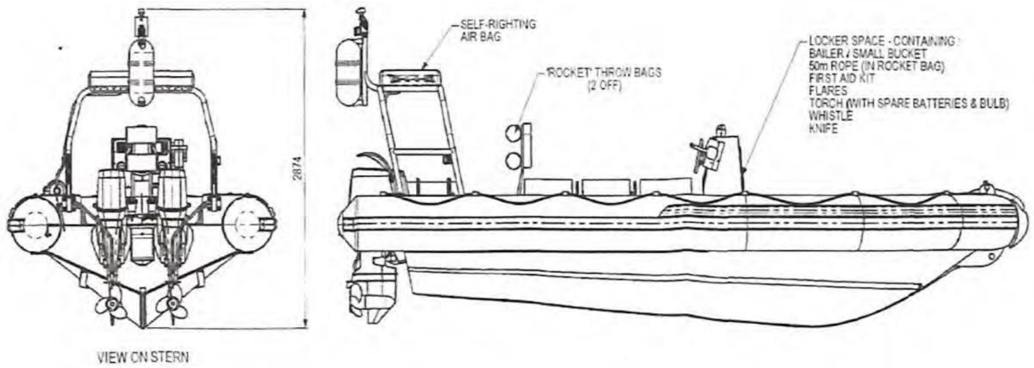


Figure 17: Speedbird One Workboat

ITEM	DESCRIPTION
Type	RHIB
Category	MCA Cat 3 (20 miles)
Dimension – Length (a/o)	8.6m
Dimension – Beam	2.13m
Draft	0.5m
Top Speed	25/30 knts

Table 8: General Specification of Speedbird One Workboat

4.11 Work Boat – UR 101

Work Boat '101' is would perform Safety Boat, Diver and project and cable support works.

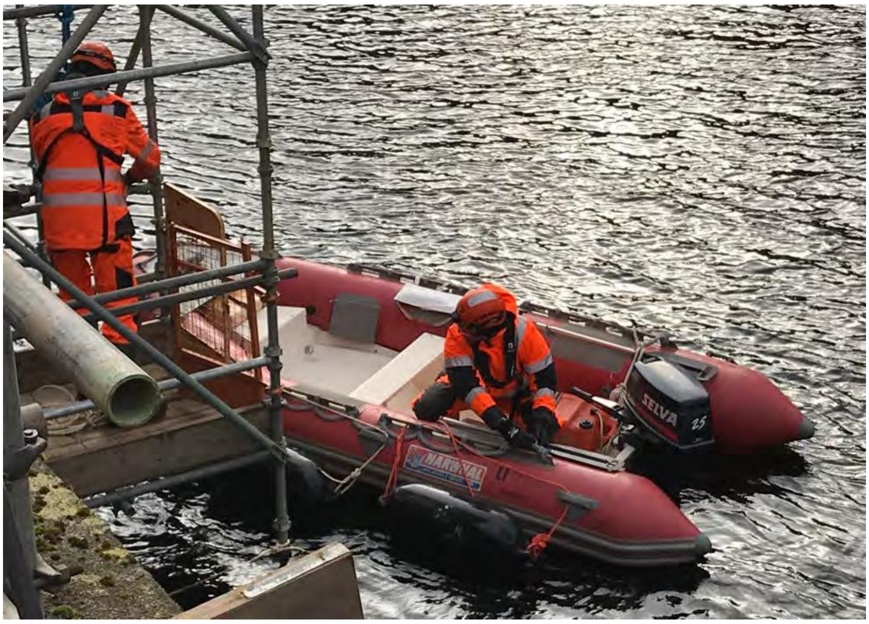


Figure 18: UR 101 Workboat

ITEM	DESCRIPTION
Type	RHIB
Dimension – Length (a/o)	4.0m
Dimension – Beam	1.0m
Draft	0.4m
Weight (Fully Equipped)	0.5te
Top Speed	25 knts

Table 9: General Specification of UR 101 Workboat

4.12 Trenching and Diving Multicat

A Multicat similar to the 'C-Odyssey' below shall be used as the Trenching and Dive Support Vessel for the nearshore cable installation and lowering works at each landfall site. The vessel shall be mobilised with a shallow water trenching tool spread along with a Diving spread.

Figure 19: Example Multicat

ITEM	DESCRIPTION
Type	Multiworker Twenty6
Built	2011
Category	MCA Cat 1 (150 miles)
Dimension – Length (a/o)	26m
Dimension – Beam	10.5m
Draft	2.5m
Free Deck Space	120m2
Passenger	12 (plus crew)
Gross Tonnage	150 GT

Table 10: General Specification of Multicat

4.13 Landing Craft – MV Challenge

A landing craft, similar to the below example, may be used to transfer plant and equipment from one work location to another. This would take place in regions where availability of local public transport and services fall short of project requirement.

In tandem with the appropriate tide cycle, the shallow water landing craft shall be sailed to shore and conduct beach landings allowing subcontractors plant and equipment to be loaded onboard. With the next favourable tide in place, the Shallow Water Landing Craft shall re-float float and shall make sail to the next work location.

Figure 20:Landing Craft

ITEM	DESCRIPTION
Type	Landing Craft
Category	MCA Cat 3 (20 miles)
Dimension – Length (a/o)	14.4m
Dimension – Beam	4.26m
Draft	1.44m
Deck Area	10m x 4.2m
Deck Cargo	10te
Passenger	2 (plus 6 crew)
Gross Tonnage	15 GT

Table 11: General Description of Landing Craft

5.0 Cable Protection and Stabilisation Plan

5.1 Overview

Offshore and Onshore surveys have been completed as per Section 2.0. Additional onsite environmental data was also gathered in late Q1 2021 using an Acoustic Doppler Current Profiler (ADCP) system. This, coupled with meto ocean data, allows for a further detailed assessment of the Cable protection methods to be deployed.

A Cable Protection and Stabilisation Plan (CPSP) has been developed as part of the Marine License application, see Table 12: Cable Protection and Stabilisation Plan below.

The CPSP conservatively outlines the number of deposits required and is the basis of the assessment made in the Environmental Supporting Information.

Engineering studies are ongoing which may reduce the number of deposits required and amend burial status assumptions.

KP From	KP To	Distance (m)	Description	Burial Status	Cable Protection Details
0.000	0.168	0.168	Mull TJB to LP	Buried	Buried by land based excavator, cable is housed in Articulated Pipe
0.168	0.182	0.014	LP to MLWS		
0.182	0.334	0.152	MLWS to End of AP	Surface Laid	Cable housed in Articulated Pipe over thin sandy veneer above rock and boulders. Cable crosses existing In-Service Mull-Coll power cable
0.334	0.853	0.519	End of AP to DSE	Surface Laid	Shallow Water burial could be possible with further analysis
0.853	2.097	1.244	Seabed	Buried	Cable buried by Jet Trenching ROV
2.097	2.305	0.208	Rock Outcrop with boulders	Surface Laid	Boulder Clearance by Picking & Cable Stabilised by Rock Bags at 90m spacings (1 x 2 off RB)
2.305	4.233	1.928	Seabed	Buried	Cable buried by Jet Trenching ROV
4.233	4.329	0.096	Boulders	Surface Laid	Boulder Clearance by Picking
4.329	5.432	1.103	Seabed	Buried	Cable buried by Jet Trenching ROV
5.432	8.750	3.318	Rock Outcrop with boulders	Surface Laid	Boulder Clearance by Picking & Cable Stabilised by Rock Bags at 90m spacings (32 x 2 off RB)
8.750	9.400	0.650	Seabed	Buried	Cable buried by Jet Trenching ROV
9.400	9.620	0.220	Rock Outcrop with boulders	Surface Laid	Boulder Clearance by Picking & Cable Stabilised by Rock Bags at 90m spacings (1 x 2 off RB)
9.620	9.790	0.170	Seabed with small sparse boulders	Buried	Cable buried by Jet Trenching ROV
9.790	9.874	0.084	Rock Outcrop with boulders	Surface Laid	Boulder Clearance by Picking
9.874	10.120	0.246	Seabed with small sparse boulders	Buried	Cable buried by Jet Trenching ROV

10.120	10.277	0.157	Rock Outcrop with boulders	Surface Laid	Cable Stabilised by Rock Bags at 80m spacings (1 x 2 off RB)
10.277	10.638	0.361	Seabed with small sparse boulders	Buried	Cable buried by Jet Trenching ROV
10.638	14.980	4.342	Rock Outcrop with gravel and boulders	Surface Laid	Boulder Clearance by Picking & Cable Stabilised by Rock Bags at 100m spacings (42 x 2 off RB)
14.980	15.058	0.078	Steep Seabed to DSE	Surface Laid	Cable on seabed
15.058	15.273	0.215	DSE to end AP	Surface Laid	Shallow Water burial could be possible with further analysis
15.273	15.339	0.066	End of AP to MLWS	Surface Laid	Cable housed in Articulated Pipe over rock and boulders. Route clearance by land-based excavator landward of MLWS.
15.339	15.348	0.009	MLWS to LP		
15.348	15.435	0.087	LP to start of grass coverage	Surface Laid	Cable housed in Articulated Pipe over rock and boulders. Route clearance by land-based excavator.
15.435	15.453	0.018	Start of grass coverage to Coll TJB	Buried	Limited burial by land-based excavator cable housed in Articulated Pipe

Table 12: Cable Protection and Stabilisation Plan

	Rock Bags		Articulated Pipe		Uraduct Protection		Concrete Mattress		Grout Bag	
	154	bags	514	m	514	m	77	mats	30	bags
+20% contingency	**185**	**bags**	**617**	**m**	**617**	**m**	**93**	**mats**	**36**	**bags**

Table 13: Cable Protection Quantity Summary

	Surface Laid (km)	Buried (km)
Length	9.565	5.888
% of Route	62	38

Table 14: Cable Burial Summary

Maximum Rock Placement Volume (m^3)*	
Rock Placement Volume	58,975
+50% Contingency	88,463

Table 15: Maximum Rock Placement Volume

***Note:** With respect to rock placement, the berm is based on being required along the length of cable that could be Surface Laid whilst at the same time still being accessible by a Rock Dump Vessel. The resulting length of the route that could result in rock placement has therefore been considered to be 8.425km, 54% of the cable route.

