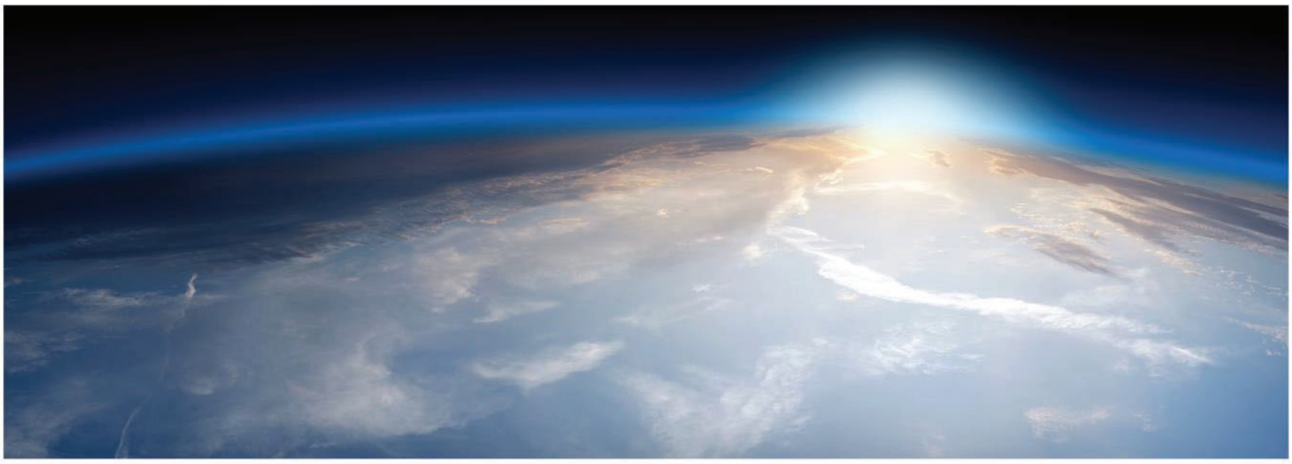

# Carradale - Arran Cable Replacement

## Marine Environmental Appraisal

**Scottish Hydro-Electric Power Distribution plc**

**Assignment Number:** A303128-S00
**Document Number:** A-303128-S00-REPT-002

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# Carradale - Arran Cable Route Marine Environmental Appraisal

## A303128-S00

**Client:** Scottish Hydro-Electric Power Distribution plc
**Document Type:** Report
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# ACRONYMS

| | |
|---|---|
| ALARP | As Low As Reasonably Practicable |
| AUV | Autonomous Underwater Vehicle |
| CBA | Cost Benefit Analysis |
| CBRA | Cable Burial Risk Assessment |
| CIfA | Chartered Institute for Archaeologists |
| CPSP | Cable Protection and Stabilisation Plan |
| DBA | Desk-Based Assessment |
| DDV | Drop-Down Video |
| DECC | The Department of Energy and Climate Change |
| DSV | Dive Support Vessel |
| DTI | Department for Trade and Industry |
| EAJ | Environmental Assessment Justification |
| EC | European Community |
| EEC | European Economic Community |
| EIA | Environmental Impact Assessment |
| EMF | Electro-Magnetic Fields |
| EPS | European Protected Species |
| EU | European Union |
| EUNIS | European Nature Information System |
| GIS | Geographic Information System |
| GMG | Global Marine Group |
| HDD | Horizontal Directional Drilling |
| HEP | Historic Environment Policy |
| HMPA | Historic Marine Protected Areas |
| HMS | Her Majesty's Ship |
| HVAC | High Voltage Alternating Current |
| ICES | International Council for the Exploration of the Sea |
| ISM | International Safety Management |
| IUCN | International Union for Conservation of Nature |
| JNCC | Joint Nature Conservation Committee |
| km | Kilometres |
| $km^2$ | Kilometres Squared |
| kV | KiloVoltz |
| kW/m | Kilo Watts per Metre |
| LAT | Lowest Astronomical Tide |

| | |
|---|---|
| LDP | Local Development Plan |
| LNR | Local Nature Reserves |
| LSE | Likely Significant Effects |
| m | Metres |
| MBES | Multi Beam Echosounder |
| MEA | Marine Environmental Appraisal |
| MHWS | Mean High Water Spring |
| MMO | Marine Mammal Observer |
| MPA | Marine Protected Area |
| NCMPA | Nature Conservation Marine Protected Area |
| NERC | Natural Environment Research Council |
| nm | Nautical Mile |
| NMP | Scottish National Marine Plan |
| NMPI | National Marine Plan interactive |
| NRHE | National Record of the Historic Environment |
| NSA | National Scenic Area |
| OBS | On Bottom Stability |
| OSPAR | Oslo and Paris Convention |
| PAC | Public Accounts Committee |
| PMF | Priority Marine Feature |
| RMP | Regional Marine Plan |
| ROV | Remotely-Operated Underwater Vehicle |
| RSPB | Royal Society for the Protection of Birds |
| SAC | Special Area of Conservation |
| SBP | Sub Bottom Profiler |
| SCOS | Special Committee on Seals |
| SHEPD | Scottish Hydro Electric Power Distribution plc |
| SPP | Scottish Planning Policy |
| SNH | Scottish Natural Heritage |
| SOLAS | The International Convention for the Safety of Life at Sea |
| SOPEP | Ship Oil Pollution Emergency Plan |
| SPA | Special Protection Area |
| SSS | Side Scan Sonar |
| SSSI | Site of Special Scientific Interest |
| SULA | Scientific Underwater Logistics and Diving |
| UAV | Unmanned Aerial Vehicle |
| UK | United Kingdom |

| | |
|---|---|
| UK BAP | UK Biodiversity Action Plan |
| UKCS | United Kingdom Continental Shelf |
| UKHO | UK Hydrographic Office |
| UNCLOS | United Nations Convention of the Law of the Sea |
| UXO | Unexploded Ordinance |

# 1 INTRODUCTION

## 1.1 Project Background

The SHEPD network serving Arran presently comprises two 33kV cables which cross the Kilbrannan Sound between Carradale in Kintyre and Balliekine in Arran. Routine inspection surveys have identified that the Carradale – Arran north cable is in poor condition with significant damage to the protective armour and based on asset integrity evaluation this cable has been identified for complete replacement. The proposed new cable is expected to be circa 7 km in length (see Table 1-2). Replacement of this cable is essential in order to maintain the security of supply for SHEPD customers on Arran.

The purpose of this report is to provide information on the proposed works for cable installation, identify the environmental receptors in the area and undertake an assessment of the potential impacts for those that are considered particularly sensitive to the proposed works.

The environmental supporting information has been based on publicly available information including that of the National Marine Plan interactive (NMPi) website platform and the NatureScot website. In addition, various surveys have also been used to inform this document which include a geophysical and geotechnical route survey, Drop-Down Video (DDV) survey and Remotely Operated Vehicle (ROV) surveys. The conclusion, drawn from the environmental information available, is that the proposed cable operations will not significantly impact the environment, or protected features, in the project area. Mitigation measures have been identified for those receptors which are identified as being particularly sensitive.

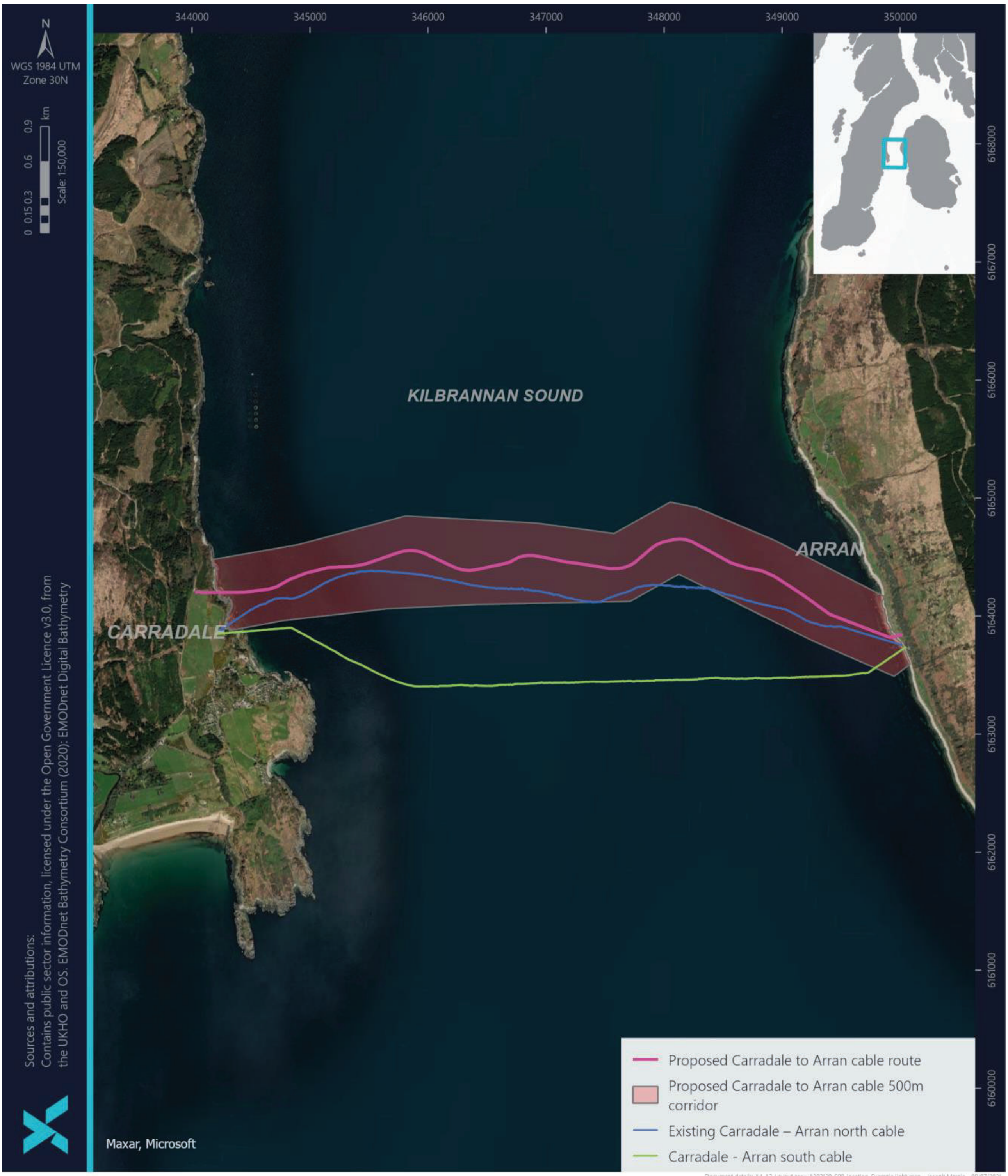
The existing Carradale - Arran cables (north and south) and the proposed cable route replacement are shown in Figure 1-1.

This Marine Environmental Appraisal (MEA) provides an assessment of the potential environmental impacts which may result from the Carradale – Arran cable replacement activities and will be used to inform the licence applications for the project. The mitigation requirements identified by this MEA will be included in the accompanying Marine Construction Environmental Management Plan (CEMP) Ref: A-303128-S00-TECH-016, in order to ensure they are effectively disseminated to, and implemented by SHEPD and the cable installation contractor during the proposed works.

This MEA should be read in conjunction with the following documents:

- Marine Licence Application Form;
- Project Description: Carradale – Arran Cable Replacement;
- Cost Benefit Analysis (CBA);
- Fishing Liaison Mitigation Action Plan (FLMAP) Clyde Region (covering all legitimate sea users);
- CEMP;
- EPS Licence Application Form; and
- Basking Shark Derogation Licence Application Form.

Figure 1-1 Carradale – Arran Existing Cables and Proposed Cable Replacement Corridor



## 1.2 Work Completed to Date

SHEPD previously appointed a contractor to conduct marine surveys along the proposed cable route in 2018. These surveys encompassed a corridor ranging from 1,444 m wide at Kintyre to 980 m at Arran. Further route surveys have been undertaken in late 2020 / early 2021 in order to inform the final design and consenting process.

SHEPD commissioned Briggs Marine to undertake geophysical and environmental surveys in 2018 to inform detailed routing for the installation of a replacement distribution cable from Balliekine on Arran and Carradale on the Scottish mainland, within the Firth of Clyde. As part of the project consenting requirements, a DDV survey was required to provide ground-truthing and benthic habitat classification along the Carradale - Arran cable corridor. A geophysical survey was required as part of an overall site development study and was used in the technical assessments to better assess the seabed in terms of site engineering and cable protection.

Ocean Ecology Limited was commissioned by Briggs to undertake intertidal Phase I walkover surveys of the two proposed landfalls of the Carradale – Arran cable to establish the main habitats present (in the form of biotope mapping) and record any features of conservation importance. The Phase I intertidal survey was carried out across an area of approximately 1,200 x 300 m covering the proposed cable landfall corridors at Balliekine and Carradale. Additionally, Aquatic Environments have been commissioned to review the 2018 Carradale - Arran DDV files and two of the 2017 cable route ROV videos.

Fugro was commissioned by Global Marine Group (GMG) to undertake a geophysical, geotechnical (Fugro, 2021b) and environmental (Fugro, 2021a) surveys for the proposed Carradale-Arran cable replacement. The geophysical survey included multibeam bathymetry (MBES), side scan sonar (SSS), magnetometer, and sub-bottom profiler (SBP) data within the cable corridor. Geotechnical sampling included the use of vibrocorers (VC) and cone penetration testing (CPT), while the environmental survey included sub-tidal drop down camera transect and benthic grab sampling, with an intertidal survey conducted at the Arran landfall.

Further detail on the survey methods and results are presented in Sections 2.2, 4 and 5.

## 1.3 Project Description

This section provides an overview of the proposed project activities which will be conducted during the replacement of the Carradale – Arran cable. A detailed project description is provided in the Carradale - Arran Cable Replacement Project Description.

### 1.3.1 Route Overview

The proposed cable replacement will be a single 7 km long High Voltage Alternating Current (HVAC) cable which will leave land at Carradale and enter the sea via ducts pre-installed by Horizontal Directional Drilling (HDD).

For the purposes of this assessment is has been assumed that HVAC cable will initially be surface laid, and thereafter protected and stabilised by jet trenching where ground conditions permit. Where jet trenching is not possible additional external protection and stabilisation may be utilised which in whole or in part may include concrete mattresses, rock bags or rock placement. Landfall at Arran will be made via an open cut trench through the intertidal area with articulated split pipe applied for protection. Identification of the proposed measures for cable stabilisation and protection has been informed by the Cable Burial Risk Assessment (CBRA), On Bottom Stability (OBS) analysis, wider engineering studies and consideration of 3rd party activities in the area.

This document considers the marine components of the route up to Mean High Water Springs (MHWS) at both landfalls. The onshore aspects of the project above MHWS are not considered in this document.

Table 1-1 - Cable Installation Corridor Coordinates in Degrees, Minutes and Seconds (DMS), Degrees & Decimal Minutes (DDM) and Decimal Degrees (DD).

| Cable Installation Corridor Coordinates (WGS84) | | | | | |
|---|---|---|---|---|---|
| Latitude DMS | Longitude DMS | Latitude DDM | Longitude DDM | Latitude DD | Longitude DD |
| 55° 36' 0.966" N | 5° 22' 59.010" W | 55° 36.016' N | 5° 22.984' W | 55.600268 | -5.383058 |
| 55° 35' 42.562" N | 5° 22' 45.023" W | 55° 35.709' N | 5° 22.750' W | 55.595156 | -5.379173 |
| 55° 35' 39.119" N | 5° 22' 52.535" W | 55° 35.652' N | 5° 22.876' W | 55.594200 | -5.381260 |
| 55° 35' 48.232" N | 5° 23' 33.192" W | 55° 35.804' N | 5° 23.553' W | 55.596731 | -5.392553 |
| 55° 36' 5.056" N | 5° 24' 38.384" W | 55° 36.084' N | 5° 24.640' W | 55.601404 | -5.410662 |
| 55° 35' 57.111" N | 5° 25' 1.540" W | 55° 35.952' N | 5° 25.026' W | 55.599198 | -5.417094 |
| 55° 35' 54.774" N | 5° 26' 16.919" W | 55° 35.913' N | 5° 26.282' W | 55.598548 | -5.438033 |
| 55° 35' 52.762" N | 5° 26' 58.966" W | 55° 35.879' N | 5° 26.983' W | 55.597989 | -5.449713 |
| 55° 35' 48.585" N | 5° 27' 48.315" W | 55° 35.810' N | 5° 27.805' W | 55.596829 | -5.463421 |
| 55° 35' 45.381" N | 5° 28' 13.770" W | 55° 35.756' N | 5° 28.229' W | 55.595939 | -5.470492 |
| 55° 36' 4.560" N | 5° 28' 24.043" W | 55° 36.076' N | 5° 28.401' W | 55.601267 | -5.473345 |
| 55° 36' 9.473" N | 5° 27' 42.999" W | 55° 36.158' N | 5° 27.717' W | 55.602631 | -5.461944 |
| 55° 36' 18.374" N | 5° 26' 51.501" W | 55° 36.306' N | 5° 26.858' W | 55.605104 | -5.447639 |
| 55° 36' 17.673" N | 5° 25' 48.039" W | 55° 36.295' N | 5° 25.801' W | 55.604909 | -5.430011 |
| 55° 36' 15.570" N | 5° 25' 10.396" W | 55° 36.260' N | 5° 25.173' W | 55.604325 | -5.419554 |
| 55° 36' 24.683" N | 5° 24' 43.758" W | 55° 36.411' N | 5° 24.729' W | 55.606856 | -5.412155 |
| 55° 36' 23.515" N | 5° 24' 31.141" W | 55° 36.392' N | 5° 24.519' W | 55.606532 | -5.408650 |
| 55° 36' 15.337" N | 5° 23' 53.054" W | 55° 36.256' N | 5° 23.884' W | 55.604260 | -5.398070 |
| 55° 35' 54.974" N | 5° 28' 20.005" W | 55° 35.916' N | 5° 28.333' W | 55.598604 | -5.472223 |
| 55° 35' 53.335" N | 5° 22' 56.248" W | 55° 35.889' N | 5° 22.937' W | 55.598149 | -5.382291 |
| *For the avoidance of doubt, the landward boundaries of the installation corridor covered by this application shall be MHWS. The landfall boundaries defined by the coordinates within this document should be considered approximations, due to the requirement to limit the number of vertices.* | | | | | |

The cable will be surface laid and buried (where possible) using a tracked ROV jet trencher within the installation corridor. Route engineering will be completed based on the offshore survey data between the existing landing points. Routing will be selected to avoid sensitive environmental receptors and technical constraints (significant rocky outcrops or complex bedforms) if possible, to reduce environmental impact, maximise trenching success and prevent cable suspension and also abrasion following the installation. Micro-routing may still be required during the lay operations however all works will be completed within the consented installation corridor.

Where seabed conditions prevent the use of trenching, external protection measures may also be required such as rock placement, rock filter bags, concrete mattresses and articulated split pipe. Should rock placement be required, the rock berms will be profiled to minimise snagging risk with shallow side slopes as detailed in the Carradale – Arran Subsea Cable Replacement Project Description.

The routing of the HDD at Carradale is subject to final detailed engineering. The two HDD ducts shall run parallel to one another, nominally 10 m apart. Two ducts are to be installed to allow one as a contingency duct. To reduce the volume of drilling fluid into the marine environment during pop-out, drilling operations will be executed by using the 'short stop' method. This is where both the pilot and reaming operations are stopped short of the exit point on the seabed. Only in the final stage, once the hole is at the designated diameter, will punch out be made out through the seabed. Once the HDD bores are complete, the holes will be lined with High Density Polyethylene (HDPE) ducts. The HDPE ducts will either be pushed into place from shore or pulled in from the marine side subject to detailed engineering. Further detail is provided in the Carradale – Arran Subsea Cable Replacement Project Description.

Prior to or during HHD operations, a reception pit may be excavated in the seabed at the punch out location. The Reception Pit is required to be of sufficient length to permit the laydown of any exposed over-length of the HDPE duct. The Reception Pit would be up to 270m$^3$ (30m x 3m x 3m) per duct, giving a total potential excavation of 540 m$^3$. The pit would be created using an air lift dredging unit or mass flow excavator which can be positioned by either divers or by ROV, with material deposited adjacent to the excavated area.

Prior to cable installation operations commencing, a final pre-lay survey of the route will be conducted to identify possible debris and obstructions on the route. Where possible, debris and obstructions will be removed using an ROV or diver. Natural obstructions such as boulders will be moved away from the route and then replaced on the seabed, while debris of human origin will be retained for onward disposal or recycling at an appropriate facility. A Pre-Lay Grapnel Run (PLGR) may also be required to prepare the route for burial where deemed appropriate. 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 pre-burial activity, where appropriate. A PLGR run may only be conducted in areas where burial of the cable is expected.

It should also be noted that during the laying of the cable below MLWS, a Remotely Operated Vehicle (ROV) will be used to monitor the cable at the touch down location with the seabed and HDD pull-in. This will capture seabed information at the contact point and will help observe the lay tension that is applied to the cable from the vessel. ROVs will also be used during trenching operations and for the installation of any external protection measures following cable laying. During all ROV operations, Ultra Short Baseline (USBL) positioning systems will be used to monitor the underwater position of the subsea equipment.

A summary of the activities considered by this MEA, is provided below. Please refer to Carradale - Arran Subsea Cable Replacement Project Description for further detail.

- Debris and obstruction clearance from the route using a work class ROV or Pre-Lay Grapnel Run (PLGR);
- HDD installation of two ducts at the Carradale landfall site;
- Laying and burial of the cable using a cable lay vessel (CLV) and jet trencher and below MLWS;
- Placement of rock, rock bags and/or concrete mattresses which may be used to stabilise and protect the cable where trenching is not possible;
- Installation the cable using an open-cut trench method between MLWS to MHWS at the Arran landfall location. An open cut trench will be excavated to install and bury the cable, and split pipe may be used; and
- Associated vessel presence.

### 1.3.2 Alternative Options

The Carradale to Arran North subsea cable was inspected in August 2017 where the cable was observed to be in poor condition with damage to the external armour. The cable was installed in 1993 and in light of its age and condition is considered to have reached the end of its economic life. The cable is however still operational at the time of this application and therefore the following options represent the alternative options available:

**Option 1** – Do nothing at this time. Under this scenario the existing cable in conjunction with the Carradale – Arran South cable would continue to provide the grid connection between the mainland of Scotland and Arran. At some point in the future it would be expected that the cable would fail and at this point require either repair or replacement. For a repair option to be progressed, the cable must be in good mechanical condition because cable recovery and jointing results in significant mechanical stresses and fatigue within the cable. On this basis a future offshore piece in repair is considered unlikely to be either successful or represent best value for consumers due to the condition of the cable and the low confidence in a successful repair being achieved. The most likely future outcome of this option would be end to end replacement of the cable.