A 50% contingency is added to the total rock volume in order to account for any settlement of the rock berm into the seabed following installation.

It should be noted that the above values are considered with reference to all date reviewed to date. Further data gathering is still ongoing and may require that these figures be updated.

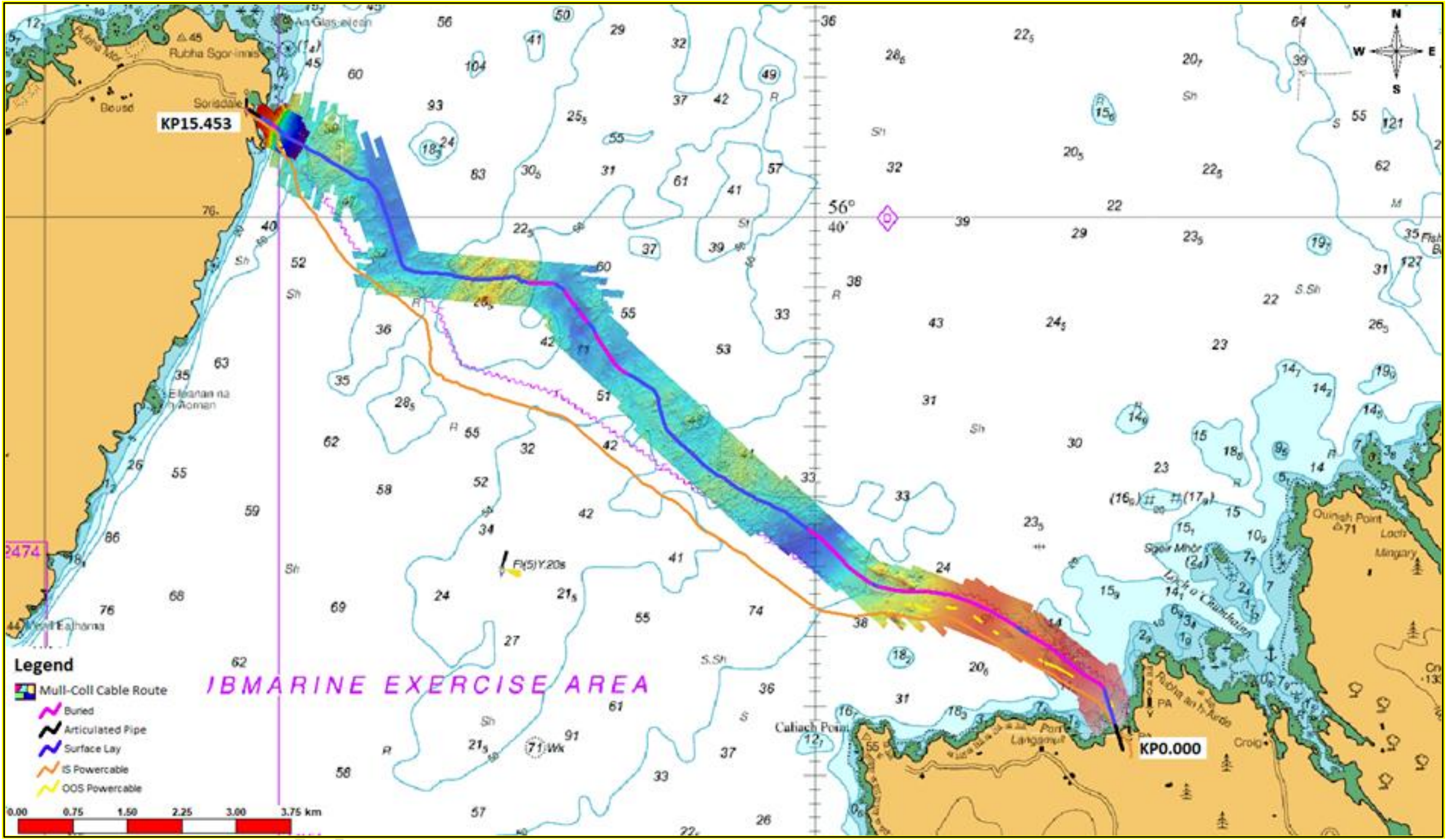


Figure 21: Cable Burial Graphic

5.2 Cable Protection and Stabilisation – Cost Benefit Analysis

Please refer to the supporting Cost Benefit Analysis and summary document.

6.0 Project Description

6.1 Proposed Route

6.1.1 Routing Decision Making Process

The primary routeing concern for the Mull-Coll cable has been the avoidance of rocky outcrop, thus minimising interaction with steep slopes that are present in these areas. This helps to maximise the potential for burial along as much of the route as possible. The existing in-service Mull-Coll power cable is crossed once in the nearshore region, and remains south of the new route until the cables meet again at the terminal pole at Coll.

The LP at Mull was chosen as there are two existing cables within the bay, and so the site has infrastructure such as the TJP and transmission network already in place. There is space to bring the new cable into either landing; however, the preferred landing is the gully to the southwest of the existing in-service cable. The site also has access from the B8073 road.

The LP at Coll was chosen for similar reasons to those at Mull, in that the new cable can share facilities with the existing cables that currently land at the site. No nearshore crossing with the existing in-service power cable is required and a separation of approximately 50m is maintained between the new and existing cables in the approaches to the LP.

6.1.2 Route Description

The Mull-Coll cable begins at KP0.00 which marks the location of the TJP. From here the cable is routed straight north-northwest at a bearing of 338.682° and after 396m the LP is reached. Just prior to this the cable crosses the existing in-service Mull-Coll power cable at approximately KP0.302. The new cable then remains to the north of the existing cable from this point on. Still heading at the same bearing, the LP as depicted on admiralty charts is at KP0.445 and the 13m WD contour is reached at KP0.935. This denotes the closest approach point of the cable ship. Shortly after, two alter courses with radii of 100m and 500m align the cable through a gully in the first rock outcrop encountered along the route, identified from UKHO bathymetry survey data. The exact location of the OOS cable will be determined from the route survey operations. A further series of alter courses manoeuvre the cable between some minor areas of undulating bathymetry before an extensive region of rock outcrop is reached at around KP5.5. Up to this point the seabed appears to be mostly smooth, sandy and relatively benign, thus the potential for good burial is anticipated.

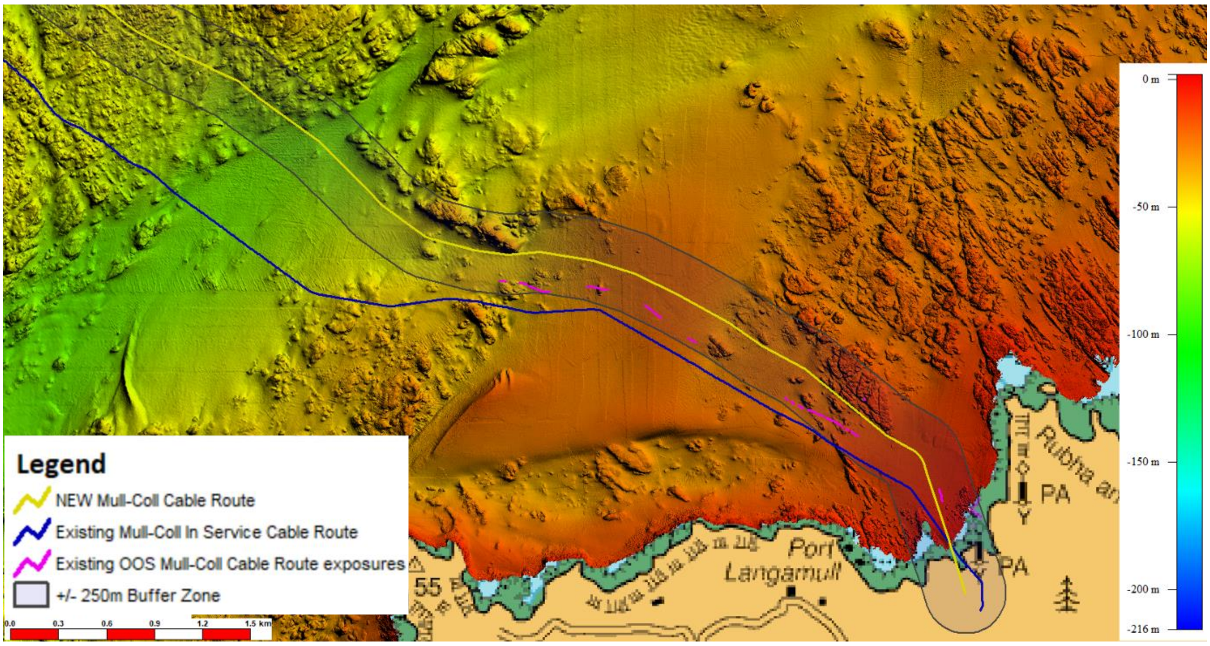


Figure 22: Mull-Coll cable route from Mull power pole to ~KP5.5

From KP5.5 to KP10.7 the cable is routed across substantial rock outcrop in water depths ranging from around 50-70m. UKHO bathymetry and slope survey data has been used to engineer the flattest route through this region, avoiding steep slopes and utilising gullies in the outcropping rock where possible.