**Option 2** – Proactive cable replacement in proximity to the existing cables. This option would see a new cable installed before the existing cable fails in order to ensure network integrity and security of supply for customers on Arran. The replacement cable would be installed in proximity to the existing cable corridor.

**Option 3** - Proactive cable replacement in a location remote from the existing cables. This option would see a new cable installed before the existing cable fails in order to ensure network integrity and security of supply for customers on Arran. The replacement cable would be installed in a new location remote from the existing cables. A suitable subsea crossing location would require to be identified and new onshore infrastructure installed in order to connect the new cable to the existing network on both Arran and mainland Scotland.

SHEPD is progressing on the basis of Option 2 as it reduces environmental effects to a minimum and is the option that most closely aligns with our statutory duty for this specific cable. Reference should also be made to the accompanying Project Description where details regarding the cable route selection process and the selection of HDD for the landfall at Carradale are presented.

### 1.3.3 Vessels

Global Marine operates a fleet of vessels that are regulated under The International Convention for the Safety of Life at Sea (SOLAS) and which are all required to comply with the International Safety Management (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.

A cable lay vessel (such as the Global Symphony or a similar design vessel) will be used for cable installation activities, cable burial and also installation of any cable protection measures. An additional smaller support vessel (such as the C-Odyssey or similar) for trenching and dive support is likely to be required in shallow shore locations and at the Arran shore-end. A guard vessel may also be used during the cable lay operations.

Where cable protection using rock placement is required, a dedicated rock placement fall pipe vessel will be utilised to allow controlled and targeted installation of rock to form the berms.

Further detail of the vessels likely to be used to install the proposed replacement cable can be found in the Carradale - Arran Cable Replacement Project Description.

### 1.3.4 Marine Installation Footprint

A Cable Protection and Stabilisation Plan (CPSP) has been developed as part of the Marine Licence application. The CPSP conservatively outlines the number of deposits required and is the basis of the assessment outlined in this MEA. Details of the CPSP can be found in the Carradale - Arran Cable Replacement Project Description.

Various items associated with the works will cause disturbance to the seabed. One instance will be through the pre-dredging pit, hereafter referred to as the 'Reception Pit'. Prior to or during drilling operations, a Reception Pit may be excavated in the seabed at the punch out location. The Reception Pit is required to be of sufficient length to permit the laydown of any exposed over-length of the duct, following completion of pigging and end cap fitment works.

The Reception Pit would be up to 270 $m^3$ (30 m x 3 m x 3 m) per duct, giving a total potential excavation of 540 $m^3$. The pit would be created using an air lift dredging unit or mass flow excavator which can be positioned by either divers or by ROV, with material deposited adjacent to the excavated area.

A Sea Earth wire may also be installed in order to provide protection from surges and lightning strikes to the electrical circuit provided by the newly installed Carradale Arran cable. If required, this Sea Earth would be installed at the Arran landfall site. 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 200 mm. Should a separate trench be required, the trench would remain within the consented cable corridor. The sea earth would be trenched to a maximin depth of 1.5 m and a width of 1 m. Due to these dimensions, it can be assumed that the Sea Earth wire will be covered by the cable route corridor of 10 m (as discussed below).

In addition to this, the cable protection strategy may also include a rock placement campaign to provide stability and protection in areas where burial may not be achievable due to localised geology and areas where it is not practicable to deposit mattresses and/or rock bags. Should this be required, then the volume of rock (38,556 $m^3$ including contingency) has been calculated based on a typical conservative rock berm design (as shown in the associated Project Description Carradale – Arran Cable Replacement). The conservative rock berm design profile is 13 m wide (6.5 m either side of the cable centreline) with a minimum of 1 m depth of cover at the centreline, tapering to each side with a 1:6 slope. Volume is approximately 7 $m^3$ of rock per metre of cable.

Lateral movement and protection of the cable will be prevented via the placement of rock filter bags and/or concrete mattress directly on top of the cable, where applicable. In addition to this, clump-weights and mooring line will also be used for multi-cat activities. These deposits (also listed in Table 1-2) will be temporary deposits.

The following worst-case assumptions have been made for the area of seabed impacted:

- The impact corridor of the landfall site at Arran where the cable will be buried is 10 m wide which includes the requirement for jet-trenching considering the footprint of the trencher. This has been assessed assuming the whole length of the cable will be buried to represent a worst-case. In reality, some sections of the cable will be surface laid at rock out-crops;
- The rock berm is expected to have a 13 m wide footprint over approximately 58% of the cable installation route;

- The two HDD ducts shall run parallel to one another, nominally 10 m apart.  A 30m x 3m reception pit may be required for each duct;
- Large clump weights for mulitcat operations are 3.5 m x 3.5m, therefore impacting an area of 12.25 $m^2$ each;
- Each grout bag measures 0.9 m x 0.9 m, therefore impacting an area of 0.81 $m^2$ each;
- Each rock bag is 2.4 m diameter, therefore impacting an area of 4.52 $m^2$; and
- Each mattress measures 6 m x 3 m, therefore impacting an area of 18 $m^2$ each.

Table 1-2 presents the overall area of seabed impact from the proposed cable installation activities.

Table 1-2 Deposit Details

| Deposit | Detail | Area of Impact ($m^2$) | Area of Impact ($km^2$) |
|---|---|---|---|
| Cable* | Diameter of cable: 132.4 mm (corridor of 10 m wide)<br>Length: approximately 7 km | 70,000 | 0.07 |
| Rock bags | Size: 2.4 m diameter – a total of 27 (includes contingency) | 122 | 0.000122 |
| Grout bags | Size: 0.9 m x 0.9m (assumed dimensions) – a total of 24 (includes contingency) | 20 | 0.00002 |
| Concrete mattresses | Size: 6 x 3 x 0.3 m (assumed dimensions) – a total of 14 (includes contingency) | 252 | 0.000252 |
| Clump weights# | Size 3.5 m x 3.5 m – a total of eight. | 98 | 0.000098 |
| Mooring lines# | 150 m length x 36 mm – a total of eight | 43 | 0.000043 |
| HDD bore | Number: Two HDD ducts on Carradale (one used and one spare). There will be no HDD works on Arran.<br>Dimensions: reception pit of 30 m x 3 m for each duct | 180 | 0.00018 |
| Rock Berm[1] | Predicted dimensions: 3,672 m x 13 m corridor | 47,736 | 0.047736 |
| | **Total Area of Impact ($m^2$)** | **118,451** | **0.11845** |
| * This footprint also includes the footprint of the jet trencher and the requirement for split pipe, Sea Earth wire and HDD ducts. | | | |
| # Temporary deposit. | | | |

### 1.3.5 Embedded Mitigation

Certain measures are incorporated into the project design as adherence to standard industry best practices or embedded mitigation which is fundamental to how the project will be executed. Details of the embedded mitigation which SHEPD are committed to implementing, and hence has been considered by this MEA are presented in Table 1-3. All embedded mitigation will be included within the CEMP.

Additional mitigation has been suggested on a receptor specific basis informed by the impact assessments. During the assessment of impacts in the receptor specific assessment chapters, all proposed mitigation is considered when assessing the significance of an impact.

[1] 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. Additional allowance has also been made to protect the cable in case burial cannot be achieved in certain locations. The resulting length of the route that could result in rock placement is therefore considered to be 3.672 km, 58% of the cable route.

Table 1-3 Embedded Mitigation and Best Practice Relevant to the Project

| Measure | Details |
|---|---|
| Production of a Construction Environmental Management Plan (CEMP) | Measures will be adopted to ensure environmental impacts are minimised, and to reduce the potential for release of pollutants from installation works. This will be informed by the results of this MEA. |
| All project personnel will be trained and informed of their responsibility to implement the environmental and ecological mitigation outlined in the CEMP | Toolbox talks, inductions, and awareness notices will be used to disseminate this information among all relevant project personnel. |
| Preconstruction surveys will be conducted to inform detailed route engineering. | Appropriate preconstruction surveys and visual inspection will be conducted to confirm the locations of potentially sensitive features. |
| Environmental planning. | The final cable routes, and positioning of filter bags and concrete mattresses will be optimised to avoid impacts on sensitive environmental features, including Annex 1 habitats and wrecks insofar as possible. |
| Scottish Marine Wildlife Watching Code (SMWWC) | All vessels will adhere to the provisions of the SMWWC during installation works. NatureScot developed the Code as part of its duties under the Nature Conservation (Scotland) Act 2004. The Code was first published in 2006 and was revised in 2017. The code aims to minimise disturbance to marine wildlife. |
| Lighting on board installation vessels will be kept to a minimum | Lighting on-board the cable installation vessel will be kept to the minimum level required to ensure safe operations. This will minimise disturbance to seabird species. |
| Deployment of anchor chains on the seabed will be kept to a minimum | Reduces the potential for disturbance to benthic habitats and species including those which utilise the seabed. |
| Vessels will be travelling at a slow speed during installation works. | The slow speed of installation vessels will minimise the risk of disturbance and injury impacts to seabird, basking shark and marine mammal receptors. |
| Production of an Emergency Spill Response Plan | An Emergency Spill Response Plan will help to ensure that the potential for release of pollutants from cable installation works is minimised. |
| Control measures and Shipboard Oil Pollution Emergency Plans (SOPEP) will be in place and adhered to under MARPOL Annex I requirements for all vessels.<br><br>In the event of an accidental fuel release occurring appropriate standard practice management procedures will be implemented accordingly. | As per the MARPOL 73/78 requirement under Annex I, all ships with 400 GT and above must carry an oil prevention plan as per the norms and guidelines laid down by International Maritime Organization under MEPC (Marine Environmental Protection Committee) act.<br><br>Production of this plan will help to ensure that the potential for release of pollutants from construction, operation and decommissioning is minimised. |
| Vessels will be equipped with waste disposal facilities (sewage treatment or waste storage) to IMO MARPOL Annex IV Prevention of Pollution from Ships standards. | Measures will be adopted to ensure that the potential for release of pollutants from installation vessels is minimised. |
| Ballast water discharges from vessels will be managed under International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (Ballast Water Management (BWM) Convention). | The BWM Convention, adopted in 2004, aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. Measures will be adopted to ensure that the risk of Non-Native Marine Species (NNMS) introduction during cable installation works is minimised. |
| Use of clean materials. | Only clean stone (free from organic contaminants) shall be used in rock berms and filter bags to reduce the risk of NNMS. |

| Measure | Details |
|---|---|
| Profiling of rock berms | All rock berms will be profiled with shallow side slopes and constructed of appropriate materials to minimise snagging risk. |
| A Fisheries Liaison Officer (FLO) will be employed to manage interactions between cable installation vessels, personnel, equipment and fishing activity. This will be managed through the Fisheries Liaison Mitigation Action Plan. | Employment of a FLO will ensure all commercial fisheries operators in the vicinity of the Project will be proactively and appropriately communicated with in terms of proposed Project operations. |
| Notice to Mariners (including local), Kingfisher bulletins, Radio Navigational Warnings, , and/or broadcast warnings will be promulgated in advance of any proposed works. The notices will include the time and location of any work being carried out, and emergency event procedures. | Ensure navigational safety and minimise the risk and equipment snagging. |
| Compliance with International Regulations for the Prevention of Collision at Sea (IRPCS) (IMO, 1972) and the International Regulations for the Safety of Life at Sea (SOLAS). | IRPCS are the international standards designed to ensure safe navigation of vessels at sea. All installation vessels will adhere to these rules, including displaying appropriate lights and shapes.<br><br>SOLAS is an international maritime treaty which sets minimum safety standards in the construction, equipment and operation of merchant ships. The convention requires signatory flag states to ensure that ships flagged by them comply with at least these standards. In relation to the Project its compliance will ensure navigational safety. |
| As built survey data will be provided to the UKHO and Kingfisher for inclusion on Admiralty Charts and the Kingfisher Information Service – Offshore Renewable and Cable Awareness (KIS-ORCA) charts. | Ensure navigational safety and minimise the risk and equipment snagging. |

## 1.4 Consent Requirements and Relevant Legislation

This section presents the key UK and Scottish policies which are applicable to the proposed cable replacement works and explains how and where these have been considered in the production of this MEA. This includes adherence to statutory legislation as well as to the policies presented in Scotland's National Marine Plan (NMP) (Scottish Government, 2015a).

### 1.4.1 Marine (Scotland) Act 2010

The installation of replacement cables is a licensable activity under Part 4 of The Marine (Scotland) Act 2010, and as such Marine Licences will be required to conduct the works. SHEPD have carried out formal Pre-Application Consultation (PAC) and a PAC Report in line with the guidance's and requirements is provided in support of this application.

Submarine cables do not require a formal Environmental Impact Assessment (EIA) as they are not listed on either Schedule 1 or Schedule 2 of the Marine Works (Environmental Assessment Justification EAJ)) Regulations 2017.

Although a formal EIA is not required for submarine cables, Marine Scotland advises, in their Guidance for Marine Licence Applicant Version 2, June 2015 (Scottish Government, 2015a) that "applicants for marine licences for submarine cables should consider the scale and nature of their projects and give consideration to the need for a proportionate environmental assessment".

For larger projects, where there is potential for the subsea cable to impact key environmental receptors, it is recommended by Marine Scotland (Scottish Government, 2015a) that an assessment of potential impacts on these receptors is carried out. Results from such an assessment, along with other relevant information about the project, should then be provided to support the Marine Licence application.

### 1.4.2 Scottish National Marine Plan

The Scottish National Marine Plan (NMP) covers the management of both Scottish inshore waters (out to 12 nautical miles(nm)) and offshore waters (12 to 200 nm). The aim of the NMP is to help ensure the sustainable development of the marine area through informing and guiding regulation, management, use and protection of the Marine Plan areas. The aim of the NMP was to enable sustainable development and the use of the marine area in a way that protects and enhances the marine environment whilst promoting both existing and emerging industries. This is underpinned by a core set of general policies which apply across existing and future development and use of the marine environment. Sectoral policies are also outlined in the Plan where a particular industry brings with it issues beyond those set out in the general policies. For the project, the policies covering sea fisheries and submarine electricity cables are of particular relevance.

SHEPD has taken all the policies outlined below into consideration when developing the replacement cable route and assessing the potential environmental and socio-economic impacts. Discussion on how compliance and alignment with the NMP has been achieved is provided in the Conclusions (Section 6 of this report).

#### General Planning

The general planning policies of particular relevance to the project include:

- General planning - There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of the plan;
- Economic benefit - Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this plan;
- Co-existence - Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision-making processes, when consistent with policies and objectives of this plan;
- Climate change - Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change;
- Natural heritage - Development and use of the marine environment must:
    - Comply with legal requirements for protected areas and protected species;
    - Not result in significant impact on the national status of Priority Marine Features (PMF); and
    - Protect and, where appropriate, enhance the health of the marine area.
- Noise: Development and use in the marine environment should avoid significant adverse effects of manmade noise and vibration, especially on species sensitive to such effects;
- Engagement: Early and effective engagement should be undertaken with the general public and interested stakeholders to facilitate planning and consenting processes; and
- Cumulative impacts: Cumulative impacts affecting the ecosystem of the Marine Plan area should be addressed in decision-making and Plan implementation.

#### Sea Fisheries

With respect to sea fisheries, the NMP sets out a number of policies. Those that are relevant to the Project include:

**'Fisheries 1'**: Taking account of the European Union (EU)'s Common Fisheries Policy, Habitats Directive, Birds Directive and Marine Strategy Framework Directive, marine planners and decision makers should aim to ensure:

- Existing fishing opportunities and activities are safeguarded wherever possible;

- Protection for vulnerable stocks (in particular for juvenile and spawning stocks through continuation of sea area closures where appropriate);
- That other sectors take into account the need to protect fish stocks and sustain healthy fisheries for both economic and conservation reasons; and
- Mechanisms for managing conflicts between fishermen and/or between the fishing sector and other users of the marine environment.

**'Fisheries 2'**: The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on fishing:

- The cultural and economic importance of fishing, in particular to vulnerable coastal communities;
- The potential impact (positive and negative) of marine developments on the sustainability of fish and shellfish stocks and resultant fishing opportunities in any given area;
- The environmental impact on fishing grounds (such as nursery, spawning areas), commercially fished species, habitats and species more generally; and
- The potential effect of displacement on: fish stocks; the wider environment; use of fuel; socio-economic costs to fishers and their communities and other marine users.

**'Fisheries 3'**: Where existing fishing opportunities or activity cannot be safeguarded, a Fisheries Management and Mitigation Strategy should be prepared by the proposer of development or use, involving full engagement with local fishing interests (and other interests as appropriate) in the development of the Strategy. All efforts should be made to agree the Strategy with those interests. Those interests should also undertake to engage with the proposer and provide transparent and accurate information and data to help complete the Strategy. The Strategy should be drawn up as part of the discharge of conditions of permissions granted.

The content of the Strategy should be relevant to the particular circumstances and could include:

- An assessment of the potential impact of the development or use on the affected fishery or fisheries, both in socio-economic terms and in terms of environmental sustainability;
- A recognition that the disruption to existing fishing opportunities/activity should be minimised as far as possible;
- Reasonable measures to mitigate any constraints which the proposed development or use may place on existing or proposed fishing activity; and
- Reasonable measures to mitigate any potential impacts on sustainability of fish stocks (e.g. impacts on spawning grounds or areas of fish or shellfish abundance) and any socioeconomic impacts.

### Submarine Cables

With respect to submarine cables, the NMP sets out a number of key objectives. Those that are relevant to the Project include:

- Protect submarine cables whilst achieving successful seabed user co-existence;
- Achieve the highest possible quality and safety standards and reduce risks to all seabed users and the marine environment; and
- Support the generation, distribution and optimisation of electricity from traditional and renewable sources to Scotland, UK and beyond.

There are three marine planning policies laid out in the NMP that are relevant to the project:

**'Cables 1'**: Cable and network owners should engage with decision makers at the early planning stage to notify of any intention to lay, repair or replace cables before routes are selected and agreed. When making proposals, cable and network owners and marine users should evidence that they have taken a joined-up approach to development and activity to minimise impacts, where possible, on the marine historic and natural environment, the assets, infrastructures and other users. Appropriate and proportionate environmental consideration and risk assessments should be provided which may include cable protection measures and mitigation plans. Any deposit, removal or dredging carried out for the purpose of executing repair works to any cable is exempt from the marine licensing regime with approval by Scottish Ministers. However, cable replacement requires a Marine Licence. Marine Licensing Guidance should be followed when considering any cable development and activity.

**'Cables 2'**: The following factors will be taken into account on a case by case basis when reaching decisions regarding submarine cable development and activities:

- Cables should be suitably routed to provide sufficient requirements for installation and cable protection;
- New cables should implement methods to minimise impacts on the environment, seabed and other users, where operationally possible and in accordance with relevant industry practice;
- Cables should be buried to maximise protection where there are safety or seabed stability risks and to reduce conflict with other marine users and to protect the assets and infrastructure;
- Where burial is demonstrated not to be feasible, cables may be suitably protected through recognised and approved measures (such as rock or mattress placement or cable armouring) where practicable and cost-effective and as risk assessments direct; and
- Consideration of the need to reinstate the seabed, undertake post-lay surveys and monitoring and carry out remedial action where required.

**'Cables 4'**: When selecting locations for land-fall of power and telecommunications equipment and cabling, developers and decision makers should consider the policies pertaining to flooding and coastal protection in Chapter 4 (of the NMP) and align with those in Scottish Planning Policy and Local Development Plans.

### 1.4.3 The Clyde Regional Marine Plan

A pre-consultation of the Clyde Regional Marine Plan (RMP) took place between the 18th March and the 27th May 2019. This outlined a vision, aims and principles for marine planning and an overarching policy framework to guide sustainable development and use of the marine and coastal environment. The aim of the RMP is to contribute to the high-level government targets that are supporting a clean and safe, productive, biologically diverse, and productive marine environment, accessible for all.

Section 1 of the RMP provides general policies to guide marine developments and activities. Section 2 outlines policy relating to the key current economic activities taking place in the Clyde Marine Region, which include fisheries, aquaculture, recreational activities and tourism, shipping, ports, harbours, ferries, military activities, energy, subsea cables and pipelines, and marine aggregates extraction (Clyde Marine Planning Partnership, 2019).

### 1.4.4 Compliance with the Scottish NMP and the Clyde Regional Marine Plan

SHEPD have considered all the relevant policies within the NMP when developing the replacement cable between Carradale and Arran. As the policy requirements of the Clyde's Marine Plan relating to the development of subsea cables reflect those of the Scottish NMP, it can be concluded that these have been considered in conjunction with the NMP as part of the project.

The need to replace the cable is of over-riding public concern as without the new cable there is high potential that the existing cable may fail resulting in loss of power supply to the island of Arran and the consequences this would have on the local communities on the island and further afield. However, the design of the replacement cable route has been carried out in a manner of sustainable development and co-existence with other users of the sea as far as practically possible.

The nearest NCMPA to the Project area is the South Arran NCMPA, located 8 km south-east of the Project area (Section 3.2). Given the distance to this NCMPA, the temporary nature of the proposed works and the small discrete area of seabed impacted (Section 5.4), no impacts on the features of the NCMPA are expected and no further assessment was undertaken.

The distribution submarine electricity cable installation will be designed to be as short as possible, thereby limiting the duration of potential impact and disturbance to sensitive species from man-made noise and physical presence as much as possible. The project area is localised at some distance from protected sites for cetaceans and pinnipeds which are the most likely to be impacted by noise. Potential impacts on protected sites and species may also be mitigated by carrying out the proposed works out-with the breeding seasons for sensitive species.

The cable has been designed using best industry practice to ensure it achieves high quality and safety standards and ensures the continued safe distribution of electricity to the inhabitants of Arran.

Whilst it is not possible to bury the cable across the whole route due to the rocky nature of the seabed, SHEPD plan to bury the cable in areas of sufficient sediment using jetting methods. Rock bags, concrete mattresses and/or rock placement may be used to stabilise and protect the cable. A post installation survey of the cable and associated protection measures will be conducted, and as built survey data will be provided to UKHO and other relevant stakeholders. This ensures that the location of the cable is fully understood and documented accurately on navigational charts. These factors ensure that Cables policy 2 (Section 1.4.2) has been complied with as far as practically possible.

The above demonstrates that as far as practically possible, SHEPD will comply with all relevant policies within the Scottish NMP and draft Clyde RMP and any policies relevant to cable installation activities.

## 1.5 Environmental Assessment Scope

The following sections provide information on:

- The identification of potential impacts on protected sites and key receptors associated with those sites;
- The identification of potential impacts on other key receptors and an assessment of the potential for those impacts to be significant; and
- Mitigation measures that will be implemented to avoid or minimise any potential impacts (these include mitigation measures that are inherent to the project design).

Ongoing liaison between the SHEPD project team and the environmental consultants during the course of the impact assessment work has allowed for environmental considerations to be incorporated into the project design as appropriate.

The cable route from Carradale to Arran has a small discrete footprint when compared to the overall offshore area. The proposed cable installation works are also temporary in nature and will be short term. A small number of potential impacts on the following key receptors have been considered to ensure that the potential impacts of the proposed project are adequately assessed and are either inherently sufficiently limited in nature or that sufficient control measures will be implemented to ensure impacts are not significant:

- Protected sites and species associated with those sites;
- Water quality;
- Benthic ecology;
- Marine megafauna;
- Marine archaeology; and
- Commercial fisheries and other sea users.

### 1.5.1 Exclusions from the Scope of Assessment

Since the cable route replacement works will be a like for like replacement of the existing cable, the operational aspects (such as electromagnetic fields, and sediment heating effects) of this project will not constitute a change from baseline conditions. Therefore, only the installation phase is considered by this MEA. This appraisal only covers the marine cable installation activities, below Mean High Water Spring (MHWS).

SHEPD are committed to undertaking a review as to the future options for decommissioning the existing cable. This review, and any subsequent works will be subsect to a separate assessment and licence application. As such decommissioning is also out-with the scope of this MEA.

Geophysical survey operations including, pre, during and post installation will be conducted as part of the proposed cable replacement works. However, these survey operations are subject to existing consents held by SHEPD, specifically:

- An EPS Licence Reference – MS EPS 32 2019 0; and
- A Basking Shark Derogation Licence Reference – MS BS 09 2019 0.

As such no geophysical survey operations are included within the scope of this MEA.

### 1.5.2 Cumulative Impact Assessment

The Current Marine Projects list on Marine Scotland's website (Marine Scotland, 2021) was reviewed to identify other projects with the potential to result in cumulative effects. However, considering the extremely localised nature of the effects likely to be associated with the proposed cable replacement works, no potential cumulative effects were identified, and no further assessment is required.

# 2 ENVIRONMENTAL OVERVIEW AND INITIAL IMPACT ASSESSMENT

## 2.1 Protected Sites

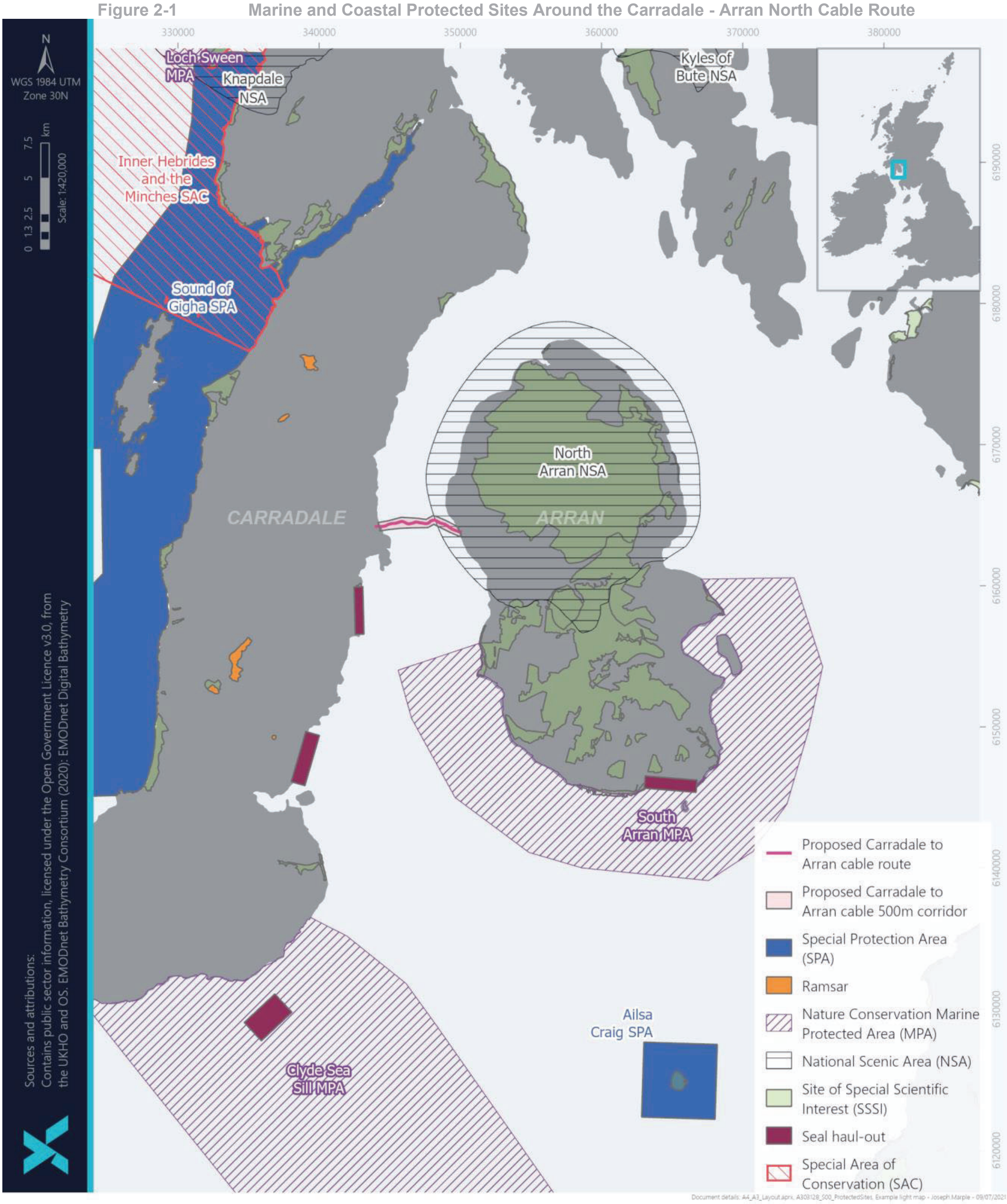
There are no offshore or coastal protected sites within the immediate vicinity of the proposed cable route, however there are several in the wider region which need considered. These sites, their designated features and the distance to the proposed cable route are detailed in Table 2-1. They are also shown on Figure 2-1.

Table 2-1 List of Marine and Coastal Protected Sites within a 40 km Radius of the Proposed Carradale - Arran Cable Route

| Site name | Designation | Designated features | Approximate distance (km) from the cable corridor |
|---|---|---|---|
| **International Designations** | | | |
| South Arran | NCMPA | • Burrowed mud;<br>• Kelp and seaweed communities on sublittoral sediments;<br>• Maerl beds;<br>• Maerl or coarse shell gravel with burrowing sea cucumbers;<br>• Ocean quahog aggregations;<br>• Seagrass beds; and<br>• Shallow tide-swept coarse sands with burrowing bivalves. | 8.1 km south-east |
| Sound of Gigha | Special Protection Area (SPA) | Proposed qualifying interests (non-breeding):<br>• Great northern diver (*Gavia immer*)<br>• Common eider (*Somateria mollissima*)<br>• Red-breasted merganser (*Mergus serrator*) | 12.9 km west |
| Inner Hebrides and the Minches | Special Area of Conservation (SAC) | • Harbour porpoise *P. phocoena* | 15.0 km north-west |
| Clyde Sea Sill | NCMPA | • Black guillemot (breeding);<br>• Circalittoral and offshore sand and coarse sediment communities; and<br>• Fronts; and<br>• Marine geomorphology of the Scottish shelf seabed (sandbanks, sand ribbon fields, sand wave fields). | 27.7 km south-west |
| South-East Islay Skerries | SAC | • Harbour seal | 33.9 km north-west |

| Site name | Designation | Designated features | Approximate distance (km) from the cable corridor |
|---|---|---|---|
| Loch Sween | MPA | • Burrowed mud<br>• Maerl beds<br>• Native oysters<br>• Sublittoral mud and mixed sediment communities | 34.4 km north-west |
| Ailsa Craig | SPA | • Northern gannet (*Morus bassanus*) (breeding);<br>• Guillemot (*Uria aalge*) (breeding). | 38.1 km south-east |
| Tayvallich Juniper and Coast | SAC | • Annex I habitats of Juniperus communis formations on heaths or calcareous grasslands<br>• Annex II species of Marsh fritillary butterfly<br>• Annex II species of otter *Lutra lutra* | 39.0 km north-west |
| **National Designations** | | | |
| North Arran | National Scenic Area (NSA) | Landscape | 0 km (Arran landfall) |
| Rubha nan Sgarbh | Seal Haul-out | Harbour seal | 4.0 km south-west |
| Yellow Rock | Seal Haul-out | Harbour seal | 15.0 km south-west |
| Knapdale | NSA | Landscape | 29.9 km north-west |
| Sound of Pladda Skerries | Seal Haul-out | Harbour seal | 21.5 km south-east |
| Sanda and Sheep Island | Seal Haul-out | Harbour seal | 33.5 km south-west |
| Southannan Sands | SSSI | Intertidal marine habitats and saline lagoons: Sandflats | 35 km north-east |
| Kyles of Bute | NSA | Landscape | 35 km north |
| Ulva, Danna and the McCormaig Isles | SSSI | Landscape and seascape | 36 km north-west |
| Jura | NSA | Landscape | 36 km north-west |
| Ballochmartin Bay | SSSI | Coastal feature:<br>• Flora and fauna of the intertidal area | 36 km north-east |
| Craighouse Small Isles and Lowlandman's Bay | Seal Haul-out | Harbour and common seal | 37.9 km north-west |

Figure 2-1 Marine and Coastal Protected Sites Around the Carradale - Arran North Cable Route




Further detail and impact assessment on ecologically protected sites and their qualifying features in the vicinity of the Project is provided in Section 3 – Ecological Protected Sites.

## 2.2 Physical Environment

The Arran Basin consists of two deep channels, the Kilbrannan Sound (where the project is located) and the Firth of Clyde. These channels reach a maximum depth of 160 m.

The Clyde region is characterised by winds from the south-west with many islands exposed to its full force. The mean wind speeds exceeded for 75% of the time are about 4 m/s across the western part of the region and about 3 m/s along the mainland coast (Barne *et al*., 1997).

The mean tidal range between Kintyre and Arran is approximately 3.2 m, which is moderate in comparison to other areas around Scotland (NMPi, 2021). The annual mean wave power in the region is 0.1-12.0 kW/m and the annual mean wave height is 0.26-0.30 (NMPi, 2021).

The irregular form of the coastline results in great variability in the wave energy experienced along the coast. To the west of Kintyre, significant wave height exceeds 3 m in winter and less than 2.5 m in summer, however the project area is more sheltered due to its location between two islands, and wave heights of 1.5 m are exceeded for only 10% of the time in this area (Barne *et al*., 1997).

The region presents a complex bathymetry with deep sea lochs and channels which are the result of the scouring action of ice and the variation in lithology within the bedrock (Barne *et al*., 1997). The bathymetry along the Carradale - Arran replacement cable route and in the nearshore areas is presented in Figure 2-2 and Figure 2-3 (Briggs Marine, 2018a; 2018b) and Figure 2-4 and Figure 2-5 (Fugro, 2021a; 2021b).

Inshore and offshore surveys were undertaken along the proposed Carradale - Arran replacement cable route. The inshore survey was designed to provide a 250 m overlap with the offshore survey coverage at each end of the crossing and extend the survey coverage inshore to safe navigational limits. The survey covered in this MEA are the Briggs Marine (2018a; 2018b) and the Fugro (2021a; 2021b). The results from all surveys suggest that the seabed consists mostly of sandy mud and sandy gravel, with rock outcrops across the survey corridor and areas of boulder fields and shell fragments (Briggs Marine, 2018a; 2018b; Fugro, 2021a; 2021b). It should be noted that boulder fields are areas where at least 5 boulders of 1 m in diameter were present in a 10 $m^2$ area) (Briggs Marine, 2018a).

| |
|---|
| Further detail and impact assessment on water quality and seabed habitats in the vicinity of the project is provided in Sections 4 and 5. |

Figure 2-2 Bathymetry Along the Carradale – Arran Replacement Cable Route (Briggs Marine, 2018a)

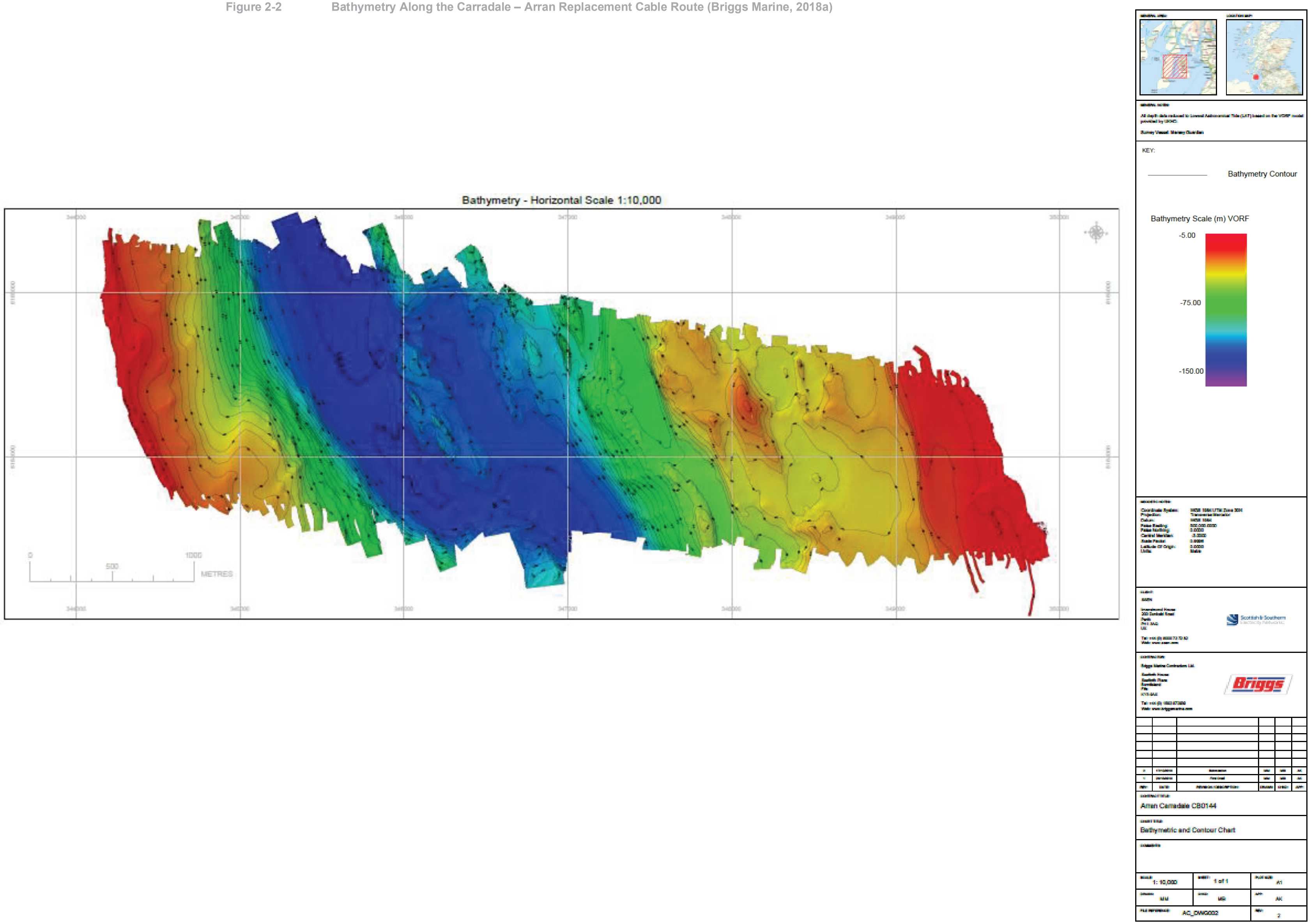


Figure 2-3 Bathymetry in the Nearshore Area at Carradale (left) and Arran (right) (Briggs Marine, 2018a)

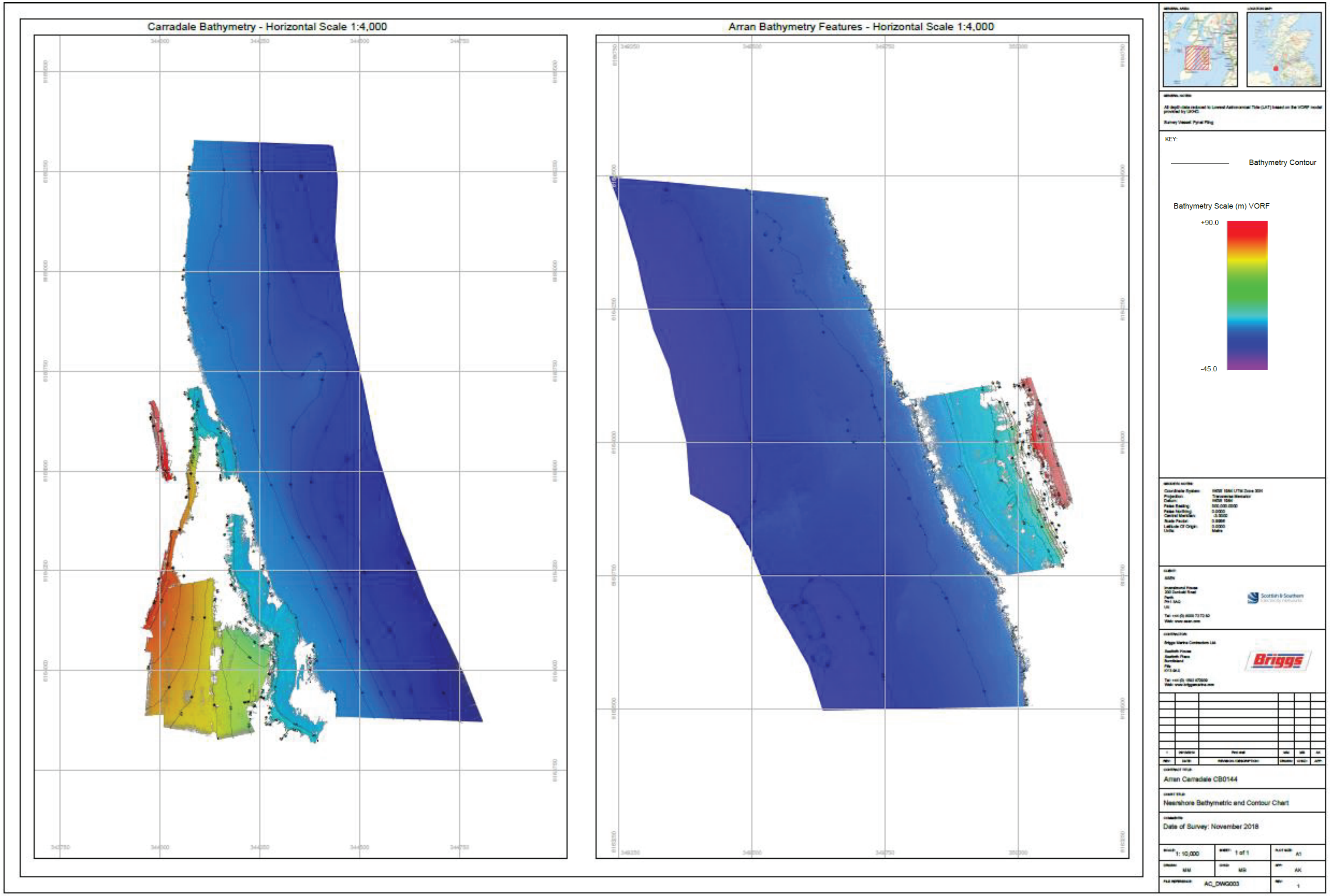


Figure 2-4 Bathymetry Along the Carradale – Arran Replacement Cable Route (Fugro, 2021b)