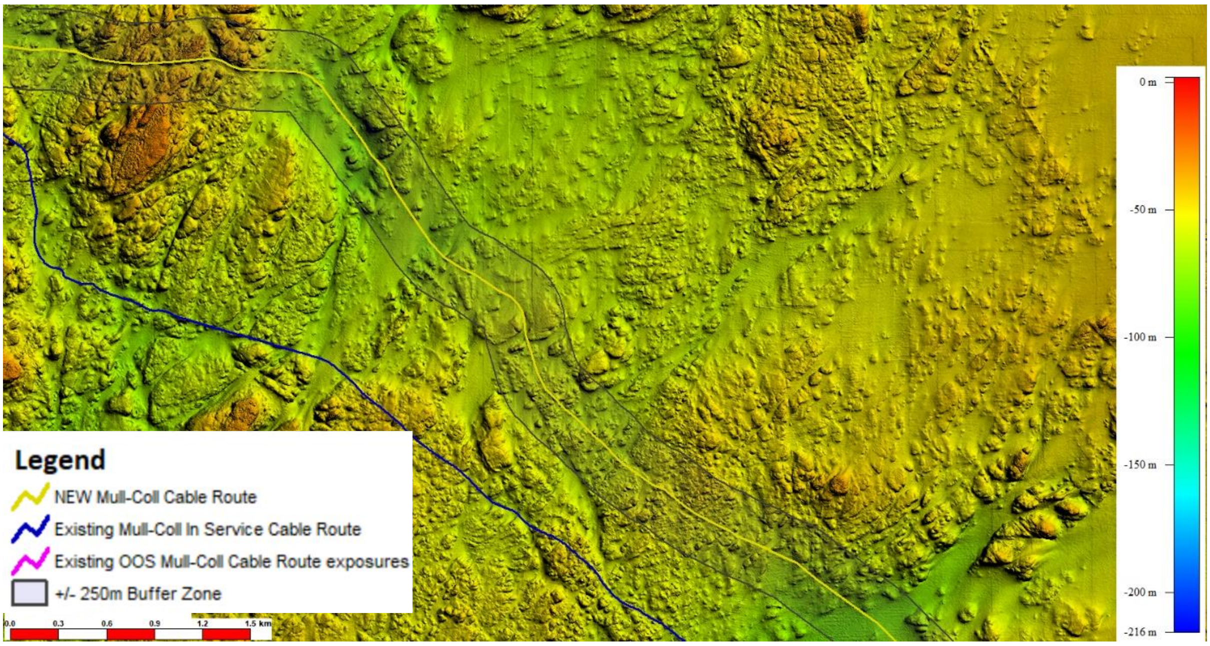


Figure 23: Mull-Coll cable route from ~KP5.5 to ~KP10.5

At around KP9.9, the cable begins to alter course from a northwest to a westerly direction to route through a narrow gully approximately 20m wide, entering at around KP10.75 for 1km (Figure 24). Still heading in a westerly direction, a series of alter courses route the cable around several steep gradients before heading north-northwest for approximately 900m at a bearing of 341.358°. This section of seabed is relatively smooth with little in the way of rock outcropping and the potential for burial is again anticipated.

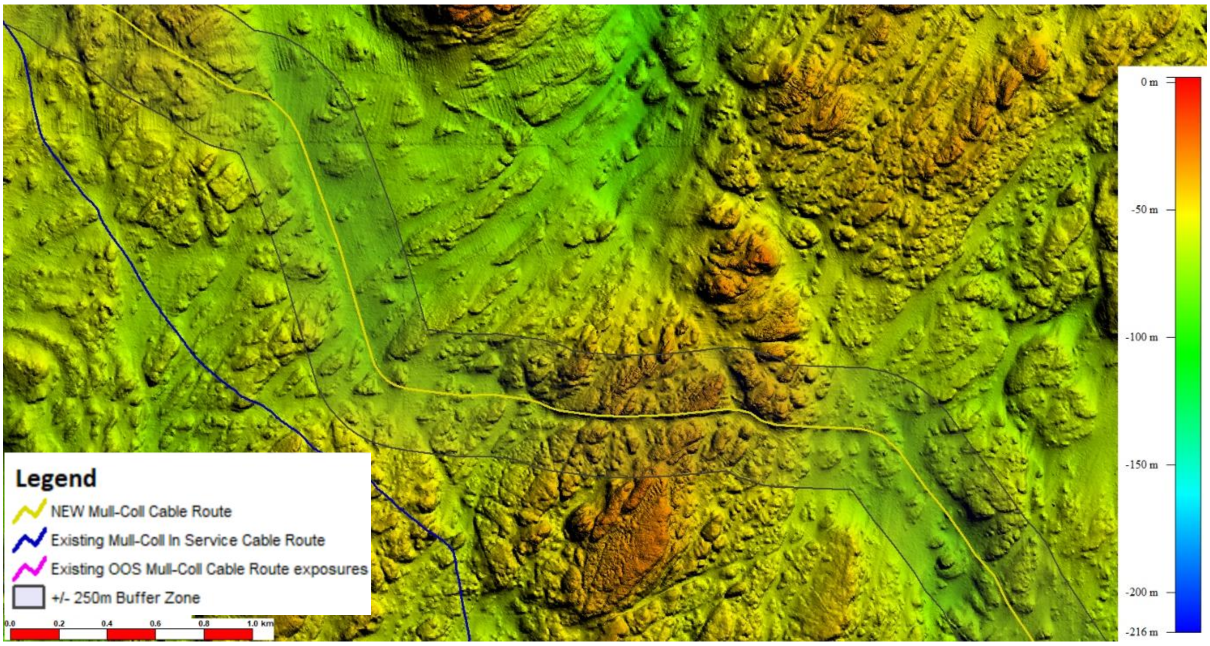


Figure 24: Mull-Coll cable route though gully at ~KP10.75 to ~KP13.00

From here the cable makes its last turn 500m in radius to line up with the approach to the shore end with a bearing of 301.548°. A patch of rocky outcrop is unavoidably crossed for a distance of around 800m. At around KP14.7 in water depths of 57m, the seabed begins to rise rapidly and the 13m WD contour marking the direct shore end is located at approximately KP15.083. Around 300m later the LP is reached. The TJP at KP15.464 marks the end of the cable route.

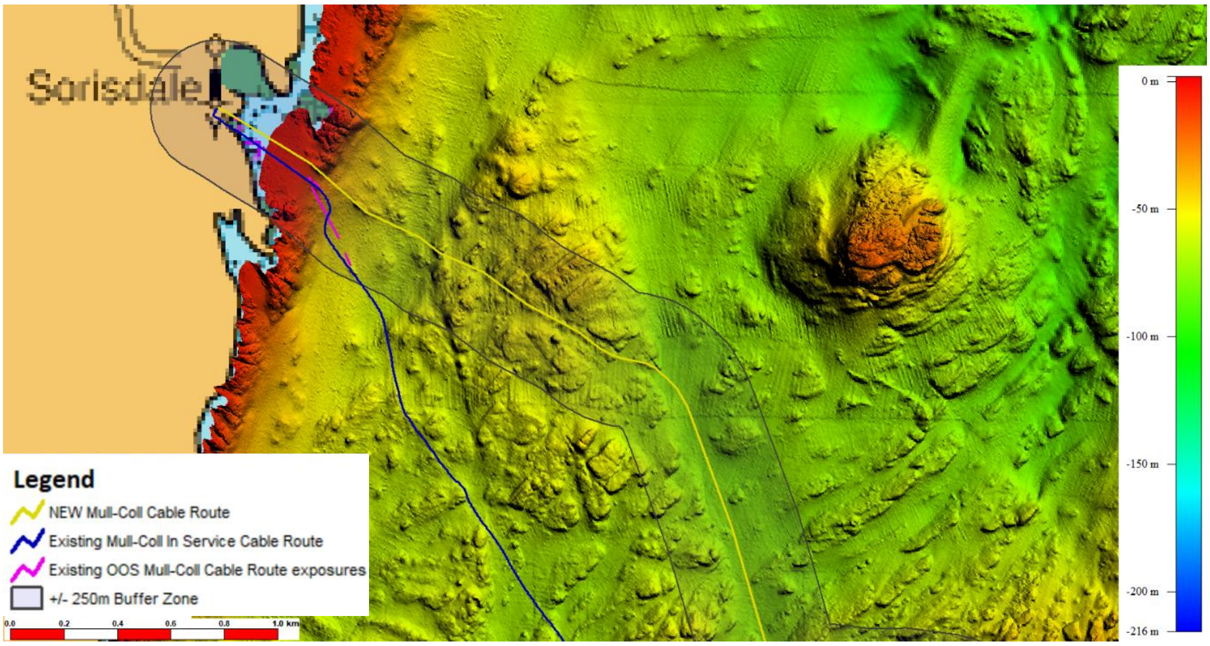


Figure 25: Mull-Coll cable route from ~KP13.00 to Coll power pole (KP15.598)

6.1.3 Route Profile

The below Figure 26 illustrates the route profile for the replacement cable route.