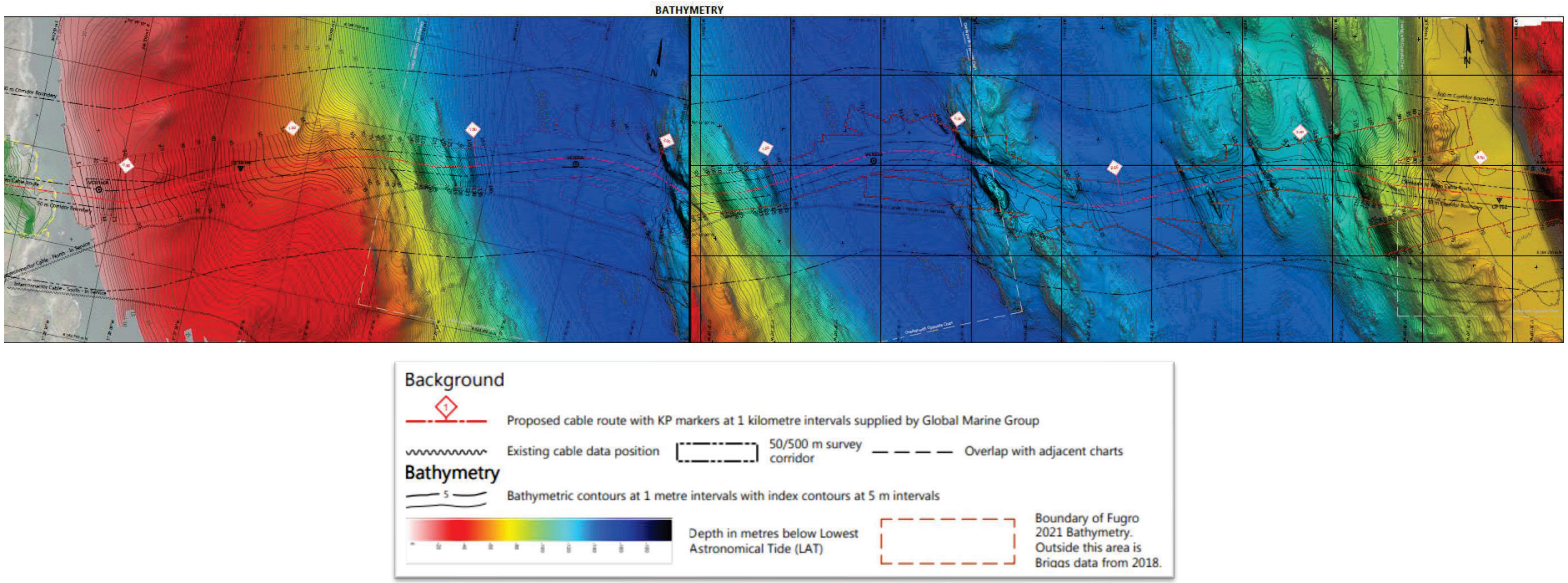
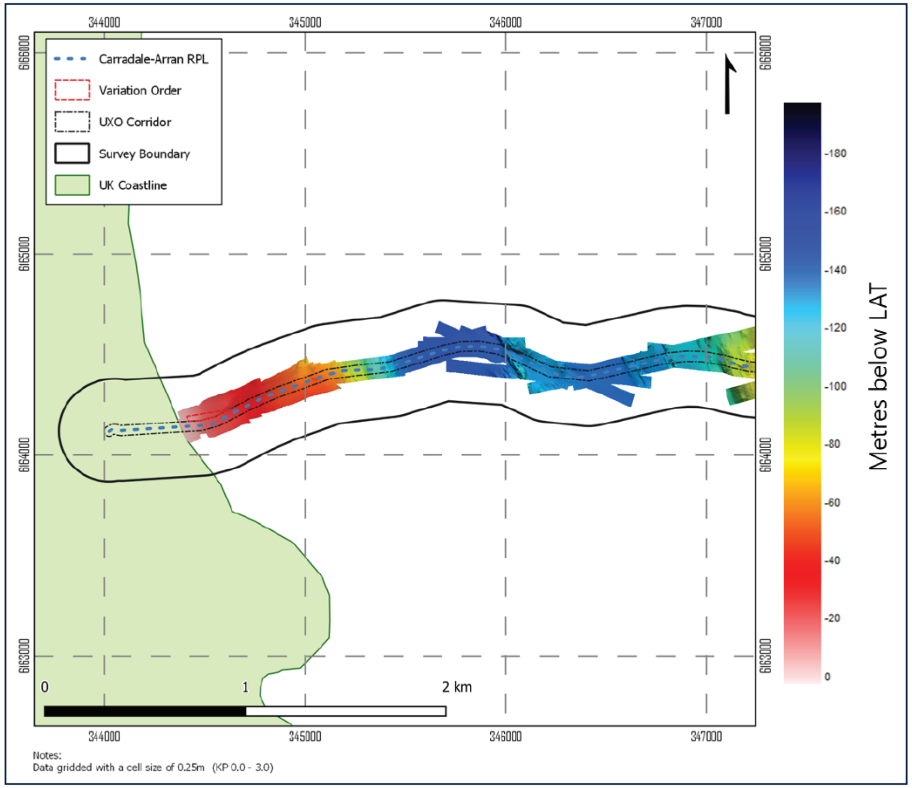
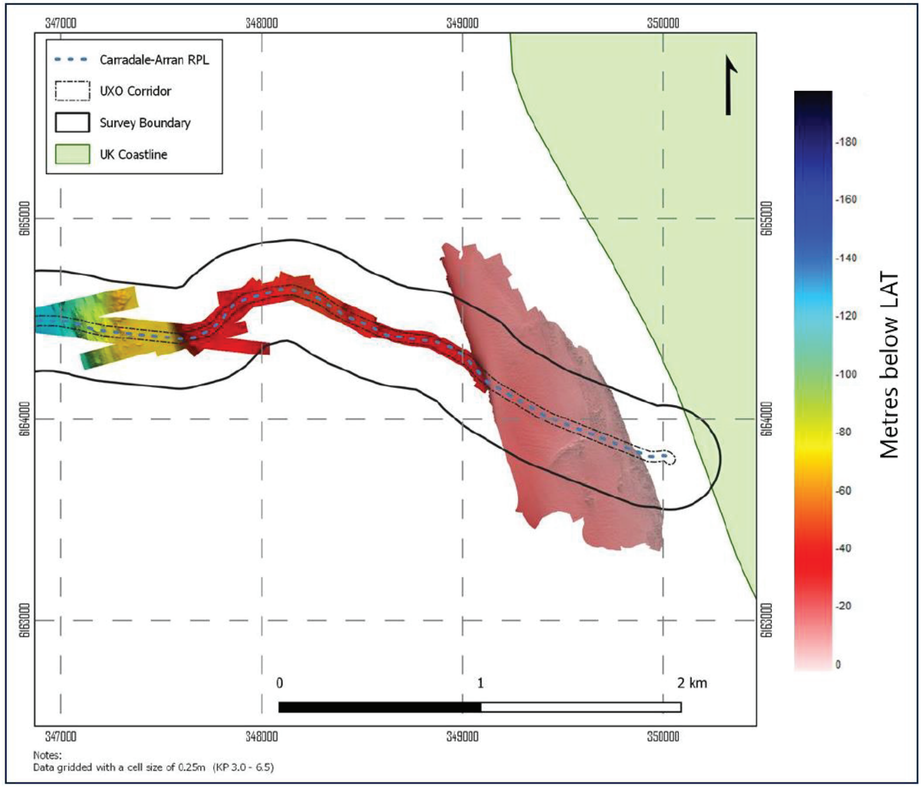


Figure 2-5 Bathymetry in the Nearshore Area at Carradale (left) and Arran (right) (Fugro, 2021b)



## 2.3 Benthic Ecology

The broad-scale habitat map UKSeaMap which uses the European Nature Information System (EUNIS) habitat classification system. This classifies the habitat in the middle section of the cable route as 'Deep circalittoral mud' (EUNIS code A5.37). The proposed cable route towards Carradale, the habitat observed varies which include: 'fucoids on sheltered marine shores' (A1.31) and Barnacles and fucoids on moderately exposed shores (A1.2) within approximately 1 km from the shoreline. In the nearshore area towards Arran the sediments include Barnacles and fucoids on moderately exposed shores (A1.2) (EMODnet, 2021).

The east coast of Kintyre, particularly at Carradale, has historically been described as displaying a variety of habitats associated with a rich fauna and flora. The common eelgrass *Zostera marina* was recorded in some intertidal pools, and dense seabed were recorded in shallow waters. A large bed of the flame shell *Limaria hians* were also reported off the south-east coast of Kintyre (Barne *et al*., 1997). *Z. marina* beds on infralittoral clean or muddy sand and flame shell beds in tide-swept sublittoral muddy mixed sediment are designated as Scottish priority marine features (PMF) (JNCC, 2012; Tyler-Walters *et al*., 2016).

To the south of the proposed cable route, approximately 8 km south-east, the South Arran NCMPA protects a number of PMFs, including kelp and seaweed communities, maerl beds, seagrass beds, ocean quahog aggregations, the biotopes 'maerl or coarse shell gravel with burrowing sea cucumbers' and 'shallow tide-swept coarse sands with burrowing bivalves', and the seabed type 'burrowed mud'.

There are a variety of PMFs which have been identified in the seas around Scotland, some of which are subtidal or intertidal. The list of PMFs is derived from an evaluation of Scotland marine biodiversity interests that are on existing conservation lists including Annexes I and II of the Habitats Directive, the OSPAR[2] list of threatened or declining habitats and species and UK Post-2010 Biodiversity Framework (2012) priority species. PMF species can also form part of Marine Protected Areas (MPAs). These are marine features that have been identified as requiring protection through the designation of NCMPAs under the Marine (Scotland) Act 2010.

During benthic surveys undertaken in the Clyde region, with the purpose of establishing the distribution of PMFs in the area, seabed sediment sampling was undertaken in the Kilbrannan Sound along transects to the north of the existing cable routes. Areas of exposed bedrock covered in silt associated with the biotope 'large solitary ascidians and erect sponges on wave-sheltered circalittoral rock' (CR.LCR.BrAs) were recorded. The fauna characterising this biotope included the sea loch anemone *Protanthea simplex*, large ascidians (e.g. *Ciona intestinalis*, *Corella parallelogramma*, and *Ascidia mentula*), the crinoid *Antedon* sp., various echinoderm species, hydroids, tube worms and squat lobsters. Between the bedrock areas, mixed sediment was identified, with several polychaete tubes, tower shells (*Turritella communis)* and terebellids. The biotope '*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock' (CR.MCR.EcCr.UrtScr) was also recorded with abundant *Antedon bifida*, *Urticina eques* and Crinoidea. (Allen *et al.,* 2013).

| |
|---|
| Results from the benthic surveys in the nearshore and offshore areas confirmed the presence of Annex I Bedrock reefs and of the PMFs kelp beds and burrowed mud within the Project area. A detailed description of the location of all key habitats and species of conservation importance is provided in Section 5 – Benthic Ecology. |

## 2.4 Fish Ecology

### 2.4.1 Spawning and Nursery Grounds

A number of commercially important fish and shellfish species can be found in the vicinity of the project area. Fish and shellfish populations may be vulnerable to impacts from offshore and nearshore activities such as pollution, noise (particularly seismic) and exposure to aqueous effluents, especially during the egg and juvenile stages of their lifecycles (Bakke *et al*., 2013).

[2] The Convention for the Protection of the Marine Environment of the North East Atlantic

The project area lies within the International Council for the Exploration of the Sea (ICES) rectangle 40E4. in an area of spawning and nursery grounds for several commercially important species. The area observed spawning for Norway lobster *Nephrops norvegicus*, sandeels *Ammodytes americanus* and sprat *Sprattus sprattus*. There is also high intensity nursery for cod *Gadus morhua*, herring *Clupea harengus* and spurdog *Squalus acanthias* as per Ellis *et al.,* (2012). Information on spawning and nursery periods for these different species, including peak spawning times (where applicable) are detailed in Table 2-2.

Table 2-2 Fisheries Sensitivities within ICES 40E4 Rectangle (Coull *et al.,* 1998; Ellis *et al.,* 2012)

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anglerfish | N | N | N | N | N | N | N | N | N | N | N | N |
| Cod | N | N | N | N | N | N | N | N | N | N | N | N |
| Common skate | N | N | N | N | N | N | N | N | N | N | N | N |
| European hake | N | N | N | N | N | N | N | N | N | N | N | N |
| Herring | N | N | N | N | N | N | N | N | N | N | N | N |
| Mackerel | N | N | N | N | N | N | N | N | N | N | N | N |
| Norway lobster | SN | SN | SN | S*N | S*N | S*N | SN | SN | SN | SN | SN | SN |
| Plaice | N | N | N | N | N | N | N | N | N | N | N | N |
| Saithe | N | N | N | N | N | N | N | N | N | N | N | N |
| Sandeels | SN | SN | N | N | N | N | N | N | N | N | SN | SN |
| Spotted ray | N | N | N | N | N | N | N | N | N | N | N | N |
| Sprat | | | | | S* | S* | S | S | | | | |
| Spurdog | N | N | N | N | N | N | N | N | N | N | N | N |
| Whiting | N | N | N | N | N | N | N | N | N | N | N | N |
| **Note:** S = Spawning; N = Nursery; * = Peak spawning; Blue highlight = high intensity nursery as per Ellis *et al.,* (2012) | | | | | | | | | | | | |

Fisheries sensitivity maps produced by Aires *et al.* (2014), for Marine Scotland Science detail the likelihood of aggregations of fish species in the first year of their life (i.e. group 0 or juvenile fish) occurring around the United Kingdom Continental Shelf (UKCS). Maps from Aires *et al.* (2014), which show the probability of the presence of aggregations of 0 group anglerfish *Lophius piscatorius*, blue whiting *Micromesistius poutassou*, European hake *Merluccius merluccius*, haddock *Melanogrammus aeglefinus*, herring, mackerel *Scomber scombrus*, horse mackerel *Trachurus trachurus*, Norway pout *Trisopterus esmarkii*, plaice *Pleuronectes platessa*, sprat and whiting *Merlangius merlangus* are available on the NMPi (2021) (note, for European hake and anglerfish the maps show probability of presence of 0 group fish as opposed to presence of aggregations). The probability of 0 group fish species occurring in the project area was low for all species.

Spawning areas for most species are not rigidly fixed and fish may spawn either earlier or later from year to year. In addition, the mapped spawning areas represent the widest known distribution given current knowledge and should not be seen as rigid unchanging descriptions of presence or absence (Coull *et al*, 1998). Whilst most species spawn into the water column of moving water masses over extensive areas, benthic spawners (e.g. sandeel) have very specific habitat requirements, and as a consequence their spawning grounds are relatively limited and potentially vulnerable to seabed disturbance and change.

Of the spawning species likely to occur in the area, only sandeels and Norway lobster use the seabed directly for spawning.

There are five species of sandeel known to occur in the North Sea, with the majority (90%) of the commercial catch made up of the lesser sandeel Ammodytes marinus. Sandeel are shoaling fish which lie buried in the sand during the night, and hunt for prey in mid-water during daylight hours (DECC, 2016). They are restricted to sandy sediments (Holland *et al.,* 2005; DECC, 2016). They feed mainly on planktonic prey such as copepods and crustacean larvae, but they also consume polychaete worms, amphipods, and small fish including other sandeel. When active, sandeel swim continually in order to remain clear of the bottom (DTI, 2001). Sandeel usually spawn between November and February and lay eggs in clumps on sandy substrates

(DECC, 2016). The larvae are pelagic for approximately two to five months after hatching and are believed to over-winter buried in the sand (DECC, 2016). Sandeel are important not only to commercial fisheries but also are of ecological significance as they are a vital food source for marine birds and predatory fish (DECC, 2016). According to Holland, *et al.,* (2005), sandeels are likely to avoid areas with greater than 4% of silt/clay or very fine sand Additionally, according to Jensen *et al.,* (2011) most sandeel species inhabit shallow, turbulent sandy areas, located at depths of 20–70 m where the content of the finest particles of silt and clay is low.

Norway lobster are widely distributed on muddy substrata throughout the northeast Atlantic (Sabatini and Hill, 2008), and spawn all year round. Norway lobster construct their burrows in muddy sediments and their range is limited by the availability of suitable sediment. They spend most of their time in their burrows, only coming out to feed and look for a mate. They carry their brood under their tails until they hatch and disperse as planktonic larvae (Scottish Government, 2017).

Particular attention also has to be considered for herring. Ellis *et al.* (2012) and Coull *et al.* (1998) indicate that there is a main nursery ground for herring *Clupea harengus* in and around the proposed cable route and that there is the potential for juvenile herring to be present in the project area. However, suitable nursery ground habitat is not restricted to the project area and is widely distributed along the west coast of Scotland. Herring are particularly sensitive to disturbance during spawning as they use the seabed, in areas of coarse sand, gravel, small stones and rock, to deposit their eggs. However, there is no known spawning ground for herring in the vicinity of the project area, the nearest being to the south of the Isle of Arran, as reported by Coull *et al*. (1998). Due to the high mobility of this species, wider availability of nursery habitat and lack of known spawning ground in the vicinity of the project, no significant impacts on herring are anticipated.

As discussed in Section, 2.3, the project area is located within a dynamic area which primarily comprises muddy sand in the centre offshore area and sandier sediments towards the coasts. Therefore, it can be determined that although sediment found within the area may be suited for some species (i.e. Norway pout) it is not suited for others. Given that the species are mobile in nature and considering the small scale, short-term nature of the project, no significant impacts on fish populations are anticipated.

### 2.4.2 Noise-Sensitive Species

The ability of fish to detect sound depends on whether they have a swim bladder and whether the swim bladder is located near to a fish's ear. Hawkins and Popper (2014) have divided fishes into several different categories based on the structures associated with hearing. The functional groups include:

- Low sensitivity to noise - fishes without a swim bladder (these can only detect kinetic energy – e.g., sharks, common skate complex, mackerel, whiting);
- Medium sensitivity to noise - fishes with a swim bladder that is far from the ear and thus not likely to contribute to pressure reception, so the fishes are primarily kinetic detectors (e.g., salmon, sea trout) and eggs and larvae that are less mobile than adult fish and therefore not able to readily move away from the noise source; and
- High sensitivity to noise - fishes with a swim bladder or other air bubble that is close to the ear and enables sound pressure to be detected, broadening the hearing range and increasing hearing sensitivity (e.g., herring, sprat, cod).

There is potential for several noise sensitive species such as cod, herring and Atlantic salmon to be present along the proposed cable route. However, underwater noise emissions associated with the project are expected to be minimal (as detailed in Appendix A), and as such no adverse impacts on noise sensitive fish are anticipated.

### 2.4.3 Electro-Sensitive Species

Electro-Magnetic Fields (EMF) emitted by submarine cables during operation could potentially affect elasmobranch species (shark and rays) which possess specialised electroreceptors and are able to detect induced voltage gradients associated with water movements and geomagnetic emissions. Species of fish that are most vulnerable to the effects of EMF are elasmobranch species (sharks, rays and skates), which possess specialised electroreceptors; and other electro-sensitive species (usually migratory species), which can detect induced voltage gradients associated with water movements and geomagnetic emissions (e.g. Atlantic salmon). Information on the distribution and migration patterns of many of these species is limited and often the patterns are widespread and not limited to specific areas. However, data shows that the replacement cable route passes through areas defined as potential nursery grounds for two elasmobranch species of commercial importance: common skate and spurdog (Ellis *et al.*, 2012; Coull *et al.*, 1998). The common skate is critically endangered per the International Union for Conservation of Nature (IUCN) Red List.

There is also potential for Atlantic salmon *Salmo salar* and sea trout *Salmo trutta* to use the west coast of Scotland as a migration route from freshwater rivers to deep offshore waters off Iceland. Atlantic salmon and sea trout are diadromous fish species have a life cycle that includes time spent in both riverine and marine environments. From their freshwater habitat, salmon and trout migrate to their marine feeding grounds and then return, several years later, to their natal river to spawn. Research has demonstrated that juvenile salmon use the earth's magnetic fields to orient themselves on their long-distance migration to their natal grounds (Putman *et al.,* 2014). These two species are highly sympatric, often sharing the same freshwater rivers and tributaries for their spawning grounds (Jensen *et al.*, 2012).

Salmon have been confirmed to be present in the Carradale Water and in the Iorsa Water, the nearest river mouths to the proposed landfall sites on Kintyre and Arran, respectively (NMPi, 2021). Since 2010, data has shown a continued decline in the number of salmon returning to Scottish waters from the open ocean, southern Greenland and sub-Antarctic marine habitat (NatureScot, 2020). Salmonid populations may be impacted by a variety of marine and freshwater environmental factors, including: habitat degradation, diminished water quality or availability (e.g. from drought or over-abstraction), and obstructions within their migration route. Migratory obstructions may include artificial water obstructions, such as dams or weirs. Salmon prefer coarse gravels for their spawning habitat, as their eggs are particularly susceptible to being smothered by fine sediments in the water column due to their prolonged incubation period (Pattison *et al.*, 2014). Consequently, it is important to consider the extent of sediment suspension and dispersal from cable trenching to ensure this migratory species is not significantly impacted.

Atlantic salmon and sea trout are both listed as PMF in Scotland (NatureScot, 2020). Salmon are afforded additional protection in Scottish waters through Schedule 3 of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) and as an OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) threatened species.

The European *eel Anguilla Anguilla* is a widespread migratory fish in Europe and can be found in freshwater bodies as well as coastal waters and in the open sea where they spawn. Studies suggest that a substantial proportion of eels never enter freshwaters, remaining along the coasts of Europe, whilst others migrate back and froth between freshwater and salt water (Scottish Government, 2017). It is listed as OSPAR threatened and/or declining species and is a PMF in Scotland (NatureScot, 2020). Due to its distribution in coastal waters and its protected status, potential impacts on European eels arising from EMFs emitted by the proposed cables need to be considered.

However, it should be noted that EMFs are already present due to the existing cable and therefore the replacement cable will not introduce any new EMF, and hence does not constitute a change from baseline. Additionally, the EMFs decrease with distance from the cable and effects become negligible within a few metres. Where the cable will be buried, benthic species will not interact with the EMF emissions. Therefore, no impacts are expected on electro-sensitive species.

| |
|---|
| Given the localised, short-term nature of the proposed works and the mobile nature of fish, any adverse impacts on this receptor are highly unlikely. Therefore, no further assessment of impacts on fish has been undertaken in this document. |

## 2.5 Ornithology

The coasts off Kintyre and Islay, as well as the surrounding region, is of national and international importance for their breeding colonies of seabirds. Seabirds from these breeding colonies are likely to be the main source of seabirds found in offshore waters, in particular the project area is known to be an important breeding area for common guillemot (Kober *et al*., 2010).

The Joint Nature Conservation Committee (JNCC) prepares the latest analysed trends in abundance, productivity, demographic parameters and diet of breeding seabirds, from the Seabird Monitoring Programme (JNCC, 2020). This data provides at-a-glance UK population trends as a percentage of change in breeding numbers from complete censuses. From the year 2000 to 2018, the following population trends for species known to use the area have been recorded: northern fulmar (-38%), black legged kittiwake (-50%) and common guillemot (+1%). Breeding seabird numbers of some species have shown a long-term decline, most probably as a result of a shortage of key prey species such as sandeel associated with changes in oceanographic conditions (Baxter *et al*., 2011: DECC, 2016).

As summarised in Table 2-1, there are a number of SPAs within 40 km of the project area. Particular attention should be given to common guillemot and northern gannet which display moderate and slight avoidance behaviour to vessels at short range (e.g. less than 200 m), respectively, and are therefore considered to have moderate sensitivity to vessel disturbance. Cormorants are typically flushed (temporarily displaced) by vessels at a moderate distance from vessels, therefore they are more sensitive to disturbance than guillemots and gannets (Furness *et al.,* 2012).

The breeding seasons for the seabirds listed above are provided in Table 2-3.

**Table 2-3 Seabirds Breeding Seasons and Nest Occupancy Periods in the Scottish Marine Environment**

| Protected seabird species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common guillemot | | | | | | | M | M | M | M | | |
| Cormorant | | | | | | | | | | | | |
| Northern gannet | | | | | | | | | | | | |

Key: **Green** = breeding season; **Dark blue** = breeding site attendance; **Light blue** = non-breeding period; = not present in significant numbers; M = flightless moult period.

> Although many seabird species may occur in the vicinity of the project area, given the small scale and short-term nature of the proposed works, only those that are designated features of protected sites in the Firth of Clyde and wider region have been taken further for assessment (Section 3.2.2), with no adverse impacts anticipated on other seabird species Impacts on protected areas with seabird features in the vicinity of the Project area are therefore assessed in Section 3 – Ecological Protected Sites. The implementation of the embedded mitigation outlined in Section 1.3.5 including minimising vessel lighting, slow speeds of project vessels, and avoidance of rafting seabirds where operationally possible will further reduce the potential for adverse impacts to seabirds.

## 2.6 Marine Megafauna

### 2.6.1 Marine Mammals

All species of cetacean (whale, dolphin and porpoise) occurring in UK waters are listed in Annex IV (species of community interest in need of strict protection) of the Habitats Directive as European Protected Species (EPS) and fully protected in Scottish territorial waters (out to 12 nautical miles) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Bottlenose dolphin and harbour porpoise are also listed on Annex II of the Habitats Directive as species whose conservation requires the designation of SACs as enforced through Schedule 2 of the Habitats Regulations.

Although not afforded the strict protection of EPS through the Habitats Directive, pinniped species (seals) occurring in UK waters are listed in Annex V (and hence Schedule 3 of the Habitats Regulations) such that they are defined as species of community interest and taking in the wild may thus be subject to management measures. Grey and harbour seals are also listed in Annex II of the Habitats Directive (and therefore Schedule 2 of the Habitats Regulations) as requiring protection through the designation of SACs and are protected while at 194 haul sites around Scotland under Part 6 of the Marine (Scotland) Act 2010. The closest designated seal haul-out is Rubha nan Sgarbh, protecting harbour seals, located 4.0 km south-west from the project area (Figure 2-1).

All species of cetacean and pinniped occurring regularly in UK waters are listed as a PMF.

Key species of cetacean reported in the vicinity of the project area include harbour porpoise and minke whale (Reid *et al*., 2003), however the predicted density of these two species in the project area are low (Hammond *et al*., 2013).

### 2.6.2 Basking sharks

Due to their size (up to 11 m in length; average 6 – 8 m), slow swimming speeds (up to 4 mph) and preference for swimming in coastal waters during summer months, basking sharks are considered to be at potential risk of collision with installation vessels during cable installation. Basking sharks are protected in UK waters under Schedule 5 of the Wildlife and Countryside Act 1981 and under the Nature Conservation (Scotland) Act 2004.

Basking sharks are frequently observed in Scottish waters between May and October with hotspots identified in the vicinity of the islands of Arran and Kintyre (Doherty *et al*., 2017; Witt *et al*., 2012).

> Potential impacts on marine mammals and basking sharks are assessed in Section 6, with commentary on potential impacts on designated sites provided in Section 3.

## 2.7 Commercial Fisheries

Based on Vessel Monitoring System (VMS) data obtained from Marine Scotland and data from the ScotMap Project (Scottish Government, 2013), it appears that, in general, fishing effort along the proposed subsea cable route is moderate. *Nephrops* trawlers dominated the fishing effort in the project area during the period 2009-2017, with an average of approximately 320 hrs per year, followed by *Nephrops* pots (NMPi, 2021). Crab and lobster pots showed low to medium fishing effort and value (Kafas *et al.,* 2012).

Mobile gear is restricted at the weekend in the Firth of Clyde, which encompasses the Project area. Crab and lobster pots are used in the vicinity of the Project area (NMPI, 2019).

In addition, the west coast region is important for aquaculture with a number of active finfish and shellfish sites along the coastline. The closest active aquaculture site for finfish is the Eilean Grianain site, approximately 510 m to the north west of the cable route corridor. The closest active aquaculture site for shellfish is the Kildalloig Bay, approximately 20 km to the south. Furthermore, the closest Shellfish Protected Area is the Loch Fyne site 17 km to the north of the cable corridor (NMPi, 2021).

> Due to the small scale, temporary and short-term nature of the Project, no significant impacts on commercial fisheries are expected during the installation phase, therefore no further assessment has been undertaken. With regard to operational impacts, it is noted that the proposed cable will be laid in close proximity to the existing Carradale – Arran North cable. In line with guidance provided by the UKHO and International Convention for the Safety of Life at Sea (SOLAS), SHEPD recommend that fishing vessels should avoid trawling over installed seabed infrastructure. Vessels are also advised in the Mariners Handbook not to anchor or fish (trawl) within 500m of a cable. As such the presence of the new cable will not comprise a change in baseline conditions, considering the existing assets in the area. Further information regarding SHEPD's approach to minimising impacts on commercial fisheries is provided in Section 8.

## 2.8 Shipping and Navigation

The Kilbrannan Sound is an area of low shipping density, with an average of 5 – 20 vessel transits weekly within the project area, mostly comprising cargo and fishing vessels (NMPi, 2021).

There are no ferry routes in the immediate vicinity of the project, the nearest is the Claonaig to Lochranza route, located approximately 15 km north-north-east of the proposed replacement cable route (NMPi, 2021).

> Due to the small scale, temporary and short-term nature of the Project, and the low level of shipping activity in the Project area, no significant impacts on shipping are expected, therefore no further assessment has been undertaken. Further information regarding SHEPD's approach to minimising impacts on other sea users is provided in Section 8.

## 2.9 Marine Archaeology

There are several wrecks in the Kilbrannan Sound, with known locations, however, none are located within the project area. The nearest wreck is located 8.7 km south-south-west of the proposed replacement cable route, and the nearest protected wreck under the Protection of Military Remains Act 1986, Her Majesty's Ship (HMS) Vandal submarine, is located 15 km north-north-east (NMPi, 2021). A munition find was reported to the south of Carradale Bay, approximately 5 km south-west of the proposed replacement cable route by sea (Ordtek, 2019).

> Further detail and impact assessment on marine archaeology in the vicinity of the Project are provided in Section 7 – Marine Archaeology.

# 3 ECOLOGICAL PROTECTED SITES

## 3.1 Introduction

This section of the report provides detail on the protected sites and their qualifying features in the vicinity of the project, as well as the relevant legislation applicable to each site.

It then assesses the potential impacts on the sites that could be impacted from the proposed activities and discusses the mitigation and management measures that will be undertaken in order to ensure impacts are avoided or minimised and provides a conclusion of the significance of potential impacts.

There are no designated ecological protected sites located in the immediate vicinity of the cable route, however the project does overlap with a National Scenic Area (NSA) – North Arran (Figure 2-1).

## 3.2 Internationally Designated Sites

### 3.2.1 Nature Conservations Marine Protected Areas (NCMPAs) and Special Areas of Conservation (SACs)

The closest NCMPA is the South Arran NCMPA, located 7.7 km south-east of the existing Carradale to Arran north cable. The site is protected for the following features:

> Burrowed mud;
> Kelp and seaweed communities on sublittoral sediments;
> Maerl beds;
> Maerl or coarse shell gravel with burrowing sea cucumbers;
> Ocean quahog aggregations;
> Seagrass beds; and
> Shallow tide-swept coarse sands with burrowing bivalves.

Burrowed mud is widely distributed around the outer regions of the MPA and supports a range of animals including Norway lobster, squat lobster, crabs, worms, ocean quahogs and the slender seapen (Scottish government, 2015b). Due to the distance to the NCMPA (7.7 km), impacts on these protected features are highly unlikely.

Maerl beds, which are made up of a free-living calcified red seaweed that looks like pink branched twiglets, support a range of other seaweeds as well as various sea anemones, starfish and juvenile fish and shellfish. Where the maerl is interspersed with coarse gravel, a variety of tube building worms are to be found as well as sea cucumbers which bury their bodies in the maerl and gravel extending only their white or orange feathery tentacles up into the water column to feed. The seagrass beds that provide shelter and protection here to a range of associated species also help to stabilise sediments as well as trapping and storing carbon dioxide (Scottish government, 2015b). Due to the distance to the NCMPA (7.7 km), impacts on these protected features are highly unlikely.

The South Arran NCMPA also features aggregations of ocean quahog, a species protected under the OSPAR list of threatened and/or declining species and habitats. Given the distance to the NCMPA (7.7 km), impacts on these protected features are highly unlikely.

The Clyde Sea Sill NCMPA, located 27.7 km south-west, protects black guillemot during the breeding season, and a number of seabed features including circalittoral and offshore sand and coarse sediment communities, front and the marine geomorphology of the seabed. Due to the distance to this NCMPA, the seabed features are unlikely to be impacted by the proposed works. Breeding black guillemots have been recorded up to 55 km from their colonies for foraging (Scottish Government, 2011), however given the distance to the Project area and the small scale, short-term nature of the proposed works, the conservation objectives of these sites will not be compromised by the proposed works and therefore, impacts on this site are very unlikely. There are no other NCMPAs within the immediate vicinity of the project area.

The EC Habitats Directive comprises a list of priority habitat types and species that require measures for protection in Europe. In the UK, various habitat types and species listed in the Directive have been recorded in the UK (McLeod *et al.*, 2005). There are currently three SACs within 40 km of the project area that are designated for the presence of Annex I habitats and Annex II species, two of which have a marine component as primary reason for the designation of the site: the Inner Hebrides and the Minches SAC and the South-East Islay Skerries SAC. The features that are primary reasons for designating these sites include harbour porpoise and harbour seal, respectively (Table 3-1). Given the separation between the installation corridor and these sites, the short term and localised nature of the project no adverse effects on these SACs have been identified, with further information provided in Section 6.

There is one SAC designated for European otter *Lutra lutra* within 40 km of the project area. This is the Tayvallich Juniper and Coast SAC located approximately 39.0 km from the cable corridor, and given the distance between the installation corridor and this site, no adverse effects on the conservation objectives are expected.

Table 3-1 NCMPAs and SACs Located in the Vicinity of the Project Area

| Site name | Description and qualifying features | Distance from Project | Potential connectivity with the Project |
|---|---|---|---|
| **NCMPAs** | | | |
| South Arran NCMPA | > Burrowed mud;<br>> Kelp and seaweed communities on sublittoral sediments;<br>> Maerl beds;<br>> Maerl or coarse shell gravel with burrowing sea cucumbers;<br>> Ocean quahog aggregations;<br>> Seagrass beds; and<br>> Shallow tide-swept coarse sands with burrowing bivalves. | 7.7 km | **No**<br>Proposed activities will not impact this site. |
| Clyde Sea Sill NCMPA | > Black guillemot (breeding);<br>> Circalittoral and offshore sand and coarse sediment communities; and<br>> Fronts; and<br>> Marine geomorphology of the Scottish shelf seabed (sandbanks, sand ribbon fields, sand wave fields). | 27.7 km | **No**<br>Proposed activities will not impact this site. |
| Loch Sween NCMPA | > Burrowed mud;<br>> Maerl beds;<br>> Native oysters; and<br>> Sublittoral mud and mixed sediment communities. | 34.4 km | **No**<br>Proposed activities will not impact this site. |
| **SACs** | | | |
| Inner Hebrides and the Minches SAC | > Harbour porpoise *P. phocoena* | 15.1 km | **No**<br>Proposed activities will not impact this site. |

| Site name | Description and qualifying features | Distance from Project | Potential connectivity with the Project |
|---|---|---|---|
| South-East Islay Skerries SAC | > Harbour seal *P. vitulina* | 33.9 km | **No**<br>Proposed activities will not impact this site. |
| Tayvallich Juniper and Coast SAC | > Annex I habitat *Juniperus communis* formations on heaths or calcareous grasslands<br>> Annex II species of otter<br>> Annex II species of marsh fritillary butterfly | 39.0 km | **No**<br>Proposed activities will not impact this site. |

### 3.2.2 Special Protection Areas (SPAs)

The waters surrounding the Isle of Arran support national and international populations of seabirds. Under the EC Birds Directive, breeding (Annex I) or regularly occurring migratory populations of seabird and marine waterfowl are protected through the designation of SPAs. The closest designated SPA to the project area is the Sound of Gigha SPA located 12.9 km to the west and the Ailsa Craig SPA located approximately 38.1 km to the south-east of the Carradale to Arran north cable. These sites are protected for great northern diver, common eider, red-breasted merganser, northern gannet and guillemot (see Table 2-1).

The Sound of Gigha is located 12.9 km to the west. The waters surrounding the Island of Gigha are a stronghold for great northern divers, common eider and red-breasted merganser during the wintering season. They use the sea surrounding Gigha to feed, and for other activities such as moulting (common eider) and roosting. Due to the distance to this SPA (12.9 km), the project will not directly impact any seabirds within the site, however it is possible that some great northern diver, common eider or red breasted merganser individuals occur within or in the vicinity of the project area.

The Ailsa Craig SPA designated for gannet and guillemot may be observed in the project area from time to time. This is due to the maximum foraging range of guillemots of 134 km and 590 km for gannets. Therefore, these species may occur within the project area during the breeding season due to the distance to the Ailsa Craig SPA (38.1 km south-east).

No other SPAs feature within 40 km of the proposed cable route corridor. Given the distance to the project area and the small scale, short term nature of the proposed works, in combination with the embedded mitigation measures detailed in Section 1.3.5; the conservation objectives of these sites will not be compromised by the proposed works and therefore, impacts on these sites are very unlikely.

## 3.3 Nationally and Locally Designated Sites

Under Section 117 of the Marine (Scotland) Act 2010, Scottish Ministers, in consultation with the Natural Environment Research Council (NERC), have formally designated a number of seal haul-out sites to provide additional protection for seals from intentional or reckless harassment under the Protection of Seals (Designated Seal Haul-Out Sites (Scotland) Order 2014). The seal haul-outs occurring in the vicinity of the proposed works are presented in Table 3-2 and shown in Figure 2-1. The majority of sites are located at a significant distance from the area of works (closest 3.9 km) and vessels associated with the project will not be present in the waters adjacent to these sites.

Harbour seal density is estimated as low along the majority of the proposed cable route, between 1 to 5 individuals per 25 $km^2$ as shown on Figure 6-1. Grey seal density is also estimated as low (1 to 5 individuals per 25 $km^2$) along the proposed cable rout, with higher densities on Carradale landfall (5 -10 individuals per 25 $km^2$ (Jones *et al*., 2015).

Nationally important sites include Sites of Special Scientific interest (SSSI). There are three SSSIs within 40 km of the proposed cable route corridor. The closest SSSI with coastal features to the project area is the South Coast of Arran SSSI (Table 3-2). However, due to the distance to these protected sites and the small scale, short-term and temporary nature of the proposed works, it is unlikely that they will be impacted by the project. The conservation objectives of the SSSIs in the Clyde Marine Region will therefore not be compromised.

The project area also overlaps with the North Arran NSA which protects both the highland interior and the coastal strip where the proposed cable landfall is located (see Table 2-1). However, due to the fact that the project is a replacement for an existing cable, and all works pertaining to this MEA are subsea, no change from baseline conditions is identified and no adverse effects are expected.

There are no Royal Society for the Protection of Birds (RSPB) reserves or Local Nature Reserves (LNR) in the close vicinity of the proposed works (NMPi, 2021).

Table 3-2 Seal Haul-Outs and SSSIs Located within 40 km of the Project Area

| Site Name | Designated Features | Distance by Sea from the Project (km) |
|---|---|---|
| **Seal Haul-Outs** | | |
| Rubha nan Sgarbh Seal Haul-out | Grey seal[3]<br>Harbour seal[4] | 4.0 |
| Yellow Rock Seal Haul-out | | 15.0 |
| Sound of Pladda Skerries Seal Haul-out | | 21.5 |
| Sanda and Sheep Island | | 33.5 |
| Craighouse Small Isles and Lowlandman's Bay | | 37.9 |
| **SSSIs** | | |
| Southannan Sands SSSI | Intertidal marine habitats and saline lagoons: Sandflats | 34 |
| Ulva, Danna and the McCormaig Isles | Landscape and seascape | 36 |
| Ballochmartin Bay SSSI | Coastal feature of flora and fauna of the intertidal area | 36 |

## 3.4 Potential Impacts

Based on the summary of protected sites provided above together with the consultation responses received with regards to protected sites, Table 3-3 below summarises those sites which could potentially be impacted as a result of the project.

[3] Grey seal foraging rage is typically over 100 km (SCOS, 2017).

[4] Harbour seal foraging range is typically 40 – 50 km (SCOS, 2017).

Table 3-3 Potential Impacts on Ecological Protected Sites and Mitigation Measures

<table>
<thead>
<tr><th>Environmental receptor</th><th>Potential impacts</th><th>Management and mitigation measures and overall impact significance</th></tr>
</thead>
<tbody>
<tr><td>Sound of Gigha SPA (12.9 km)<br>-<br>Non-breeding seabirds</td><td>• Physical disturbance/displacement of breeding and foraging.<br>• Accidental fuel release.</td><td>There is not considered to be the potential for Likely Significant Effects (LSE) on great northern diver, common eider and red-breasted merganser, which are protected within this site due to the following:<br>• Marine (vessel) activities will be temporary;<br>• Slow speed of vessels (maximum of few knots per hour) will minimise disturbance impacts;<br>• Lighting onboard vessels will be minimised;<br>• Vessels will avoid rafting seabirds where safe to do so;<br>• Potential for accidental release of pollutants is very low. Vessel Ship Oil Pollution Emergency Plan (SOPEP) details procedures and description of actions to be taken in the event of an oil pollution incident; and<br>• Operating instructions in place for all hazardous substances including hydraulic oil.</td></tr>
<tr><td>Rubha nan Sgarbh (4.0 km)<br>Seal Haul-out</td><td rowspan="5">Harbour and/or grey seals could potentially be present in the Project area and be temporarily disturbed by vessel presence and noise.<br>Risk from accidental pollution e.g. from oil seepage, hydraulic fluid release, vessel fuel release.</td><td rowspan="5">No potential for significant impacts on seals, due to:<br>• Separation between the haul outs and the installation mean that vessels and personnel will not be operating in the vicinity of these sites; and<br>• All vessels will adhere to the Scottish Marine Wildlife Watching Code.</td></tr>
<tr><td>Yellow Rock<br>Seal Haul-out<br>(15.0 km)</td></tr>
<tr><td>Sound of Pladda Skerries (21.5 km)<br>Seal Haul-out</td></tr>
<tr><td>Sanda and Sheep Island (33.5 km) Seal Haul-out</td></tr>
<tr><td>Craighouse Small Isles and Lowlandman’s Bay (37.9 km) Seal Haul-out</td></tr>
</tbody>
</table>

# 4 WATER QUALITY

## 4.1 Overview

This section provides an overview of potential impacts on water quality resulting from the proposed cable replacement works. The following pathways for impacts on water quality have been identified and considered:

- Coastal sediment resuspension;
- Offshore sediment resuspension; and
- Accidental releases of hydrocarbons.

## 4.2 Coastal Sediment Resuspension

At the Arran landfall, the cable will be installed in an open cut trench through the intertidal zone (landward of MLWS), which has the potential to result in resuspension of sediments in the coastal area. The timing of works will be tide dependent (working at low water when the intertidal zone is exposed), using traditional terrestrial-based plant including excavators at low tide. It is therefore expected that there will be no disturbance of submerged sediments associated with the installation of the open cut trench. There may be temporary and highly localised increase in suspended sediment caused by the incoming tide interacting with the trench walls and associated spoil. However, this will not be significantly greater than that expected by wave action causing low-level erosion of the shoreline sediments. As such the impact on water quality is not considered to be a change from baseline conditions, and is not considered further.

The Carradale landfall will be made using HDD ducts, and hence no impacts on water quality from coastal sediment resuspension are anticipated.

## 4.3 Offshore Sediment Resuspension

As detailed in Section 1.3, the cable will be buried using a jet trencher. Jet trenching is a method of fluidising and transporting the sediment by injecting water with low pressure and high volume below the sediment surface via jet legs/swords. When the water pressure is removed, a proportion of the sediment resettles over the cable. It is expected that in general approximately 60% to 80% of the fluidised sediment would remain or settle back into the trench, and only the remaining 20-40% would be suspended into the water column. A study on the Environmental Impact of Subsea Trenching Operations (Gooding *et al.*, 2012) identified that impacts from sediment disturbance are localised and considered to be restricted to the immediate vicinity of the trench (less than 10 m either side). Suspended solid concentrations, although elevated immediately after trenching, have been shown to fall to ambient levels within 66 m of trenching activity in hard ground areas and 70 m in sandy areas.

If the HDD reception pits at Carradale are required, these will be formed using MFE or airlift dredging which also have the potential to impact water quality through resuspension of sediments. These techniques use sediment transport to form the excavation, and do not utilise seabed fluidisation, but the effects on water quality are broadly similar to those resulting from jet trenching. Coarser fractions down to and including fine sand, removed from the reception pit will be raised a few metres, or less, from the seafloor, and are expected to be re-deposited within a maximum of 10 m of the cable trench. Finer silt fractions will remain in suspension for longer with levels expected to fall to ambient levels within 70 m.

As such, the effects of sediment resuspension resulting from cable burial and potential formation of the HDD reception pits are anticipated to localised to the immediate vicinity of the subsea equipment, temporary and transient. As such, potential impacts on water quality are assessed as not significant, and are not considered further by this MEA.

## 4.4 Changes to Sediment and Water Quality Following Accidental Release of Hydrocarbons

There is the potential for an unplanned spill to occur in the event that a collision with another vessel occurs, one of the project vessels loses containment of hydrocarbon bunkers, or that a hydraulic line leaks or fails (for example associated with cranes and ROVs. The main release risk associated with the cable installations is a loss of diesel fuel from the installation and support vessels. Diesel has very high levels of light ends, evaporating quickly on release. The low asphaltene content prevents emulsification, therefore reducing its persistence in the marine environment. Light oil (such as diesel) tends to dissipate completely through evaporation and physical dispersion within 1 - 2 days and does not normally form emulsions. Some small-dispersed globules of semi-solid oil may persist for some time if the oil possesses wax or other persistent components.

Any discharge of hydrocarbons will be limited to the inventory of each vessel during the cable installation. Due to the low viscosity of diesel, it will spread very rapidly to form a thin sheen at the surface. The sheen will break up rapidly under the influence of spreading and evaporation. Diesel is unlikely to persist within the water column once the spill has occurred.

Based on the volume and components of marine diesel, it is unlikely that diesel will percolate to the seabed and deposit on sediments. Therefore, sediments are unlikely to be affected by a spill. As such, it is not considered to present a major risk to the environment. Additionally, the project's Emergency Spill Response Plan, and the SOPEPs in place for each vessel, will provide a clear protocol in the event of a release scenario, resulting in rapid and effective remedial action, limiting the extent of any spill.

Accidental releases of hydraulic fluids from the cranes on the project vessels and used for the ROVs are possible. Hydraulic fluids are used as part of a closed system (i.e. lines) in cranes and other machinery equipment (such as ROVs). The potential impacts of a hydraulic fluid release depend on the properties and components of each hydraulic fluid. Hydraulic fluids can either be oil or water-based. Water-based hydraulic fluids used are unlikely to be toxic to the marine environment and will disperse rapidly as they tend to not bioaccumulate and are biodegradable. Any accidental spills of oil-based hydraulic fluid are unlikely to form a sheen, as the potential volume of hydraulic fluid spilled is likely to be small and mineral oil content is low. Equipment (cranes, ROVs etc.) used during the project will be regularly maintained, reducing the likelihood of a release.

A large spill of hydrocarbons or hydraulic fluids is very unlikely during the planned cable replacement activities. The impact of an accidental release (diesel or hydraulic fluid) is therefore considered to be minor and not significant.

## 4.5 Conclusion

The resuspension of seabed sediments resulting from the project have been found to be localised, temporary, transient and in the case of the installation of an open cut trench at Arran, not s significant change from baseline. As such effects on water quality have been found to be not significant.

Best practice will be followed by all installation vessels, therefore the likelihood of an accidental hydrocarbon releases from the installation vessel is extremely remote. The level of impact is therefore considered not significant.

# 5 BENTHIC ECOLOGY

## 5.1 Introduction

This section of the report provides detail on the nearshore and offshore habitats in the vicinity of the project, as well as the relevant legislation and policy guidance. It then assesses the potential impacts on intertidal and subtidal ecology and the management and mitigation measures that will be undertaken in order to ensure impacts are minimised.