At its deepest, the route reaches c.75m.

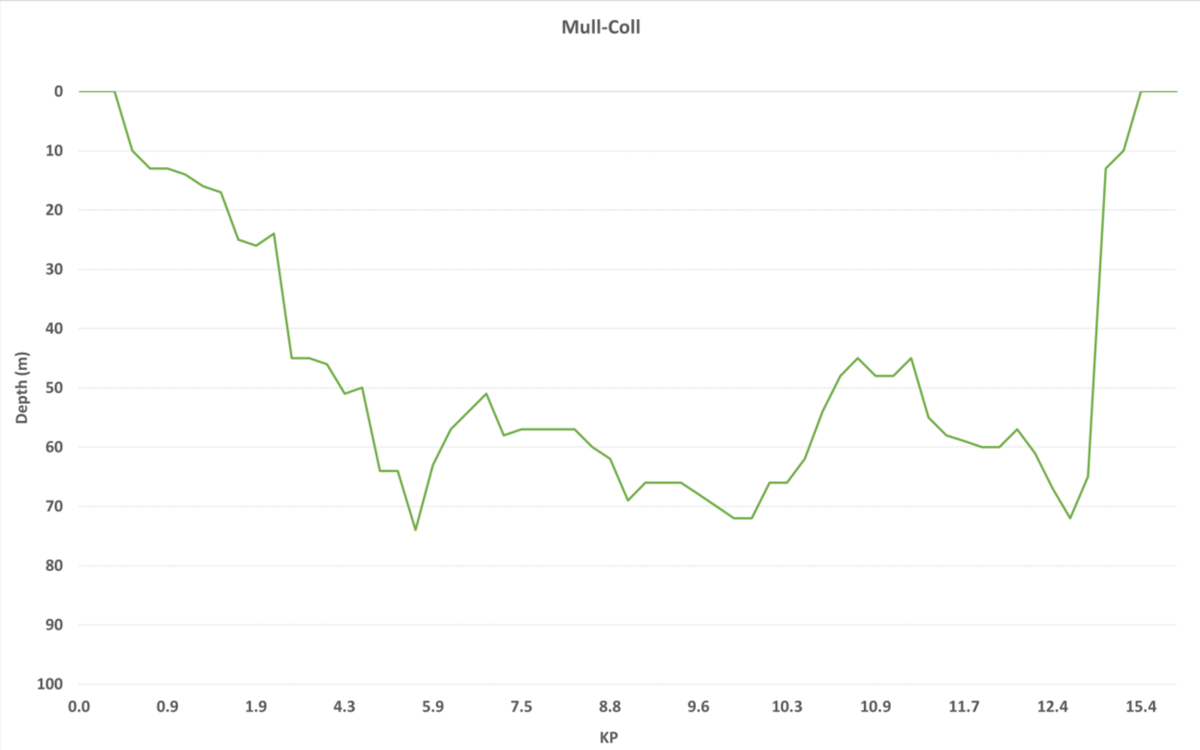


Figure 26: Bathymetry profile along proposed Mull-Coll cable route

6.2 Landfall Preparations

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

- Site setup, including fencing, signage, welfare units etc.;
- Landfall drone survey and site walkover;
- Nearshore visual survey;
- Excavation works along landfall cable route from MLWS to the TJB; and
- Cable pull-in preparation, including cable rollers, quadrants winches etc

6.2.1 Access to Site

Access to the TJP will be via public roads and paths. Where access via public routes are not possible, permissions from landowners have been agreed and will be used throughout the temporary engineering works. All land will be re-instated after completion of the engineering works.

6.2.2 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 flammable materials;
- Compound lighting where work is required to be undertaken in low light levels;
- An area designated for waste and waste recycling skips, with clear signs to indicate the waste segregation requirements of each container or skip.

The site shall have a traffic management plan in order 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.

120 Liter Spill Kits at each site

Machine Nappies to protect from leaks

Figure 27: 120L Spill Kits and Machine Nappy Trays

6.2.3 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, for clarity this will be above MHWS.

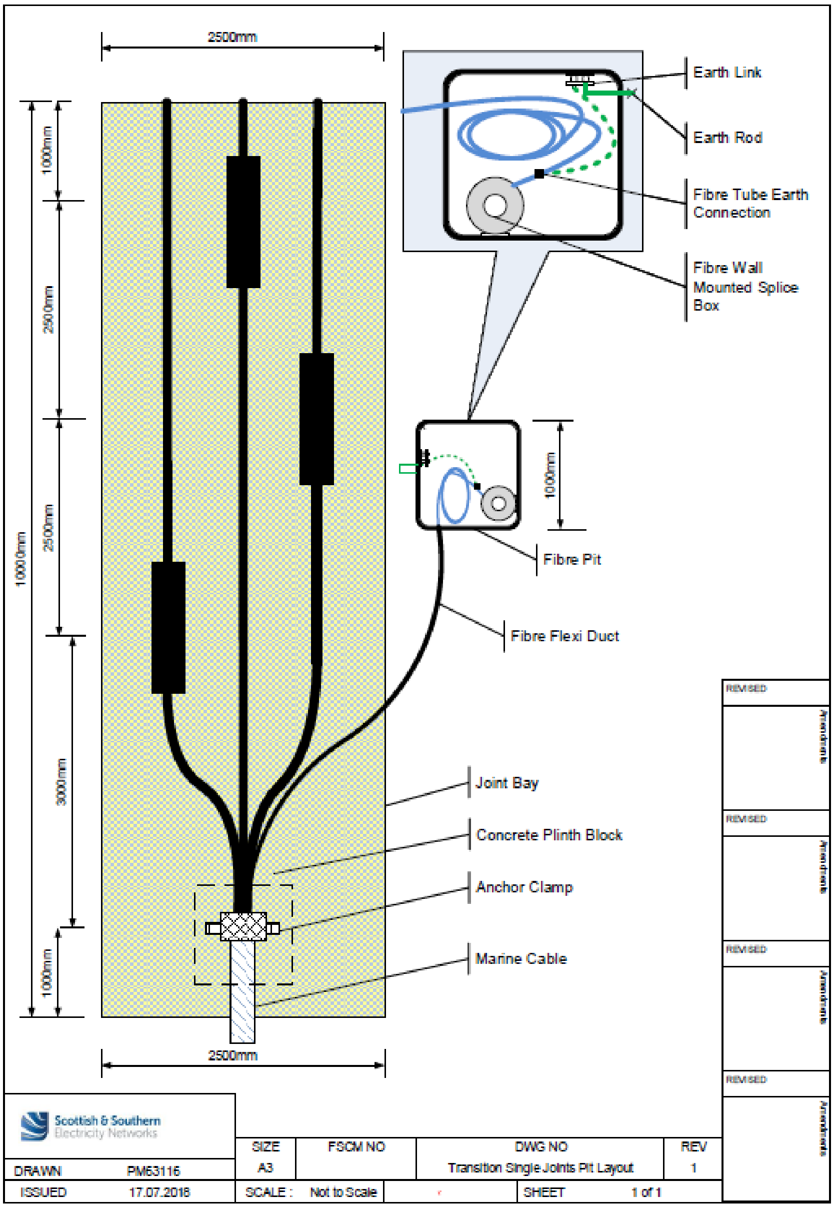


Figure 28: SSEN provided TJP plan

Figure 29: TJP final layout (example)

6.3 Earthing Protection

A Sea Earth may be installed in order to provide protection from surges and lightning strikes to the electrical circuit provided by the newly installed Mull-Coll cable.

A sea earth could be installed at the either landfall. The Sea Earth would consist of up to two bare copper earth wires (c.1kg/m) at each landfall, typically 95mm², and be installed around the TJB perimeter and connected to the outer marine cable armour wire which has been terminated on the anchor clamp within the TJB. It would also be connected to the metallic elements of the FO cable package within the joint housing.