## 5.2 Legislation and Policy Context

With respect to subtidal and intertidal ecology, in order to identify potential constraints to installing a subsea cable, it is necessary to identify potential habitats and species of conservation importance that could potentially be present in the Project area and along potential subsea cable route corridors.

There are a number of different regulations and guidance that are relevant in this regard. These include:

- European Habitats Directive (Directive 92/43/EEC);
- The Habitats (Scotland) Regulations 1994 (as amended) which implements species protection requirements of the Habitats Directive in Scotland, on land and in inshore waters (within 12 nm);
- The Convention for the Protection of the Marine Environment of the North East Atlantic (known as the OSPAR Convention);
- Marine (Scotland) Act 2010 and Marine and Coastal Access Act (2009); and
- UK Post-2010 Biodiversity Framework (July 2012) – this supersedes the UK Biodiversity Action Plan (UKBAP) which was the UK Governments Response to the Convention on Biological Diversity (CBD), which the UK signed up to in 1992 in Rio de Janeiro.

### 5.2.1 European Habitats Directive

The European Habitats Directive lists 15 marine and coastal habitats and eight marine species in Annexes I and II respectively. To meet the requirements outlined in Article 3 of the European Habitats Directive, SACs have been designated in UK waters to contribute to the European network of important high-quality conservation sites that will make a significant contribution to conserving these species and habitats. There are records of Annex I Bedrock reefs, as listed in the Habitats Directive, in the Project area.

### 5.2.2 Marine (Scotland) Act 2010

On behalf of the Scottish Government; JNCC, SNH and Marine Scotland have together developed recommended lists of PMFs in Scotland's seas. The list of PMFs has not been developed in accordance with any specific legislation, agreement or convention; it was developed to guide policy decisions regarding the conservation of Scotland's seas, through the identification of priority species and habitats.

The list of recommended PMFs in Scotland's offshore waters was adopted in 2014 and contains various habitats and species considered to be of conservation importance (NatureScot, 2020). Howson *et al*. (2012) have also developed an equivalent list for Scotland's territorial waters which comprises particular PMFs associated with Scottish waters. The Scottish PMFs that have been identified within the project area are 'Kelp and seaweed communities on sublittoral sediments' (or kelp beds) and 'Burrowed mud'.

### 5.2.3 Biodiversity Action Plan (BAPs)

The UK Biodiversity Action Plan (UK BAP) was launched in 1994 as a means of meeting the UK's obligations under the Biodiversity Convention (signed by the UK and over a hundred other countries at the Rio Earth Summit in 1992) to "*develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity*". The stated goal of the UK BAP is to "*conserve and enhance biological diversity within the UK, and to contribute to the conservation of global diversity through all appropriate mechanisms*".

UK BAP priority species were those identified as being the most threatened and requiring conservation action under the UK BAP. As a result of devolution, and new country-level and international drivers and requirements, much of the work previously carried out by the UK BAP is now focused at a country-level rather than a UK-level, and in July 2012 the UK BAP was succeeded by the UK Post-2010 Biodiversity Framework'. The UK list of priority species, however, remains an important reference source and has been used to help draw up statutory lists of priorities in Scotland.

### 5.2.4 The Clyde Regional Marine Plan

A pre-consultation on the draft Clyde Regional Marine Plan took place between 18th March and 27th May 2019. The protection of the natural heritage within the Firth of Clyde marine region is an objective of the Clyde Regional Marine Plan. The obligations of marine users in the region that are relevant to submarine cables are set by Policies NH1, NH2, NH4, NH5 and NH7. These aim to ensure that the health of the marine and coastal natural heritage of the Clyde Region is protected, and that the development and use of the coastal and marine environment does not have significant negative impact on biodiversity, the MPA network, other protected habitats and species and PMF occurring in the region, as set in the objectives of the Plan.

The Regional Marine Plan sets out objective to mitigate and adapt to climate change. This includes the protection of carbons sinks occurring in the Firth of Clyde region including flame shell beds, horse mussel beds, blue mussel beds, seagrass beds, kelp and seaweed communities and maerl beds (Clyde Marine Planning Partnership, 2019). Policy CC2 states that '*development(s) and/or activities will be supported where they can demonstrate that they will avoid damage to and/or, where possible, enhance the capacity of recognised carbon sinks in the Clyde Marine Region'*.

The management of marine invasive species is enforced by a number of policies that are relevant to submarine cables, including Policy NNS1 and NNS3.

## 5.3 Benthic Ecology Description

### 5.3.1 Key Data Sources

The information provided in this section has been gathered from existing literature, project specific data, consultation with stakeholders and statutory bodies as well as from specialist studies and surveys undertaken to inform the project. These studies and surveys conducted to inform the project are listed in Table 5-1.

Table 5-1 List of Survey Reports and ROV/DDV Images Used to Inform the Benthic Environment Description

| Title | Type of survey | Date of survey | Reference |
|---|---|---|---|
| Carradale – Arran Environmental Survey | Integrated analysis of video and photography data with acquired geophysical data. | 2020 - 2021 | Fugro (2021a) |
| Carradale – Arran Geophysical Survey | Offshore and nearshore geophysical surveys including:<br>• MBES;<br>• SBP;<br>• SSS;<br>• Magnetometer. | 2020 - 2021 | Fugro (2021b) |
| Carradale – Arran Route Survey Report | Offshore and nearshore geophysical surveys including:<br>• MBES;<br>• SBP;<br>• SSS;<br>• Magnetometer. | 2018 | Briggs (2018a) |
| Arran to Carradale Pre-Lay Cable Survey – Intertidal Walkover Survey Report 2018 | • Walkover survey (photographs and GPS fixes);<br>• Quadrat sampling;<br>• Unmanned Aerial Vehicle (UAV) mapping. | 2018 | Ocean Ecology (2018a) |
| Arran to Carradale Pre-Lay Cable Survey – Drop-Down Video Ground-Truthing Survey Technical Report | Drop-down video survey using a telemetry drop camera system deployed from the survey vessel. | 2018 | Ocean Ecology (2018b) |
| Carradale - Arran Cable Route Environmental Supporting Information | DDV and ROV surveys | DDV survey undertaken in 2018 (Ocean Ecology, 2018b)<br>ROV survey undertaken in 2017 | Xodus Group (2019) |

## 5.3.2 Nearshore Characteristics

### *5.3.2.1 Intertidal Survey Methodology*

Ocean Ecology Limited ('Ocean Ecology') was commissioned by Briggs to undertake intertidal Phase I walkover surveys of the two proposed landfalls of the proposed cable, in order to establish the main biotopes and identify any features of conservation importance. This intertidal survey was undertaken in December 2018.

The intertidal walkover survey was carried out across an area of 1,200 m x 300 m covering the cable landfalls at Balliekine and Carradale. Biotope identification was undertaken for a total of 37 quadrats at Balliekine and 79 at Carradale in the survey areas. Additionally, an UAV survey was undertaken to provide high-resolution aerial images of the survey area at low tide. However, the UAV survey was only undertaken at the Arran landfall due to weather constraints (Ocean Ecology, 2018a).

Nearshore surveys were also conducted in November and December 2018 to the south of Balliekine on the Isle of Arran and just north of Carradale on the Kintyre mainland. These surveys were required to supplement the offshore geophysical surveys and were designed to extend the survey coverage inshore to safe navigational limits using MBES, SSS, SBP, magnetometer and UAV (Briggs Marine, 2018a, 2018b). Figure 2-3 shows the bathymetry in the nearshore areas obtained during these nearshore surveys. The UAV images of the Carradale and Arran landfalls obtained during these inshore surveys are provided in Section 5.3.2.2 and 5.3.2.3 below.

Fugro was also commissioned by GMG to undertake nearshore and offshore surveys of the proposed cable route and two landfall sites. These surveys were conducted in order to establish the main biotopes and identify any features of conservation importance, much like the prior Briggs (2018a; 2018b) surveys. The Fugro surveys were conducted in late 2020 and into early 2021. The mobilisation of the vessel Fugro Seeker was conducted between 16 December and 23 December 2020, with survey operations carried out between 24 December 2020 and 3 January 2021.

#### *5.3.2.2 Arran Nearshore Area*

The proposed cable will make landfall at Balliekine, Arran, a long, narrow grass bank backed shingle beach (Figure 5-1). The beach is westerly facing and is relatively uniform with various outcrops of algae covered rock and boulder at the lower extent of the beach (Ocean Ecology, 2018a). An aerial view of the Arran landfall is shown Figure 5-2.

**Figure 5-1 View Looking North Across the Survey Area on Arran (Ocean Ecology, 2018a)**

Figure 5-2 Birdseye View of the Arran Landfall Area (Fugro, 2021a)

At the proposed Balliekine landfall, Arran, the biotope on the upper shore was classified as shingle (pebble) and gravel shore, falling under the EUNIS code A2.11. The mid shore was dominated by '*Fucus spiralis* on sheltered upper eulittoral rock' (A1.312) and the lower shore, particularly in the northern section of the survey area, was dominated by '*Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock' (A1.313). The southern area was similar in zonation although had a much narrower range with a steeper gradient between the upper and lower shores, and also contained the biotope '*Pelvetia canaliculate* on sheltered littoral fringe rock' (A1.311) above the *F. spiralis* dominated shoreline. The central section has a small area of mixed substrate with exposed bare rock (A3.1) and lichen-covered rock, representative of 'Yellow and grey lichens on supralittoral rock' (B3.111).

A list of the key biotopes recorded during the intertidal surveys at the proposed landfall location at Balliekine, Arran is provided in Table 5-2.

The rocky habitats classified as A1 all qualify as Annex I bedrock reef. Bedrock reefs are defined by areas where bedrock or stable boulders and cobbles arise from the surrounding seabed, creating a habitat that is colonised by many different marine animals and plants. A1 habitats were observed in the Ocean Ecology (2018a) survey and the Fugro (2021a) survey. There were no other features of conservation interest observed during the walkover intertidal survey at the Arran landfall (Ocean Ecology, 2018a; Fugro, 2021a).

The kelp biotope '*Saccharina latissima* and red seaweeds on infralittoral sediments', classified as PMF in Scottish waters, was identified in the Arran nearshore area (Ocean Ecology, 2018b; Fugro, 2021a). This kelp habitat extends further offshore and is therefore described in Section 5.3.3.

Table 5-2 Key Biotopes Recorded in the Intertidal Areas at the Proposed Arran Landfall

| Habitat | EUNIS Code | EUNIS Description | Survey Observed In |
|---|---|---|---|
| | A1.1132 | Semibalanus balanoides, Fucus vesiculosus and red seaweeds on exposed to moderately exposed eulittoral rock | Fugro (2021a) |
| | A1.2 | Moderate energy littoral rock | Ocean Ecology (2018a); Fugro (2021a) |
| | A1.211 | *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock | Ocean Ecology (2018a) |
| | A1.212 | *Fucus spiralis* on full salinity exposed to moderately exposed upper eulittoral rock | Ocean Ecology (2018a) |
| | A1.213 | *Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock | Ocean Ecology (2018a) |
| | A1.214 | Fucus serratus on moderately exposed lower eulittoral rock | Fugro (2021a) |
| | A1.311 | *Pelvetia canaliculata* on sheltered littoral fringe rock | Ocean Ecology (2018a); Fugro (2021a) |
| | A1.312 | Fucus spiralis on sheltered upper eulittoral rock | Fugro (2021a) |
| | A1.3121 | *Fucus spiralis* on full salinity sheltered upper eulittoral rock | Ocean Ecology (2018a) |
| | A1.313 | Fucus vesiculosus on moderately exposed to | Fugro (2021a) |

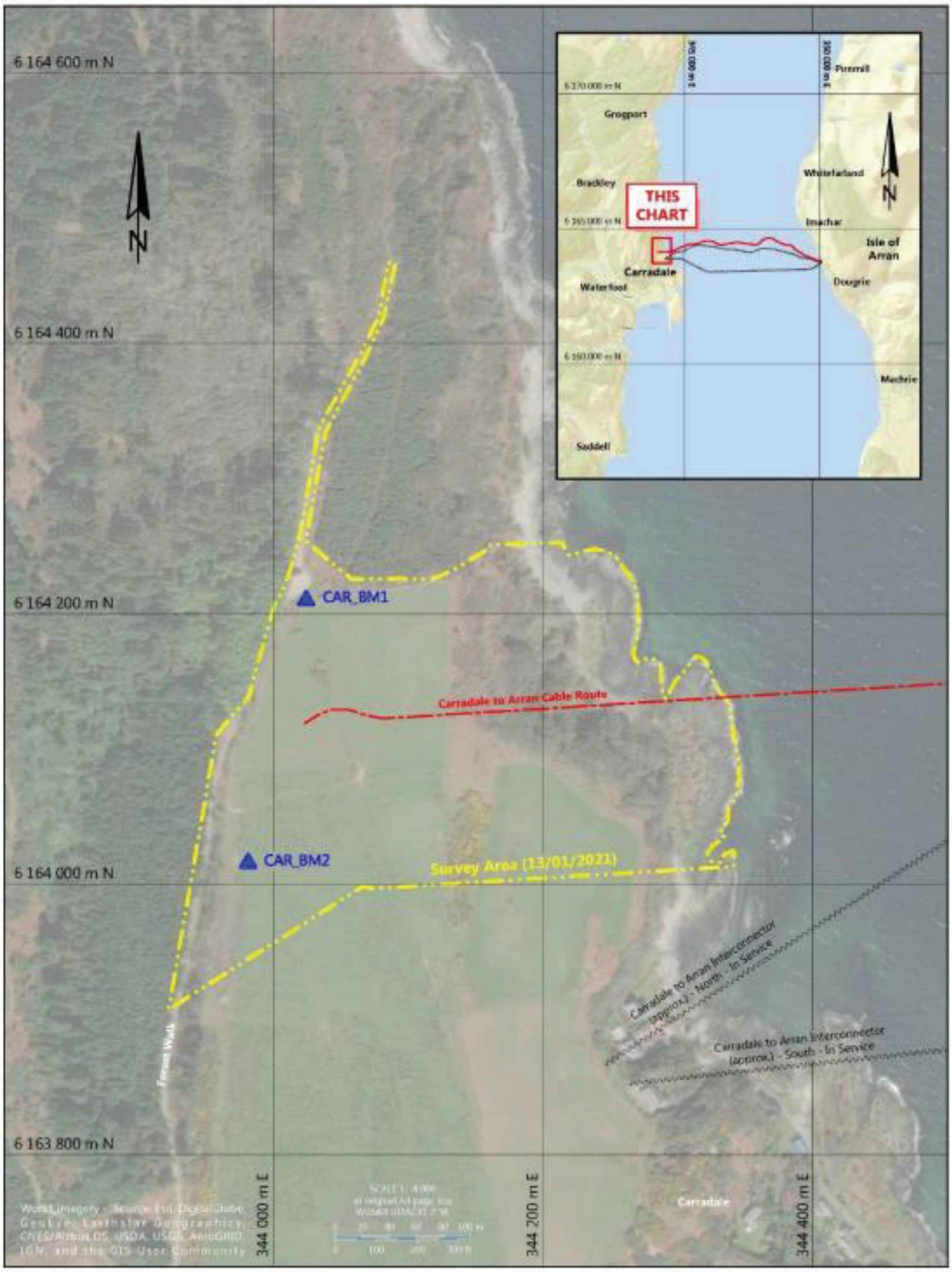
| | | | |
|---|---|---|---|
| | | sheltered mid eulittoral rock | |
| | A1.3132 | *Fucus vesiculosus* on mid eulittoral mixed substrata | Ocean Ecology (2018a) |
| | A1.3141 | *Ascophyllum nodosum* on full salinity mid eulittoral rock | Ocean Ecology (2018a); Fugro (2021a) |
| | A1.3142 | *Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata | Ocean Ecology (2018a) |
| | A1.413 | Seaweeds in sediment-floored eulittoral rockpools | Fugro (2021a) |
| | A1.45 | Ephemeral green or red seaweeds (freshwater or sand-influenced) on nonmobile substrata | Fugro (2021a) |
| A2 - Littoral Sediment | A2.1 | Littoral coarse sediment | Fugro (2021a) |
| | A2.11 | Shingle (pebble) and gravel shores | Ocean Ecology (2018a) |
| | A2.21 | Strandline | Ocean Ecology (2018a) |
| B2 - Coastal Shingle | B2.1 | Shingle beach driftlines | Ocean Ecology (2018a); Fugro (2021a) |
| | B2.4 | Fixed shingle beaches, with herbaceous vegetation | Ocean Ecology (2018a); Fugro (2021a) |
| B3 - Rock cliffs, ledges and shores, including the Supralittoral | B3.111 | Yellow and grey Lichens on supralittoral rock | Ocean Ecology (2018a) |
| | B3.113 | Verrucaria maura on littoral fringe rock | Fugro (2021a) |

#### *5.3.2.3 Carradale Nearshore Area*

The intertidal area at the Carradale landfall is a complex shoreline with stretches of rocky shore lined by barren shingle beaches, steep cliffs and overhanging foliage areas of salt tolerant grass in the supralittoral zone (Figure 5-3). An aerial view of the Carradale landfall is shown on Figure 5-4.

Figure 5-3 View Looking North (left) and Down the Shore (right) Across the Survey Area at Carradale (Ocean Ecology, 2018a)

Figure 5-4 Birdseye View of the Carradale Landfall Area (Fugro, 2021b)




The shoreline at Carradale is backed by terrestrial grassland and woodland with rock cliffs, ledges and vegetated shores, representative of biotope B3.3, often acting as a buffer between wooded areas and areas of unvegetated mobile shingle beaches above the driftline, representative of the biotope B2.2. These areas give way to areas of exposed rock, often dominated by lichens (B3.111 – Yellow and grey lichens on supralittoral rock). In some areas, shingle beaches extended from the uppermost part of the shore down to the very lowest, sometimes forming small gullies between areas of rocky shore. The lower rocky shore areas were generally dominated by the biotopes A1.211 – *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock and A1.113 – *Semibalanus balanoides* with reduced gradient, this biotope graded into fucoid dominated mid-lower shore habitats (A1.312 / A1.315) with very sheltered, low gradient areas dominated by *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (A1.324).

A list of the key biotopes recorded during the intertidal survey at the proposed landfall location at Balliekine Arran is provided in Table 5-3 and their distribution is shown on Figure 5-5.

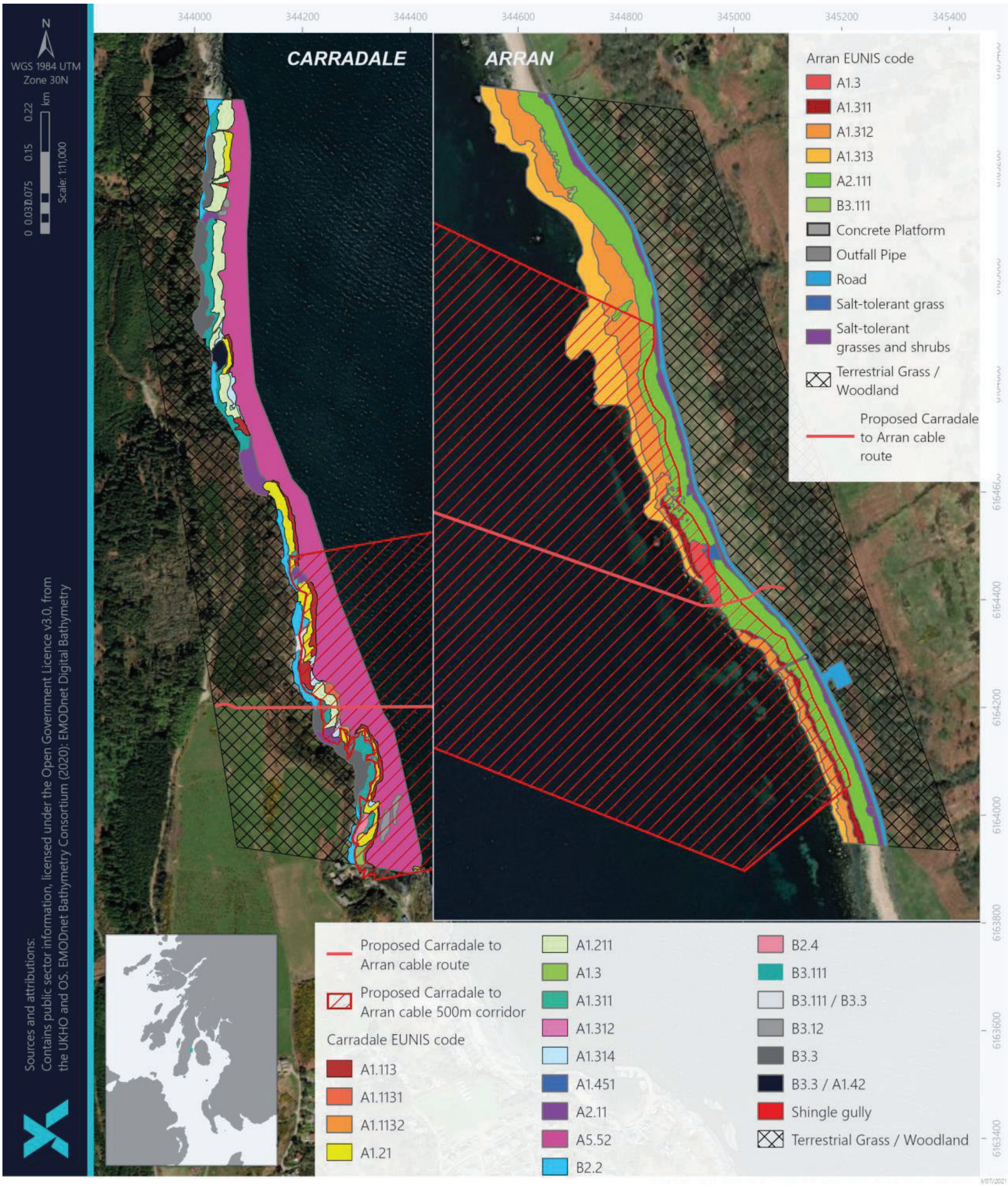
Several littoral rock pools were representative of the biotope A1.42 - Communities of rockpools in the supralittoral zone, often dominated by fucoids. All rock biotopes (A1) qualify as Annex I bedrock reefs. No other features of conservation importance were observed in the intertidal area at the Arran landfall (Ocean Ecology, 2018a).

The DDV survey undertaken along the Carradale to Arran route allowed identifying the kelp biotope '*Saccharina latissima* and red seaweeds on infralittoral sediments' (A5.521), classified as PMF in Scottish waters, at the western end of the cable route, in shallow waters. This kelp habitat extends further offshore and is therefore described in Section 5.3.3.

Table 5-3 Key Biotopes Recorded in the Intertidal Areas at the Proposed Carradale Landfall (Ocean Ecology, 2018a)

| Habitat | EUNIS Code | EUNIS Description |
|---|---|---|
| A1 - Littoral rock and other hard substrata | A1.113 | *Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock |
| | A1.1131 | *Semibalanus balanoides, Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock |
| | A1.1132 | *Semibalanus balanoides, Fucus vesiculosus* and red seaweeds on exposed to moderately exposed eulittoral rock |
| | A1.1133 | *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles |
| | A1.211 | *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock |
| | A1.311 | *Pelvetia canaliculata* on sheltered littoral fringe rock |
| | A1.3121 | *Fucus spiralis* on full salinity sheltered upper eulittoral rock |
| | A1.3141 | *Ascophyllum nodosum* on full salinity mid eulittoral rock |
| | A1.3151 | *Fucus serratus* on full salinity sheltered lower eulittoral rock |
| | A1.321 | *Pelvetia canaliculata* on sheltered variable salinity littoral fringe rock |
| | A1.324 | *Ascophyllum nodosum* and *Fucus vesiculosus* on variable salinity mid eulittoral rock |
| | A1.42 | Communities of rockpools in the supralittoral zone |
| | A1.451 | *Enteromorpha* spp. on freshwater-influenced and/or unstable upper eulittoral rock |
| A2 - Littoral sediment | A2.11 | Shingle (pebble) and gravel shores |
| B1 - Coastal dunes and sandy shores | B1.21 | Unvegetated sand beaches above the driftline |
| B2 - Coastal Shingle | B2.1 | Shingle beach driftlines |
| | B2.2 | Unvegetated mobile shingle beaches above the driftline |
| | B2.4 | Fixed shingle beaches, with herbaceous vegetation |
| B3 - Rock cliffs, ledges and shores, including the Supralittoral | B3.1 | Supralittoral rock (lichen or splash zone) |
| | B3.111 | Yellow and grey lichens on supralittoral rock |
| | B3.3 | Rock cliffs, ledges and shores, with angiosperms |

Figure 5-5 Biotope Distribution in the Intertidal Area at the Carradale (left) and Arran (right) Landfalls (Offshore Ecology, 2018a)



### 5.3.3 Offshore Area Characteristics

Offshore surveys were undertaken along the proposed Carradale – Arran replacement cable route, and included MBES, SSS, SBP and magnetometer. As mentioned in Section 1.1, the geophysical survey results suggested that the seabed in the Carradale – Arran survey corridor consisted mostly of sandy mud and sandy gravel and shell fragments with rock outcrops across the survey corridor and areas of boulder fields (Briggs Marine, 2018a,b; Fugro, 2021a).

The data on EUSeaMap 2019 suggest that the majority of the route corridor is composed of 'Deep circalittoral mud' (EUNIS code A5.37). The proposed cable route towards Carradale crosses habitats of 'fucoids on sheltered marine shores' (A1.31) and Barnacles and fucoids on moderately exposed shores (A1.2) within approximately 1 km from the shoreline. In the nearshore area towards Arran the sediments include Barnacles and fucoids on moderately exposed shores (A1.2) (EMODnet, 2021).

### 5.3.4 Offshore Area Characteristics from Ocean Ecology Survey

A DDV survey was undertaken both in the nearshore and offshore survey areas to determine the EUNIS biotopes via the interpretation of available seabed imagery and geophysical data. In total, 22 DDV transects were positioned across the geophysical survey corridor based on an initial interpretation of MBES and SSS data (Ocean Ecology, 2018b).

Interpretation of the data collected during the DDV survey allowed mapping of the subtidal habitats along the cable route which were generally consistent with the existing EMODnet mapping but provided increased confidence in the data and greater spatial resolution. The DDV survey data indicate that the installation corridor along the cable route is characterised by five EUNIS biotopes, as detailed below. A summary of the main biotopes identified in the subtidal area along with some example images are provided in Table 5-4. The distribution of habitats along the cable corridor is shown in Figure 5-6.

The biotope 'Offshore circalittoral mud' (A5.37) was identified in the central section of the cable route which aligns with the main, deep-water channel running between Arran and the mainland. While the faunal community observed included the presence of burrowing megafauna there was a notable absence of seapens. This habitat was also only recorded in areas of the cable route where water depths were in excess of 50 m depth including a large section in excess of 100 m depth. Observed fauna were generally scarce and restricted to mobile decapods (Paguridae, *Munida* sp. and *Liocarcinu*s sp.) with occasional burrows occupied by Norway lobster *Nephrops norvegicus*. The biotope variant is therefore deemed to constitute a component of the PMF 'Burrowed mud' and to be conservatively representative of the 'Seapen and burrowing megafauna communities' included on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, 2008). Although numerous observations of *N. norvegicus were* made, no seapens were observed despite being a component of this habitat and previously recorded nearby (NMPi, 2021).

In the central and deepest section of the cable corridor where water depths were in excess of 100 m, the habitat was a mosaic of the soft sediment biotope 'Offshore circalittoral mud' (A5.37) and exposed rocky outcrops representative of the 'Atlantic and Mediterranean high energy circalittoral rock' (A4.1) biotope. Seabed imagery corroborated the SSS and MBES data which showed distinct outcrops of rock, with significant elevation amongst the background soft sediments. These rocky outcrops were formed of various sized cobbles and boulders and some exposed bedrock, with associated mixed faunal turf communities identified in the seabed imagery dominated by dominated by hydroid and bryozoan turf with solitary ascidians (sea squirts). These mosaic areas of soft sediment (A5.37) and exposed rocky outcrops (A4.1) have been identified as Annex I bedrock reef habitat due to the spatial extent and elevation of the rock observed. The SSS and MBES data suggest these areas are both extensive and considerably elevated above the surrounding soft sediment habitat. This habitat is protected under the Habitats Directive (92/43/EEC).

During the surveys, the two ends of the cable corridor were classified as '*Saccharina latissima* and red seaweeds on infralittoral sediments' (A5.521). The western end of the cable corridor, in the subtidal area, was classified under this biotope based solely on the interpretation of SSS and MBES data as no seabed imagery was collected in these shallow nearshore areas. This habitat is comprised of coarse sediment amongst a mosaic of boulders and cobbles, with some bedrock in the infralittoral shallow subtidal zone, typically supporting communities of kelp and other seaweeds. The upper limit of this biotope is defined by the top of the kelp zone and the lower limit of kelp or dense seaweed growth. Communities associated with these habitats generally include the kelp *Laminaria hyperborea* and *S. latissima*, which together with other associated seaweeds, generally silt-tolerant and filamentous species, can form dense and productive forests that support high levels of biodiversity. This biotope is a component of the PMF 'Kelp and seaweed communities on sublittoral sediment' (Tyler-Walters *et al*., 2016).

A review of the DDV footage obtained during the 2018 survey and ROV footage from 2017 was undertaken by Aquatic Environments (Xodus, 2019). The review of the footage confirmed the assessment of the biotopes and PMFs previously made by Ocean Ecology (2018). The footage taken from the middle of the channel revealed a muddy gravel habitat of infralittoral mixed sediment/ circalittoral mixed sediment (SS.SMX.IMx/ SS.SMX.CMx) inhabited by numerous large bivalves, large decapod crustaceans and large predatory echinoderms. The collection of shell debris seen on the seafloor surface indicated that the bivalve *Arctica islandica* may inhabit this area, although it was not possible to definitively confirm their presence. This PMF species, also listed under Annex V of the OSPAR convention has been previously recorded off the south coast of Arran and approximately 850 m south of the survey area (NMPi, 2021).

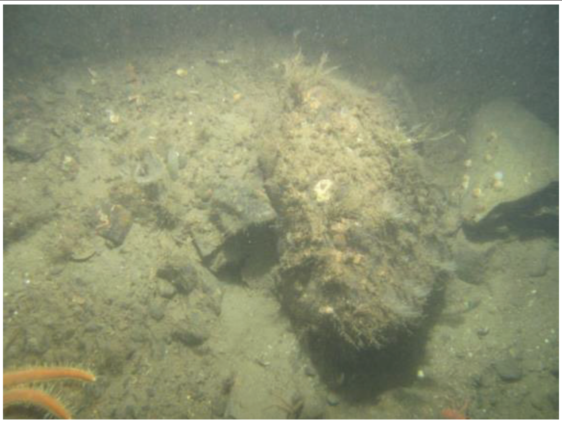
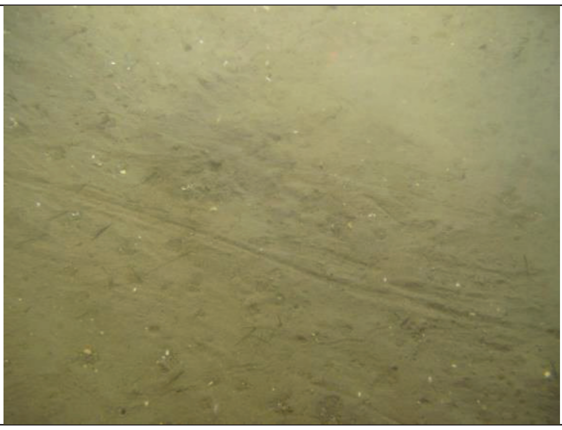
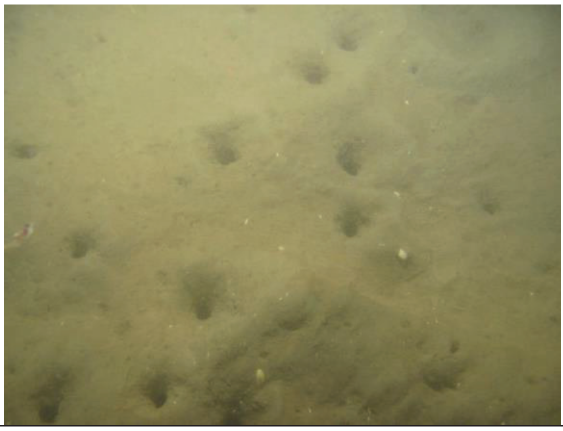
In the central deep channel of the corridor lie extensive deposits of the PMF 'burrowed mud'. These areas were observed to be inhabited by *Nephrops norvegicus* (Norway lobster) but may include other component species such as the mud volcano worm, *Maximuelleria lankesteri*. This habitat would also be vulnerable to cable installation activities.

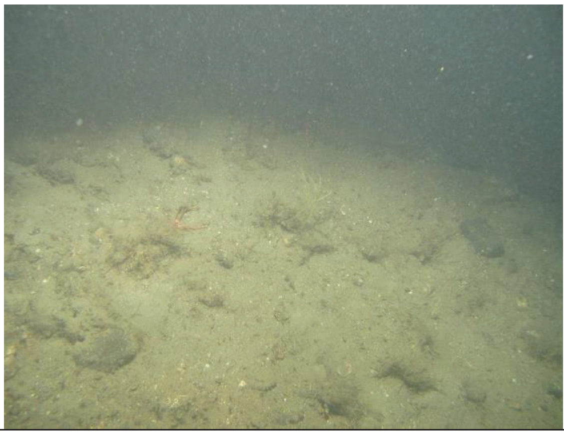
A small area of boulder and cobble matrix was observed on the eastern slope of the channel. The elevation of the boulders and cobbles could not be discerned from the video, has and was characterised as a 'low to medium resemblance' to Annex I bedrock reef (CR.LCR) as defined by JNCC (2009). The encrusting community appeared to be of low diversity but does support a population of low mobility large anemone, likely either *Urticina* sp. or *Bolocera tuediae*. Therefore, this habitat is considered sensitive and vulnerable to cable installation activities.

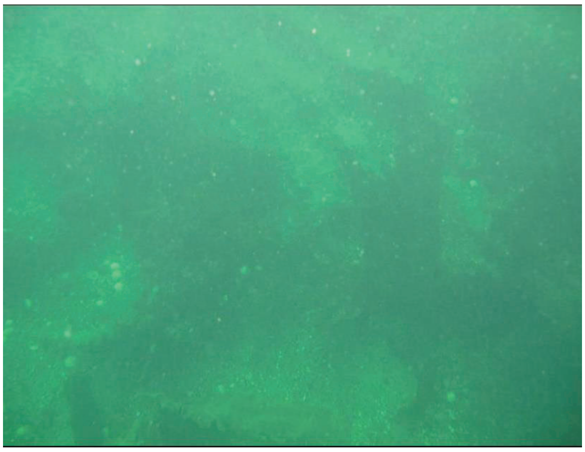
The dominant biotope observed along the DDV tracks was '*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment' (SS.SMX.CMx.ClloMx). This biotope lies along the edges of the deep channel, in the shallow circalittoral. The biotope is extensive and contains many mobile megafauna, such as *Munida rugosa, Liocarcinus* spp., *Porania pulvillus* and *Marthasterias glacialis*. This biotope should recover relatively quickly following the laying of the inter-connector cable.

In the shallows on the east side of the channel, the biotope 'Kelp and seaweed communities on sublittoral sediment' (SS.SMP.KSwSS) was recorded, also indicating the presence of Annex I bedrock reef. This algal biotope is also a PMF and is sensitive to disturbance. However, provided the flow regime and surrounding sediment type were not altered by the laying of the cable, then this feature would be expected to recover relatively quickly.

Table 5-4 Biotopes Recorded During the DDV Survey in the Carradale - Arran Cable Corridor (Ocean Ecology, 2018b)

| EUNIS Biotope | PMF | Annex I | Example image |
|---|---|---|---|
| A4.13 Mixed faunal turf communities on circalittoral rock | No | Yes |  |
| A5.37 Deep circalittoral mud | No | No |  |
| A5.37 Deep circalittoral mud, with PMF 'Burrowed mud' | Yes | No |  |

| EUNIS Biotope | PMF | Annex I | Example image |
|---|---|---|---|
| A5.44 Circalittoral mixed sediments | No | No |  |
| A5.441 *Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment | No | No |  |
| A5.4411 *Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment | No | No |  |

| EUNIS Biotope | PMF | Annex I | Example image |
|---|---|---|---|
| A5.521 *Saccharina latissima* and red seaweeds on infralittoral sediments | Yes | No |  |

### 5.3.5 Offshore Area Characteristics from Fugro Survey

Along the Carradale to Arran corridor, most of the seabed was classified as 'Atlantic and Mediterranean high energy circalittoral rock' (A4.2), 'Circalittoral mixed sediments' (A5.44), or 'Deep circalittoral mud' (A5.37). These habitat classifications are broadly in agreement with those presented by EMODnet (2019) for the survey area, which listed the presence of 'Deep circalittoral mud' (A5.37) and 'Deep circalittoral mixed sediments' (A5.45), as well as previous surveys carried out in the region in 2017 and 2018 as detailed in Section 5.3.4.

Most of the seabed across the survey area was covered by different fractions of sand with shell fragments, cobbles and occasional boulders found at the west, middle and middle-east side of the corridor, corresponding to the EUNIS biotope 'Circalittoral mixed sediments' (A5.44) or 'Infralittoral mixed sediments' (A5.43). Low-lying exposed bedrock and bedrock outcrops present offshore and at the east side of the corridor extending up to the nearshore area of Arran were classified as 'Atlantic and Mediterranean high energy circalittoral rock' (A4.1) or 'Atlantic and Mediterranean high energy infralittoral rock' (A3.1). Areas of sandy mud with shell fragments and bioturbated seabed found in the middle and towards the west side of the corridor were classified as 'Deep circalittoral mud' (A5.37). Muddy sand/sandy mud with shell fragments corresponding to the EUNIS biotope 'Deep circalittoral sand' (A5.27) were present in the east side of the corridor. Similar sediment composition was observed at the eastern nearshore end of the corridor but in shallow waters, hence the broader 'Sublittoral sand' (A5.2) EUNIS classification was given. A section of cobbles, boulders and possible bedrock interspersed with sand was also observed at the east side of the corridor covered by red, brown and encrusting corraline algae hence the 'Sediment-affected or disturbed kelp and seaweed communities' (A3.12) was given, whereas sandy gravel was noted a bit further offshore classified as 'Sublittoral coarse sediment' (A5.1).

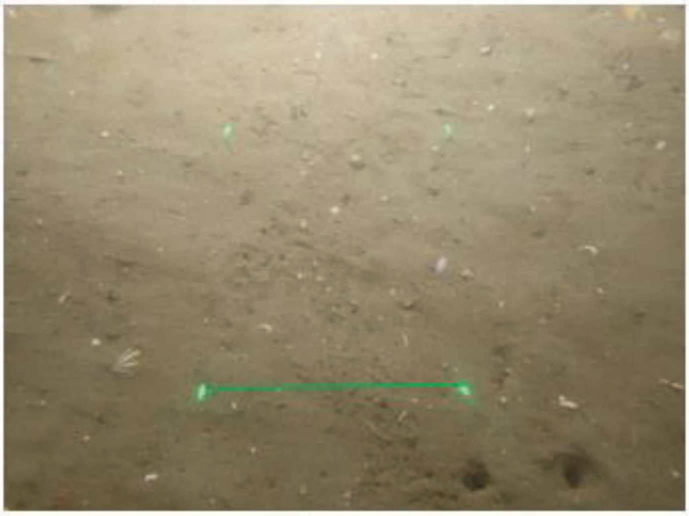
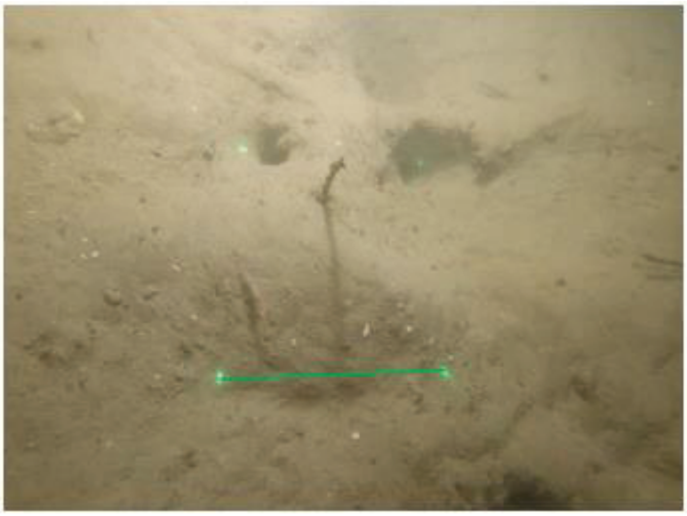
Although reported quite extensively in the south of the survey area in the previous survey, the EUNIS biotope '*Laminaria saccharina* and red seaweeds on infralittoral sediments' (A5.521, note that *L. saccharina* is now *Saccharina latissima*) was not observed in the Fugro survey. Consequently, the PMF 'Kelp and seaweed communities on sublittoral sediment' was also not observed. However, areas of sublittoral (including infralittoral) mixed sediment were observed, which is suitable substrata for this biotope.

It has been reported that the kelp *S. latissima* generally features higher mortality rates higher in autumn and winter, or associated with extreme weather events (e.g. cold, wind). Recruitment of juvenile *S. latissimi* sporophytes in northern waters usually occurs in winter and spring. Therefore, it is likely that the apparent loss of this biotope in this area is a function of the differences in survey seasons between the past and present survey, rather than a true change in habitat, with the previously survey carried out in August 2017 and the current survey carried out from January to March 2021. Consequently, the PMF 'Kelp and seaweed communities on sublittoral sediment' may be observed on nearshore mixed sediments later in the year, and are assumed to be present to reflect a conservative approach.

Interpretation of the data collected during the surveys allowed mapping of the subtidal habitats along the cable route which were generally consistent with the existing EMODnet mapping but provided increased confidence in the data and greater spatial resolution. A summary of the main biotopes identified in the subtidal area along with some example images are provided in Table 5-5. The distribution of habitats along the cable corridor is shown in Figure 5-6.

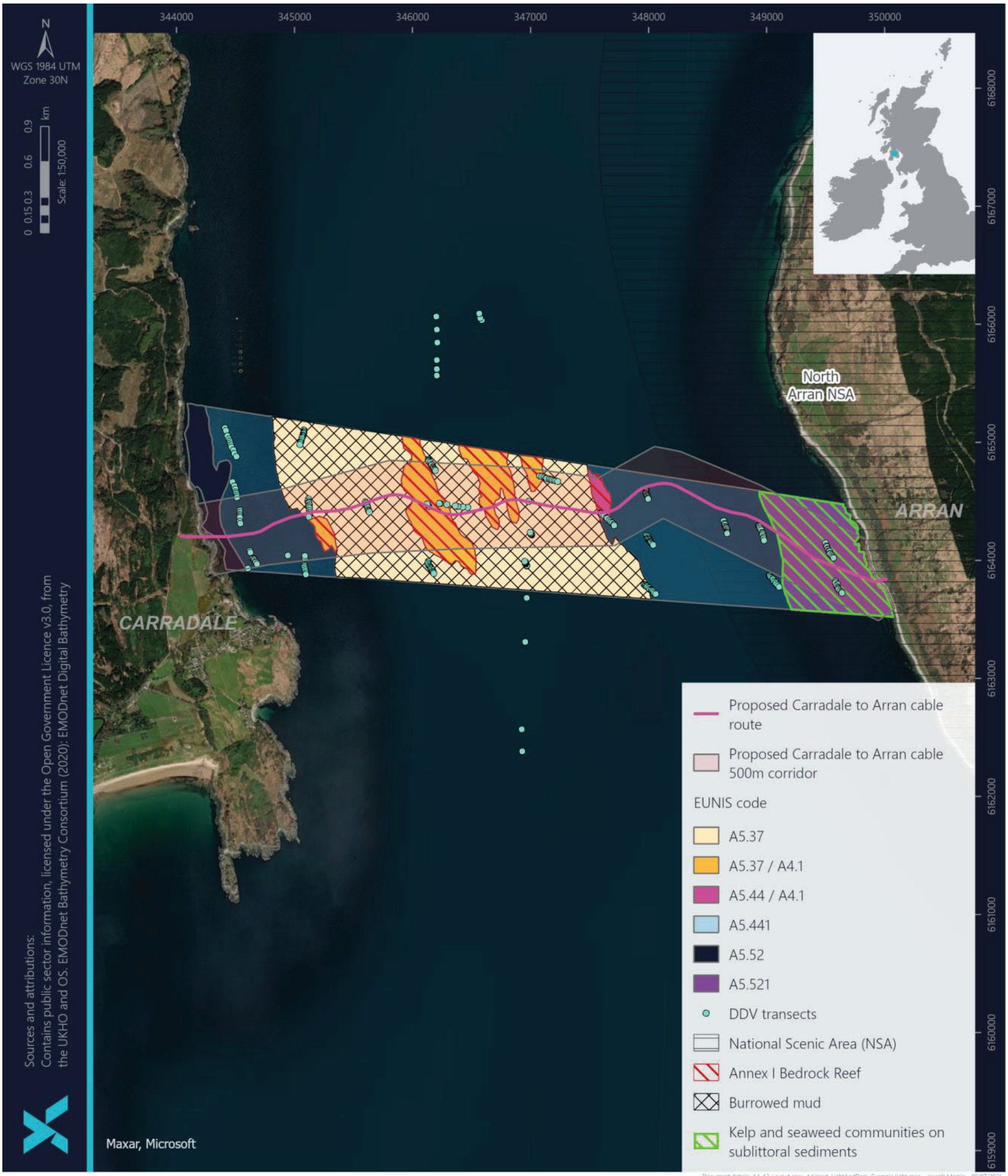
Table 5-5 Biotopes Recorded During the Fugro Surveys in the Carradale - Arran Cable Corridor (Fugro, 2021a; 2021b)

| EUNIS Biotope | PMF | Annex I | Example image |
|---|---|---|---|
| A3.12 Sediment-affected or disturbed kelp and seaweed communities | No | No |  |
| A4.1 Atlantic and Mediterranean high energy circalittoral rock | No | No |  |

| EUNIS Biotope | PMF | Annex I | Example image |
|---|---|---|---|
| A5.27 Deep Circalittoral Sand | | |  |
| A5.37 Deep circalittoral mud | No | No |  |
| A5.37 Deep circalittoral mud, with PMF 'Burrowed mud' | Yes | No |  |

| EUNIS Biotope | PMF | Annex I | Example image |
|---|---|---|---|
| A5.44 Circalittoral mixed sediments | No | No |  |

Figure 5-6 Biotopes and Features of Conservation Importance Identified Across the Proposed Carradale - Arran Cable Route Corridor (Ocean Ecology, 2018b)



## 5.4 Potential Impacts to Benthic Ecology

### 5.4.1 Potential Impacts During Cable Installation

The cable installation methods proposed are regarded as the best available technique. The installation activities discussed in this document take into account the worst-case scenario which has been used to assess potential impacts on benthic ecology.