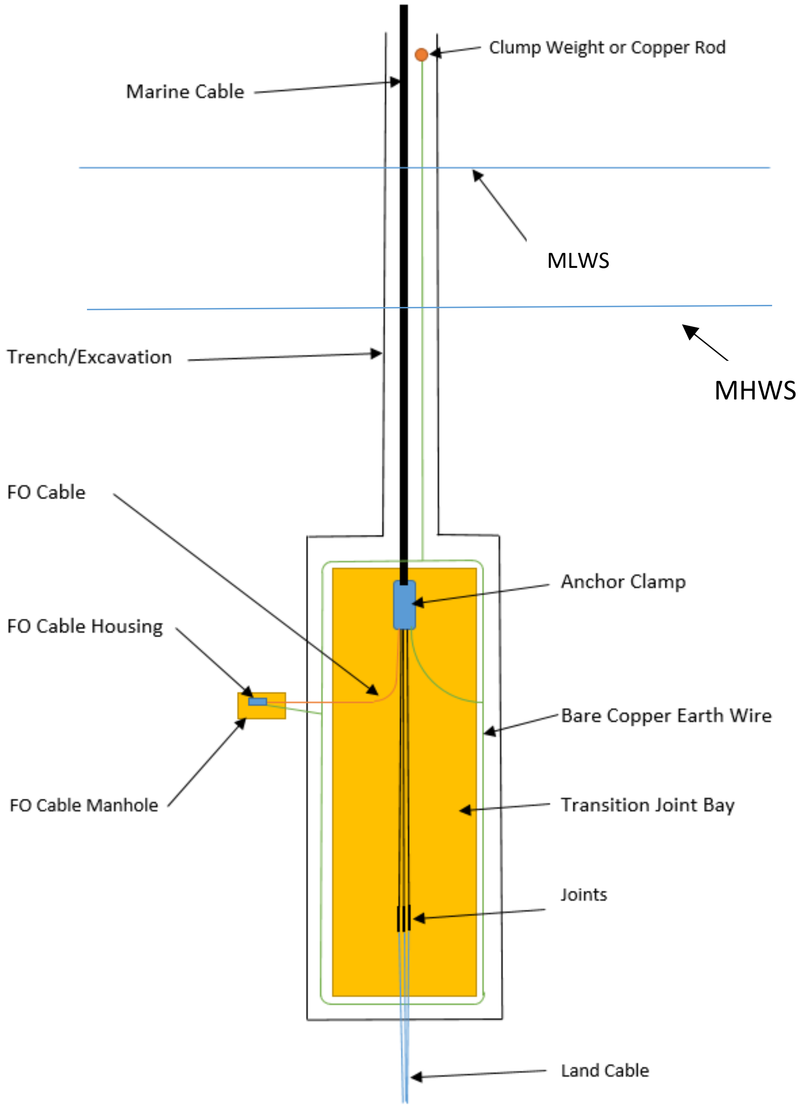


Figure 30: Sea Earth Schematic

The earth wire is typically installed into the same trench as the marine cable (although some cable manufactures may stipulate a separate trench) with a minimum separation of approx. 200mm. Should a separate trench be required, the trench would remain within the consented +/- 50m cable corridor. The sea earth would be trenched to a maximin depth of approx. 1.5m and a width of approx. 1m. Up to two trenches may be required at each landfall site. One containing the earth for the submarine cable and one for the fibre optic cable.

Figure 31: Bare Earth wire being installed in Subsea cable Trench

The length of the earth wires will vary between sites and the locations of the TJB but will have to be installed 30-50m beyond MLWS or deep enough to ensure the earth wire is always in sea water. At Coll this is anticipated to be approx 140m per trench from the TJB and at Miull this is anticipated to be approx 340m per trench from the TJB.

Depending on the landfall materials, either a clump weight or a copper rod will have the earth wire connected by either welding or crimping and will then be installed into the seabed below the surface. The copper rod would be approx. 12mm in diameter and up to 5m in length. The rod would be driven into the seabed and covered for protection. Where a copper rod cannot be used as an anchor to the earthing wire, a concrete clump weight with a pre-installed padeye may be used to anchor the earth wire. The concrete clump weight would have a footprint of approx. 1.0m diameter x 0.5m high and would be placed on the seabed.

	Bare Copper Wire		Concrete Clump Weight		Copper Earth Anchor	
Coll	**140m x 2 = 280m**	**95mm² wire @ 1kg/m = 280kg**	**1 per earth = 2**	**Up to 300kg each**	**5m length per earth = 10m**	**15kg / rod = 30kg**
Mull	**340m x 2 = 680m**	**95mm² wire @ 1kg/m = 680kg**	**1 per earth = 2**	**Up to 300kg each**	**5m length per earth = 10m**	**15kg / rod = 30kg**

Figure 32: Sea Earth Deposits

6.4 Proposed Marine Cable Installation Method

This section outlines the envelope of all potential marine cable installation activities for which consent is being requested. Note that the final methodology will be engineered following the results of the pre-installation survey operations and on completion of the On-Bottom Stability (OBS) and Cable Burial Risk Assessment (CBRA). The outline below is intended to give an overview of the options available to the installation of the Marine Cable.

6.4.1 Pre-Lay Debris Removal

Prior to lay operations commencing, a pre-lay survey will be conducted. The objective of the survey will be to:

- Identify and investigate possible debris;
- Identify any obstructions on the proposed route

Any obstructions or debris will be removed, if possible. A work class ROV or Pre-Lay Grapnel Run (PLGR) will be undertaken to remove debris from the proposed route. In the nearshore area, a diver may be required to remove debris. It is envisaged that natural debris found to obstruct the cable replacement operations will be moved away from the RPL by 20-30m. Any manmade debris will be removed from site and disposed of appropriately.

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 on-board Client Representative (CR) – at all times staying within the licensed installation corridor.

In areas where individual boulders require relocating, a subsea rock grab may be used.

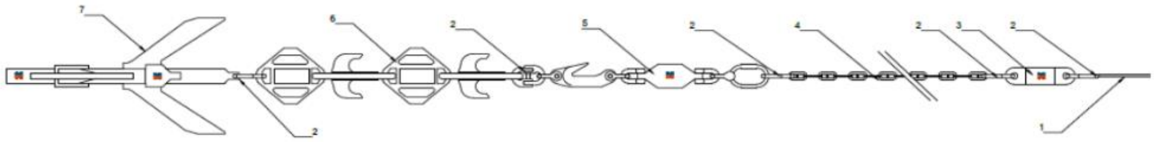
Figure 33: Subsea Rock/ Boulder Grab

The above example rock grab us a hydraulic powered grab operated form a deck HPU with downlines running form the vessel. The grab is located over a boulder/rock and lowered to seabed using a vessel crane. This type of grab usually has the capacity to recover or relocate boulders of up to 8te. Size of boulder to relocate or recover are dependant of the specification of the grab being used.

The grab can be deployed from the main CLV or from a smaller Multicat depending on location of intervention works. See Section 4.1 & Section 4.12 for details.

6.4.2 Pre-Lay Grapnel Run (PLGR)

A PLGR may be required to prepare the route where deemed appropriate. A typical grapnel train is shown below in Figure 34: Typical Grapnel Train. Multiple pre-lay grapnel runs both end to end and perpendicular to the route may be required within the licensed installation corridor as part of any route preparation activities, where appropriate.



	ITEM	QUANTITY	SWL	WEIGHT
1	VESSEL WINCH WIRE 48mm x 1000m	1	200TE	-
2	HAMMER LOCK	5	26TE	6Kg
3	BEARING SWIVEL	1	25TE	59Kg
4	Ø32MM CHAIN	Approx 7m	+25TE	-
5	GIFFORD TYPE HOOKS	1	13TE	240.4Kg
6	RENNIE TYPE HOOKS	1	13TE	237.2Kg
7	SLIDING PRONG GRAPNEL	1	13TE	223Kg

Figure 34: Typical Grapnel Train

6.4.3 First End Pull-In

Onshore preparation for the TJP and pull-in site at Coll shall be completed ahead of the CLV arriving to location, this will include beach quadrants, rollers, cable handling equipment and personnel. Equipment shall be accurately orientated and positioned via the use of handheld DGPS positioning devices.

Onshore pulling equipment will be set up and winch wire pulled though the TJP and winch wire flaked out on the beach to ensure there is enough available slack to hand over to the CLV.

The beach pull-in contractor shall use support craft to take the winch wire end towards the 'Hand Over Zone' located approximately 200m from the CLV stern. The wire between the beach and support craft will be fitted with clamped floats to reduce the weight of the wire whilst in the water. A second support craft will receive a messenger line from the CLV stern and transport it to the 'Hand Over Zone'. Here the connection between the main pull-in winch and messenger line is made.

Figure 35: Example Cable Support Vessel

Next, the support crafts shall move to a safe distance, clear of the messenger line and winch wire. The CLV shall then pick up in order to pull the main winch wire onto its back deck. The onshore team shall pay slave to the CLV during winch wire transfer. Once the winch wire in on the deck of the CLV, the messenger line is to be removed from the system and the winch wire connected to the cable pulling head with a suitably rated swivel between them. The onshore team will then be asked to take up any remaining slack in the system by picking up on the main pull-in winch.

All parties involved in the operation will be advised of the intention to commence the pull-in and confirm their readiness to commence. The CLV shall be master throughout the operations, with the onshore team acting as slave. The CLV will install pillow floats, and any pipe shells or any other cable protection that may be required, onto the cable as it is deployed over the vessel stern. The pillow floats will reduce the weight of the cable in the water and therefore reduce the required pull-in tensions. The floats will be removed by support craft / divers support teams as the cable settles onto the cable rollers positioned on the beach. The floats will be collected and stored on the beach for re-use and will not be discarded locally.

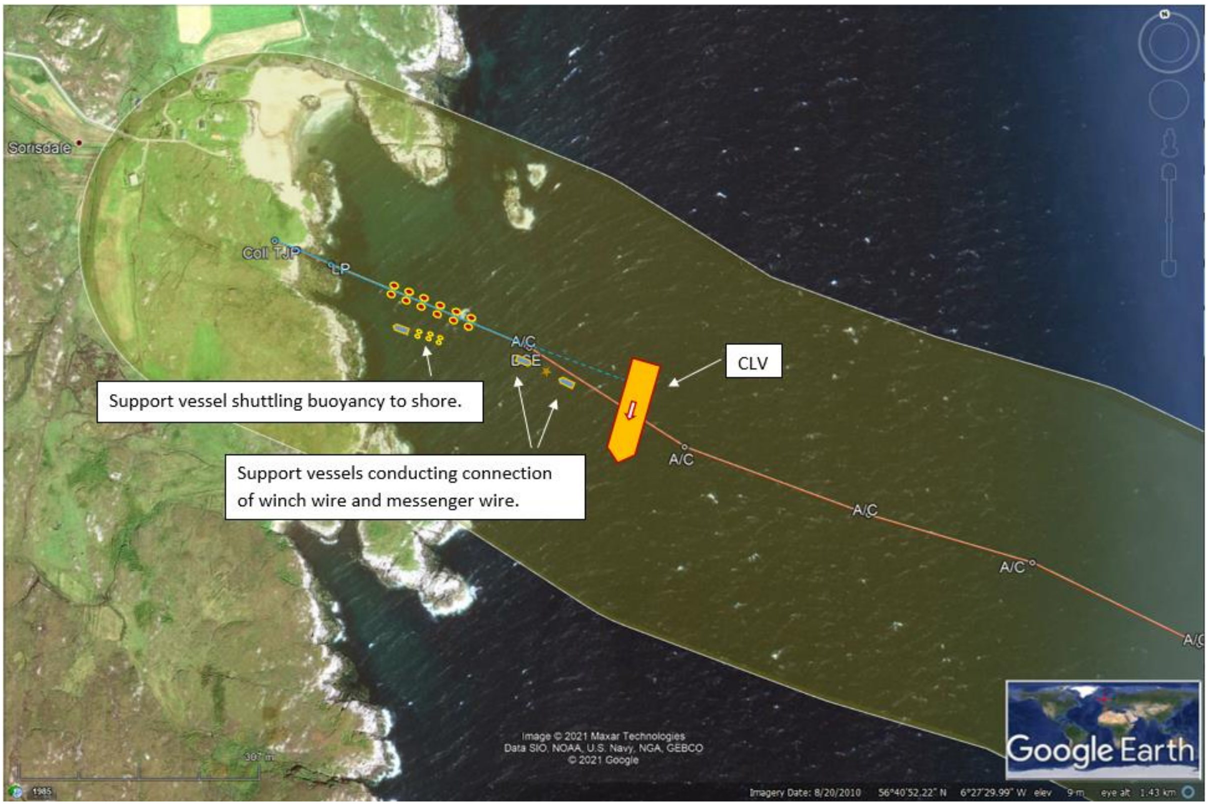


Figure 36: 1st End Pull-In Overview

An excavator will be used at the beach location to support the cable end into and quadrant handling equipment of TJP entry as required. The cable end will be visually monitored throughout the pull-in operations as it reached the TJP and beyond. The cable will be pulled passed the TJP to an agreed point approximately 20m beyond the TJP. The cable tension will then be relaxed and secured into the TJP to avoid any uncontrolled cable movements. The pull-in contractor dive team will then remove any remaining pillow floats and sink the cable onto the RPL.

With the cable in position, and offshore survey will take place at MHWS and the onshore survey at MLWS using a handheld DGPS. This will create an overlap in date to stitch together.

It should be noted that that the cable pull-in at the Coll location will take place close to an in-service 11kV subsea cable. The newly installed cable will be positioned a safe distance from the existing cable in line with SSEN requirements.

6.4.4 Cable Lay Operations

Once the cable is successfully pulled to its required position onshore, surface swimmers will gradually remove the buoyancy units allowing the cable to come to rest on the seafloor.

Once all buoyancy units have been removed, the CLV will commence laying the cable on the seabed from the First end to the Second end. The CLV will be a DP2 Class vessel and expected cable laying speed will be between 200 m/h and 450 m/h.

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; expected lay tensions are between 10 kN and 20 kN.

Monitoring of the cable's touchdown point on the seabed, which is expected to be between 1 x WD and 1.5 x WD away from the installation vessel, will be conducted with the vessel's ROV and/or subsea sonar equipment.

During cable lay operations, the vessel will install the cable within the cable installation corridor. 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 notice to mariners issued to inform other sea users for safety.

6.4.5 Second End Pull-In

The site at Mull for the 2nd end pull-in will be prepared ahead of the arrival of the CLV to that location. This will require there to be separate pull-in equipment sets for each landfall site to avoid any delays due to repositioning them for the CLV when arriving on site from the cable lay works.

Once the cable has been installed along the main RPL towards 2nd end, the CLV will stand off at a suitable position offshore and hold position at the agreed water depth. The cable support vessels will then approach and assist with the cable offload into an omega shape and act as a Hold Back support vessel in order to manage the cable at this location as the omega is laid on the water surface. Cable floats will be attached to the cable by the CLV deck crew and lowered into the water column and the omega loop laid.

Figure 37: Typical Pull In Floats

As the omega is created, the bight shall be managed by the support vessels. A support vessel shall also transfer a messenger line from the CLV to the onshore main winch wire and connect at the Hand Over Zone in the same manner as performed for the 1st end. The CLV shall pick up on its messenger line and receive the onshore winch wire on board. The main winch wire will be connected to the cable pull-in head via a suitably rated swivel and prepared for pull in.

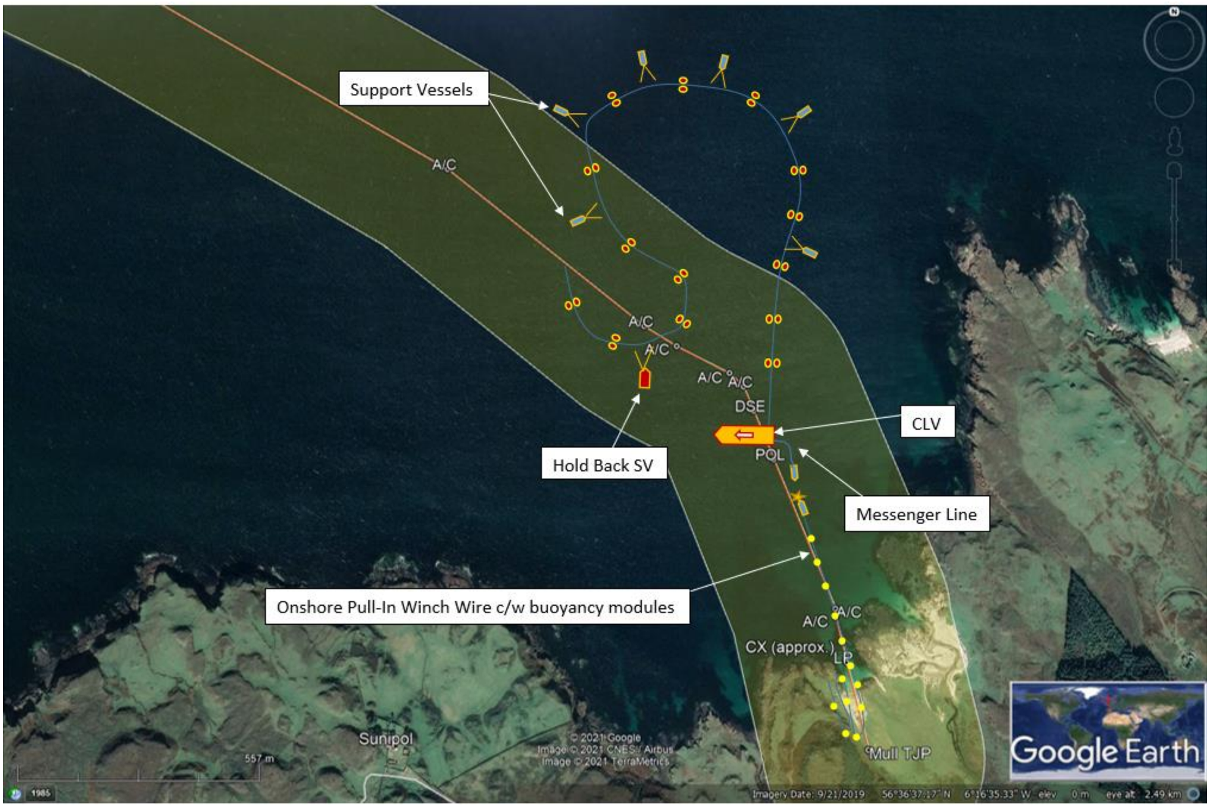


Figure 38: 2nd End Pull In Overview

The cable will be received by support craft that will manage the cable bight on the surface of the water ensuring the MBR of the cable is not compromised. The CLV crane may be used to support the offloading of the cable end from the CLV. Pillow floats will be installed along the length of the cable to prevent the cable from sinking and therefore reducing the pull in tension. This will also make it easier for the support vessels to manage the omega bight on the surface. The pace of operations shall be dictated by the crew on the CLV managing the speeds on the lay system but the positioning and the control of the cable bight and support vessel shall be managed by the Beach Master ensuring that the cable MBR is not compromised.

It should be noted that that the cable pull-in at the Mull location will take place close to an in-service 11kV subsea cable. The newly installed cable will be positioned a safe distance from the existing cable in line with SSEN requirements.

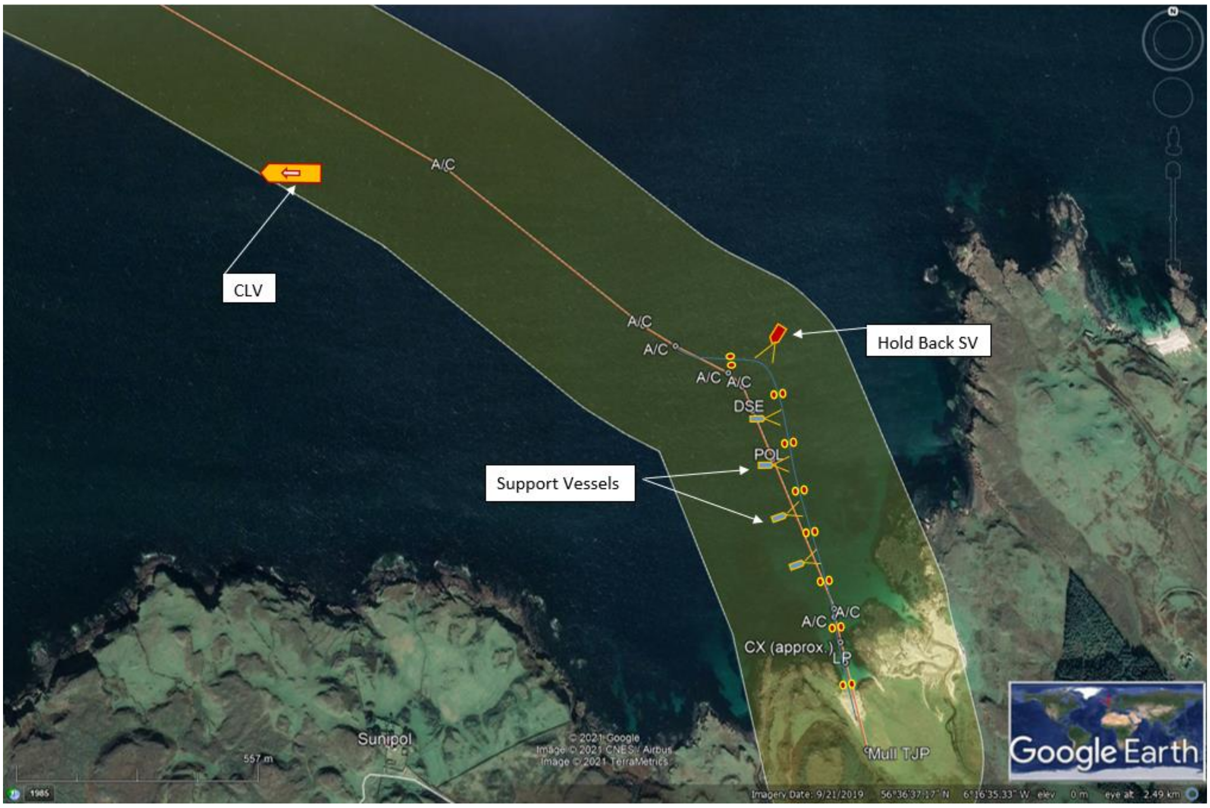


Figure 39: 2nd End Pull In Overview

Once the full length of cable has been laid out on the water surface, the CLV will relocate to a safe distance from the omega bight and support vessels. Under direction from the Beach Master, the pull in shall take place with support vessels assisting the cable pull in works. The pull-in shall continue until the cable end is received onshore. The support vessels and divers will manage the floating cable and excavators may be used on the beach to support the cable end. The pull in shall be complete when the agreed overpull from the TJP has been achieved.

Once the final pull in has been achieved the cable floats will be released in a systematic way (offshore to nearshore) and the cable settled onto the RPL. Divers may be used to fit articulated pipe in this area with the articulated pipe providing protection from an existing OoS cable. Offshore survey will take place at MHWS and the onshore survey at MLWS by divers using a handheld DGPS. This will create an overlap in data to stitch together.

Figure 40: Second End Pull In Example

6.4.6 Cable Protection Methods

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

6.4.6.1 Mattress Installation

If mattress installation is required, a Multicat type vessel will carry out the installation in shallow water. During the installation, the Mulitcat may need to hold position by means of clump weights. An overview of the likely clump weight arrangement is shown in Figure 42: Example Clump Weight Configuration, Figure 43: Example Clump Weight, and Figure 44: Example Shallow Water Anchor Spread. The clump weights have a 3.5m x 3.5m footprint with a 10m 36mm chain laid on the seabed on the seabed, when under tension, and are designed to be non-penetrative and rely on the self-weight of the arrangement to provide stability to the vessel.

A typical arrangement would use a 4point anchor spread but, depending on environmental conditions, could use up to eight anchors. The anchor spread is designed for use in shallow waters and can have varying offsets for the vessel depending on water depth and proximity to the subsea cable. In water depths of 3-4m the each anchor could be positioned up to 150m from the vessel.

Figure 41: Concrete Mattress Deployment

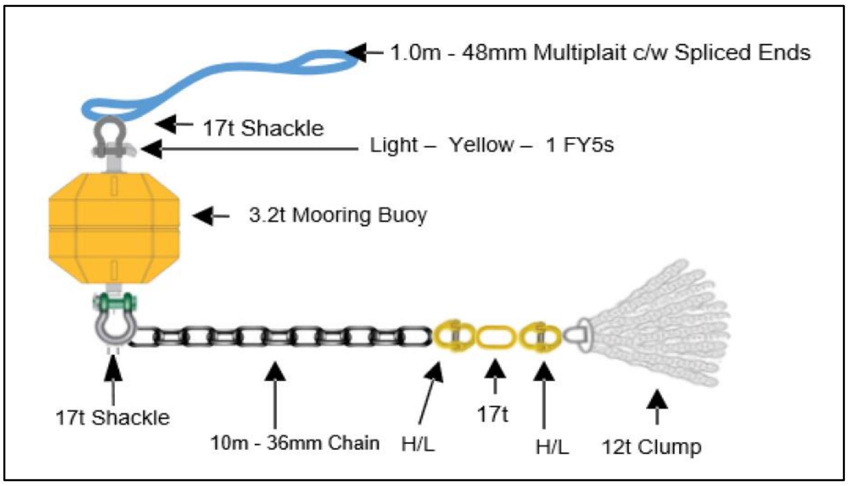


Figure 42: Example Clump Weight Configuration

Figure 43: Example Clump Weight

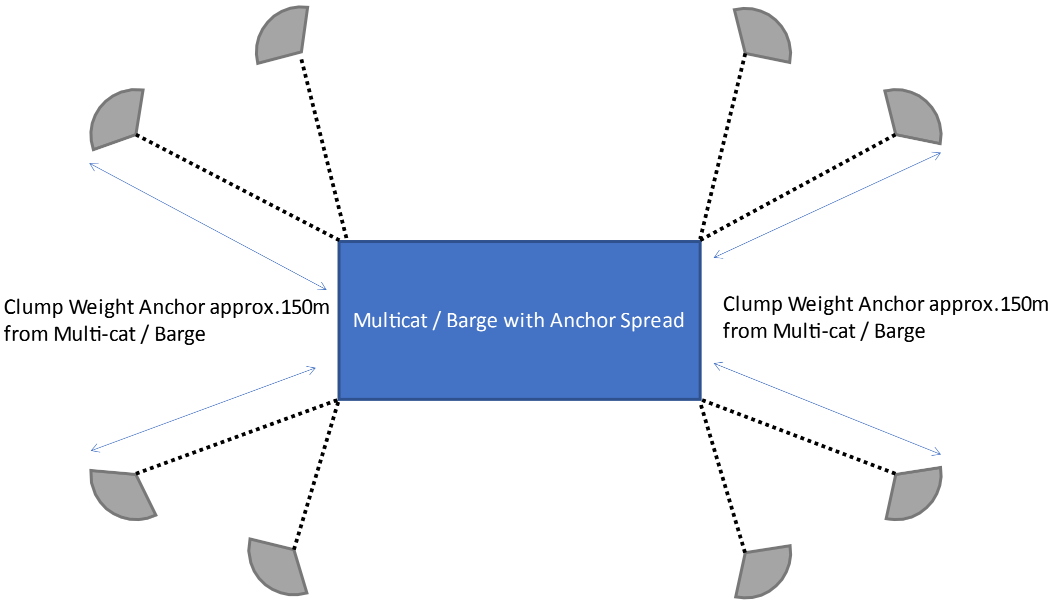


Figure 44: Example Shallow Water Anchor Spread

6.4.6.2 Rock Placement

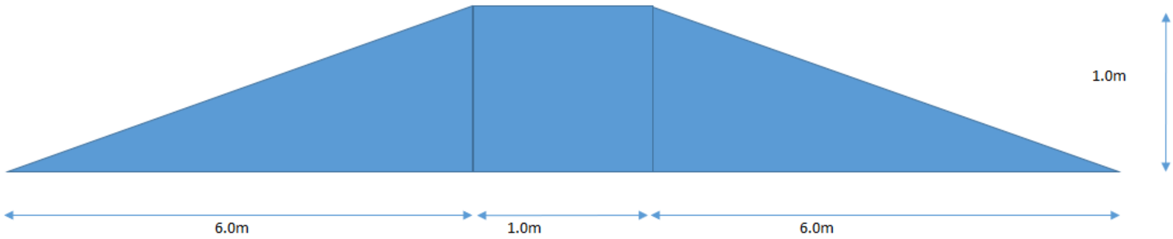
The cable protection strategy may include a rock placement campaign to provide stability and protection in areas where burial may not be achievable due to localised geology.

Should this be required, then the volume of rock, identified in Section 5.1,

Maximum Rock Placement Volume (m^3)*	
Rock Placement Volume	58,975
+50% Contingency	88,463

Table 15: Maximum Rock Placement Volume, has been calculated based on a typical conservative Rock Berm design.

The conservative rock dump design profile is a 13.0m widespread (6.5m either side of the cable centreline) with a minimum 1.0m depth of cover at the centreline, tapering to each side with a 1:6 slope. Volume is approximately 7.0m³ of rock per metre of cable.



Total Volume = 7.0m³/m

Figure 45: Typical Rock Berm Design

Final Rock Berm Design will be agreed with a specialist contractor and in line with Cable Burial Risk Assessment (CBRA).

6.4.6.3 Rock Bag Installation

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 (see Figure 46 and Figure 47). The vessel's ROV monitors the installation and detaches the crane wire from the Rock Bag once in position.

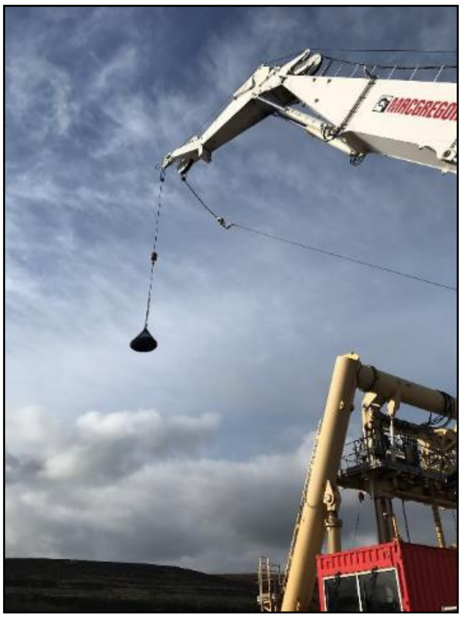


Figure 46: Rock Bag Being Lifted off the Vessel

Figure 47: Rock Bag in Position Subsea

Details of a 4te rock back can be seen in Table 16: Rock Bag Dimensions below:

Rock Bag Mass in Air (Te)	Diameter (m)	Height (m)	Volume (m³)
4	2.4	0.6	2.5

Table 16: Rock Bag Dimensions

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.

6.4.6.4 Grout Bag Installation

There are currently no pre-installation plans for grout bags to be used, however they may be required to rectify any cable free spans that are observed following cable installation. If these are required, then this can be installed from the CLV using its 150te subsea crane in a similar manner to the Rock bags as described in Section 6.4.6.3 above. Each 1 Te Grout Bag (0.9 m x 0.9 m x 0.9 m) contains 40 x 25 kg individual units. If required divers will position the individual bags where free span rectification is required.

6.4.6.5 Post Lay Burial

It is proposed to utilise a Q1400 jet trencher based on Global Symphony for all post-lay burial operations.

Figure 48: Q1400 Trencher

Sequence for Cable Burial Operations (Jetting Mode):

1) Post-lay data processed and uploaded to navigation screen (carried out on the CLV) for the Trencher Pilot, pre-trench report also conducted and discussed.
2) Launch trencher at start of burial location.
3) Deploy Jet-legs and transition in to required burial depth over 10m transition
4) Continue trenching operations tracking cable using TSS440.
5) Transition out over 10m at end of trench and recover to deck.

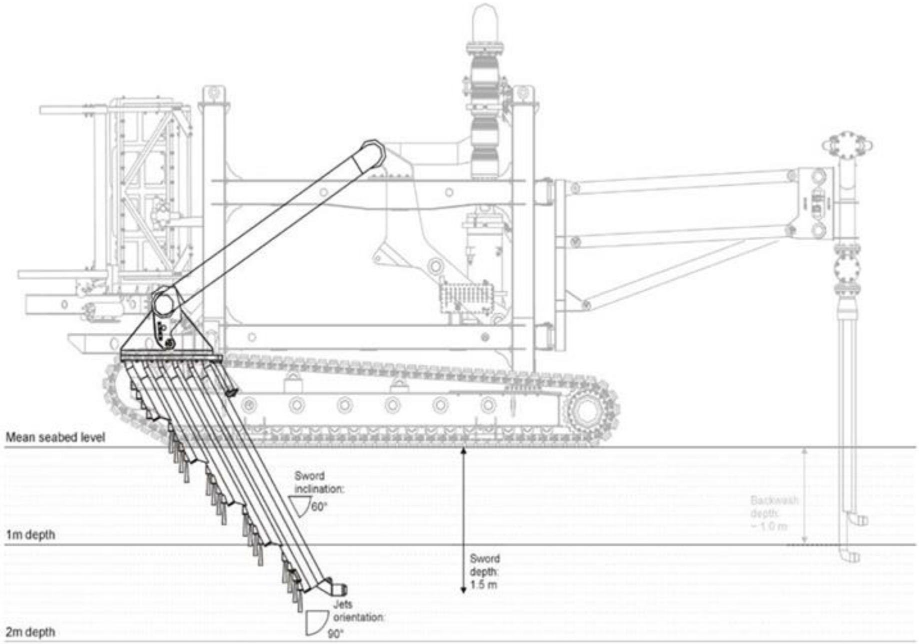


Figure 49 Example set-up of Q1400 with 2m swords deployed at 1.5m for a DOL of 1.0m. Backwash deployment is represented in light grey colour

6.4.6.6 Shallow water Burial Skid

In area close to shore where access via CLV and traditional jet trenchers are not possible, it may be suitable to utilise a shallow water jet trenching skid.

Figure 50: Shallow Water Jetting Skid

These jetting skids have surface fed pumps to provide the subsea jetting requirements for cable burial. The shallow water jetting skids are available to mobilise onboard third party shallow water multicat type vessels or can be utilised with integrated pump vessels.

The jetting skid can be launched via the vessels crane or launched from the beach. When launched from the beach the high pressure jetting hoses need to be handed over the pump vessel and connected up to allow the surface fed pumps to be provide the jetting for cable burial.

These shallow water skids are either towed along the cable section or driven and steered via diver support.

6.4.6.7 Split Pipe / Uraduct Installation

The cable protection strategy includes the installation of Split Pipe or Uraduct. In areas below MLWS this is normally installed following cable pull-in operations by divers and protects the cable in the nearshore and intertidal section of the cable route. Divers will not be required for installation in the intertidal section.

For both cable ends, between MHWS and MLWS, the cable is proposed to be encased either in Articulated Pipe (AP) (‘split pipe’) or uraduct. At Mull, a trench will be opened up from the TJP to MLWS and the cable laid into it, with AP then applied and the spoil replaced.

The situation at Coll is similar although burial will be limited by the natural rock outcrops and subcrops. Here cable burial will most likely be restricted to opening up a trench where possible from the Coll TJP and elsewhere clearing gravel, cobbles and boulders so the AP lies on the bedrock with subsequent replacement of spoil to a seaward limit of MLWS. Beyond MLWS, the cable will be surface laid initially and encased in AP or uraduct, and thereafter either buried and stabilised by jet trenching where ground conditions permit or surface laid with external protection such as rock placement, rock bags or mattresses.

See Section 5.1 for details of anticipated Split Pipe or Uraduct installation. An example Split Pipe installation is shown in Figure 51: Example Split Pipe Installation. In locations where Split Pipe is to be employed as cable protection, this will be installed onto the cable from the CLV and deployed over the cable chute as part of the cable lay.

Figure 51: Example Split Pipe Installation

6.5 As-Built Survey and Site Re-Instatement

Following completion of operations, an As-Built survey will be undertaken of the replacement cable and protection. This will record the as installed position of the cable and the deposits utilised to stabilise and or protect the cable. The landfall sites will also be re-instated 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.

The As-Built survey will document the installed position of the cable from TJP to TJP with events listed and positions given (i.e. Rock Bags, Mattresses, and Split Pipe etc.).