The cable will be installed by HDD at the Carradale landfall. The HDD ducts will be installed between a location on land underground to a location offshore in the vicinity of the 10 m LAT contour, a distance of about 500 m from the landfall, thus avoiding any impacts on benthic ecology in the Carradale nearshore area. It may be necessary to excavate reception pits for each duct, as detailed in Section 1.3. The combined footprint of the reception pits would be 180 $m^2$, which are anticipated to be located in an area of Circalittoral mixed sediments' (A5.44) on the approach to the Carradale landfall. Once offshore, the cable will be either surface laid or buried between the offshore end of the HDD duct at Carradale and the location of the shore landing at Arran. Deposit material such a mattresses and rock bags may be used where required.

There are two sensitive habitats in the Arran nearshore area, including the kelp and red seaweed communities, biotope called '*Saccharina latissima* and red seaweeds on infralittoral sediments' (A5.521) and designated as PMF, and a number of biotopes classified as Annex I bedrock reef habitats. Cable burial may not be possible in this area as this biotope typically displays cobbles and boulders. Therefore, surface laying with additional protection is the preferred option within these habitats. The use of rock placement as cable protection method in these habitats represents the worst-case scenario (13 m wide footprint of impact).

It has been assumed that in sandy or muddy sediments, the cable will be buried via trenching methods, which typically occur within a 10 m wide corridor considering the footprint of the trencher. The biotopes which present muddy or sandy sediments where it has been assumed that cable trenching would occur, are 'Circalittoral mixed sediments' (A5.44) and 'Deep circalittoral mud' (A5.37).

In the offshore areas where bedrock or mixed sediments occur and trenching is not possible, it has been assumed that additional protection will be installed on top of the cable to provide stability, such as rock berms, concrete mattresses or rock filter bags. Areas where cable burial will not be possible due to the seabed type are the biotopes 'Mixed faunal turf communities on circalittoral rock' (A4.13) which are interspersed with 'Deep circalittoral mud' (A5.37), and '*Saccharina latissima* and red seaweeds on infralittoral sediments' (A5.521).

The benthic organisms located within the direct footprint of the deposits will be smothered. However, kelp and red seaweed communities are expected to recover relatively quickly from the proposed works, given the fast growth rate of kelp which will be able to recolonise the hard substrate provided by the deposits during cable installation works. Similarly, the organisms within the Annex I bedrock reefs in the immediate vicinity of the cable installation works will recolonise the deposits. Given the small footprint of the activities (0.11845 $km^2$ – see Section 1.3.4) relative to the extent of these habitats in the wider area, the kelp and seaweed communities and Annex I bedrock reefs are expected to recover relatively quickly from the proposed works, therefore, the these sensitive benthic features are not expected to be significantly affected.

In areas of burrowed mud, given that the cable will be buried, the loss of habitat will be temporary and limited to the duration of the proposed works. Once buried, any burrowing megafauna from the surrounding environment will be able to recolonise the sediments above the cable. Given the small footprint of the proposed works (0.11845 $km^2$), the burrowed mud habitats are likely to recover quickly, therefore no significant adverse impacts are anticipated on burrowed mud.

As detailed in Section 4, the proposed cable installation and protection measures will result in the resuspension of sediments, which will then resettle in the vicinity of the works (approximately 70 m). It is acknowledged the re-settlement of the sediment could result in the smothering of benthic species in the vicinity of the project (Gubbay, 2003), which in turn can impact their ability to clear particles from their feeding and respiratory surfaces (Rogers, 1990). Benthic communities will gradually become re-established through re-adjustment to the new sediment surface and by migration and/or reproduction and settlement from nearby undisturbed areas. With regard to the settlement of re-suspended sediments, the communities that dominate within the sedimentary environment present are by their nature less susceptible to temporary variations in sedimentation rates. In addition, the benthic environment in the project area is dynamic and subject to natural dispersal of sediments from wave and tidal action (McBreen *et al*., 2011) and there is good potential for rapid recovery. Given the localised nature of this effect, together with the likely recoverability of the surrounding habitats, sediment deposition is not expected to result in significant adverse effects on the sensitive benthic habitats.

### 5.4.2 Potential Impacts During Cable Operation and Maintenance

The cable will be buried where possible or where burial is not possible, surface laid with rock/rock bags/concrete mattresses placed on the cable to hold it in position, thereby minimising the potential for the cable to move around on the seabed over its lifetime and protect the cable and other sea users. Given this reduced likelihood for movement of the cable, potential impacts on benthic habitats during cable operation are highly unlikely. The only source of potential impact would be if the cable fails and needs to be repaired; a repair operation could potentially disturb protected habitats in the area as sections of the cable (or the whole cable) may need to be replaced.

### 5.4.3 Impact, Management and Mitigation Summary

Based on the summary of the nearshore and offshore benthic environments provided above and in Table 5-6 below summarises potential impacts on each receptor as a result of the project.

Table 5-6 Potential Impacts on Benthic Ecology

| Environmental Receptor | Potential Impacts | Overall Impact Significance |
|---|---|---|
| Subtidal ecology | Seabed disturbance from physical interaction with the seabed, shoreline and their associated habitats, particularly:<br>• Annex I bedrock reefs;<br>• Burrowed mud (PMF in Scotland);<br>• Kelp beds (PMF in Scotland);<br>• Ocean quahog (OSPAR listed), which presence is suspected in the survey corridor. | **No potential for significant impacts on intertidal and subtidal ecology from seabed disturbance,** due to**:**<br>> HDD installation will prevent any interaction with the seabed in the intertidal zone at Carradale;<br>> Very small area of impact from deposits and installation methods, with minimal impact to associated kelp beds, bedrock reef, ocean quahog or burrowed mud;<br>> Cable installation activities will be temporary and any increase in suspended sediments will quickly revert back to background levels; and<br>> All cable landfall works undertaken in line with standard best practice and general environmental management plans as detailed in the Section 1.3.5. |

# 6 MARINE MEGAFAUNA

## 6.1 Overview

This section of the report provides further detail on the large marine species, including marine mammals and basking sharks, in the vicinity of the proposed marine cable installation corridors, and presents results from an assessment of potential impacts on key sensitive species. Management and mitigation measures to ensure impacts are minimised will also be suggested.

This section also provides a Protected Species Risk assessment, with regard to potential impacts on cetaceans and basking sharks, in order to inform the associated EPS and basking shark licence applications.

This section draws on a number of data sources including published papers and industry-wide surveys such as Hague (2020). A key data source available for Scottish waters is the NMPi website (NMPi, 2021) which underpins the Scottish NMP (Scottish Government, 2015c).

## 6.2 Cetaceans

Around nine species of cetacean have been recorded off the west coast of Scotland, with three being commonly observed in the region (NMPi, 2021; Reid *et al,* 2003); harbour porpoise *Phocoena phocoena*, minke whale *Balaenoptera acutrostrata* and bottlenose dolphin *Tursiops truncates* (NMPi, 2021). It should be noted that the project area is located within SCANS Block G. The following summarises those species regularly sighted within the project area:

> **Harbour porpoise** are the most abundant cetacean species in UK waters and are generally observed in small groups of one to three individuals (Reid *et al.,* 2003). They are the most frequently sighted cetacean along the west coast of Scotland where they are present year-round (NMPi, 2021; Reid *et al*., 2003; Hague *et al.,* 2020). They are most commonly sighted between May to September (Reid *et al*., 2003). The density of harbour porpoise within Block G of the SCANS III survey, within which the project resides, was approximately 0.336 animals/km$^2$, which is average in the context of the wider United Kingdom Continental Shelf (UKCS) region (Hammond *et al*., 2017). According to density modelling data (combining SCANS-III density data with environmental predictive factors), it is predicted that harbour porpoise densities within the area will be low, with higher densities occurring in deeper offshore waters (Hague *et al.*, 2020; Hammond *et al.,* 2017).

> **Minke whale** are the smallest, most prevalent baleen whales to occur in Scottish waters. They feed mainly in shallower waters over the continental shelf and regularly appear around shelf banks and mounds, or near fronts where zooplankton and fish are concentrated at the surface (Reid *et al*., 2003). They are also commonly seen in the strong currents around headlands and small islands, where they can come close to land, even entering estuaries, bays and inlets. Minke whale density within Block G of the SCANS -III survey is considered to be moderate in comparison to the rest of the UKCS, with an estimate 0.027 animals/km$^2$ (Hammond *et al*., 2017). This species shows a large seasonal variation with much lower densities in the winter months, likely driven by variations in sea surface temperature and chlorophyll concentrations (Hague *et al*., 2020). Breeding locations of this species are currently unknown.

> **Bottlenose dolphin** sightings are less common in Western areas when compared to coastal eastern areas off of Scotland (Cheney *et al.,* 2013). The main bottlenose dolphin population on the east coast of Scotland resides between the Moray Firth and Fife (Cheney *et al*., 2013). These bottlenose dolphins are highly mobile and do move north towards the project area in smaller numbers (Cheney *et al.,* 2013; NMPi, 2021). The north coast of Scotland is the most northerly known extent of the coastal bottlenose dolphin ecotype in the Atlantic coasts of Western Europe, and while bottlenose dolphins have been encountered further north and off the shelf edge, they are likely to be the offshore ecotype (Cheney *et al,* 2013; Hague *et al*., 2020). Densities of bottlenose dolphin along the North coast of Scotland are expected to be

lower than the West and East coast and densities within Block G of the SCANS-III survey were approximately 0.121 animals/ km$^2$, which is low to average for the region (Hammond *et al.*, 2017; Hague *et al.*, 2020).

> **Other species**, such as killer whale, white-beaked dolphin, common dolphin, humpback whale and Risso's dolphin are seen infrequently in varying numbers and are occasional and/or seasonal visitors (Hammond *et al,* 2017; Reid *et al.*, 2003). However, these species do not occur frequently enough to require specific assessment.

The distribution, density, and abundance of the three most commonly occurring cetacean species in the vicinity of the cable corridor are described in Table 6-1.

Table 6-1 Population Parameters of Cetacean Species Potentially Present in the Vicinity of the Installation Corridors

| Species name | Estimated density across the project area[5] (individuals/km$^2$) (Hammond *et al.,* 2017) | Management Unit (MU) / biogeographical population estimate (IAMMWG, 2015) |
|---|---|---|
| Harbour porpoise | 0.336 | 21,462 |
| Minke whale | 0.027 | 23,528 |
| Bottlenose dolphin | 0.121 | 45 |

## 6.3 Seals

Two species of seals inhabit UK waters with any regularity: the grey seal *Halichoerus grypus* and the harbour seal *Phoca vitulina*. The waters around Scotland are an important habitat for both species, which utilise the coastlines and nearshore waters year-round for breeding and feeding (Pollock *et al.,* 2000).

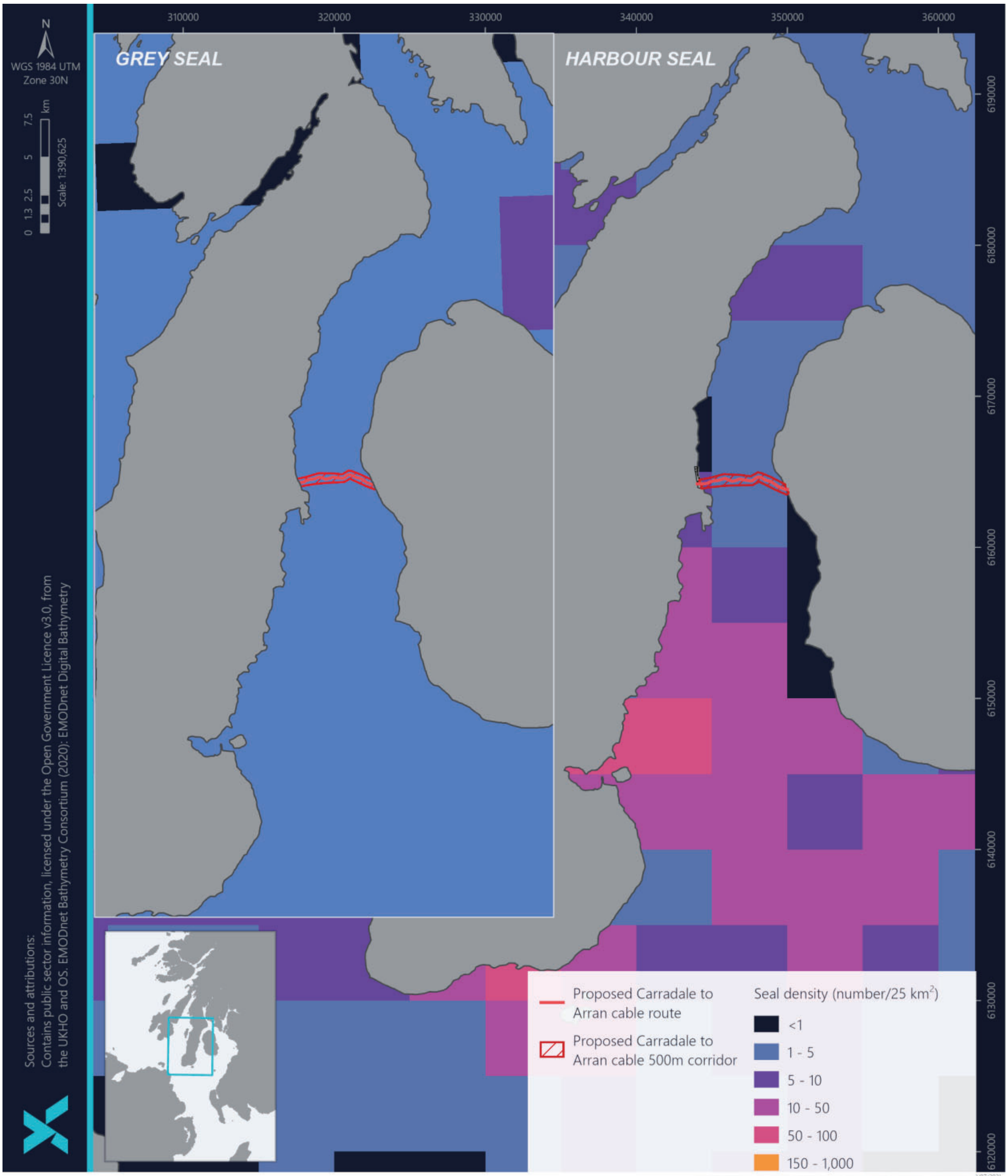
The at-sea density of grey and harbour seals surrounding the Carradale - Arran installation corridor is shown in Figure 6-1.

The mean at-sea usage of harbour seals is low for the installation corridors (1 - 5 individuals per 25 km$^2$) when compared with the wider Scottish waters (Russell *et al.,* 2016). The mean at-sea usage of grey seals is low to moderate when compared to the wider region (1 – 10 individuals per 25 km$^2$) with higher densities observes at the coast.

The pupping season of harbour seals is mid-June to July with moulting occurring in August and grey seals breed from October through to December and then moult until early April (SCOS, 2018). Similar to seabirds, seals are central-place foragers, utilising a terrestrial 'base' for important life history events (i.e. breeding, pupping, moulting, etc.) and to rest, and then head offshore on foraging trips before returning to land (Pollock, 2000). While both species are associated with shallower shelf waters, grey seals often make longer foraging trips to deeper waters than harbour seals.

[5] SCANS III Block G used for density estimate

Figure 6-1 Harbour and Grey Seal Densities in the Vicinity of the Carradale - Arran Cable Corridor (Jones *et al.*, 2015)




## 6.4 Otters

Despite not actually being a marine mammal, the European otter is a semi-aquatic mammal. While otters are resident throughout the UK and generally considered a freshwater species, the Scottish otter population differs in that half the population are coastal dwellers that spend a considerable amount of time foraging at sea and are therefore commonly referred to as sea otters (SNH, 2015). Populations in coastal areas utilise shallow, inshore marine areas for feeding (JNCC, 2018a).

It should be noted that during survey works conducted by ERM, a high level of otter activity was observed on Arran, centred on the beach. An active resting site was identified within the works area, approximately 30 m northeast of the substation (where the existing out of service 33kV cables come onshore). An active feeding site was also identified in close proximity. Given that no signs of otter activity were observed further inland, it's possible otters may only be commuting and feeding in the area. It should be noted that there are no designated areas in the immediate vicinity of the cable corridor for otters.

Otters may be encountered from time to time due to the sheltered and coastal nature of the area. This Annex II species and Scottish PMF will be monitored ahead and during the proposed works at the landfall site at Arran. The management and mitigation of otters in the vicinity of the Arran landfall will be implemented through the onshore environmental management plans, and are therefore not included in the scope of this MEA. This notwithstanding, all vessels and personnel will abide by the provisions of the Scottish Marine Wildlife Watching code.

## 6.5 Basking Shark

Basking sharks are one of the only three species of shark which filter feed and are the second largest fish in the world (Sims, 2008). This species can be found throughout the offshore waters in the UK continental shelf (Sims, 2008) and are considered frequent visitors to the north and west coasts of Scotland (HWDT, 2018). They are widely distributed in cold and temperate waters and feed predominantly on plankton and zooplankton e.g. barnacles, copepods, fish eggs and deep-water oceanic shrimps by filtering large volumes of water through their wide-open mouth. They typically move very slowly (around 4 miles per hour). In the winter, they dive to great depths to get plankton while in the summer they are mostly near the surface, where the water is warmer.

Basking sharks are present on the west coast of Scotland between spring and autumn, with peak sighting densities occurring in August (Bloomfield & Solandt, 2006; Witt *et al*., 2012). The west coast of Scotland has one of the highest encounter rates of basking sharks in the UK, and sightings occur throughout the Clyde marine region (Bloomfield & Solandt, 2006; Witt *et al*., 2012). The Clyde marine region is historically important for basking sharks, with Arran having previously been designated as a hotspot for sightings (Nicholson *et al*., 2000). However, basking shark densities in the Clyde marine region are lower than other areas of the west coast of Scotland (e.g. waters surrounding Mull, Coll and Tiree) (Speedie *et al*., 2009). For instance, Speedie *et al*., (2009) observed an encounter rate of 0.05 individuals per hour of survey effort in the Clyde marine region compared to an average of 0.61 individuals per hour in the wider west Scotland area. Importantly, basking shark densities appear to fluctuate in the region as reports carried out in different years obtain basking shark encounter rates which are either one of the highest in the wider area, or one of the lowest (Nicholson *et al*., 2000; Speedie *et al*., 2009; Solandt & Ricks, 2009). Nevertheless, in the context of the entire UK coastal waters, basking shark sightings are reasonably frequent (Bloomfield & Solandt, 2006).

## 6.6 Identification of Potential Impacts

This section reviews potential impacts to marine megafauna receptor species from the proposed project and narrows down which project activities require further assessment to identify the likelihood and significance of those impacts.

Impacts from accidental releases from pollution for all marine megafauna have not been considered for further assessment given that the likelihood of this is extremely low.

### 6.6.1 Impacts on Marine Mammals

Underwater noise emissions from the cable installation activities are likely to constitute the greatest potential risk to marine mammals within the vicinity of the project. Noise has the potential to impact cetaceans and other marine species in two ways:

> Injury – physiological damage to auditory or other internal organs; and

> Disturbance (temporary or continuous) – disruptions to behavioural patterns, including, but not limited to: migration, breathing, nursing, breeding, foraging, socialising and / or sheltering (note: this impact factor does not have the potential to cause injury).

If a noise emission is composed of frequencies which lie outside the estimated auditory bandwidth for a given species, then the potential for auditory impacts are considered to be very unlikely (NOAA, 2018). To understand the potential for noise-related impacts, the likely hearing sensitivities of different marine mammal hearing groups has been summarised in below in Table 6-2.

Table 6-2 Auditory Bandwidths Estimated for Marine Mammals (Southall *et al.*, 2019; NOAA, 2018)

| Hearing group | Estimated auditory bandwidth |
|---|---|
| Low-frequency cetaceans (LF): (e.g. baleen whales, such as minke whales, humpback whales, etc.) | 7 Hz to 35 kHz |
| High-frequency cetaceans (HF): (e.g. dolphins, toothed whales, beaked whales and bottlenose whales) | 150 Hz to 160 kHz |
| Very high-frequency cetaceans (VHF): (e.g. marine mammal species such as harbour porpoises and other 'true' porpoises) | 275 Hz to 160 kHz |
| Phocid carnivores in water (PW): (e.g. earless or 'true' seals, such as grey and harbour seals) | 50 Hz to 86 kHz |

The main sources of underwater noise associated with cable installation activities include:

> Vessel noise from ships and other marine plant utilised during the works;

> Noise from cable laying activities;

> Noise from the ROV to conduct touch down monitoring and installation of external protection; and

> Noise from geophysical survey devices used during pre, during and post installation survey and inspection. However, geophysical surveys are subject to existing consents held by SHEPD and are out-with the scope of this assessment.

While vessel noise is broadband and will be audible to marine mammals, the presence of the installation vessels along the Installation Corridors will not constitute a substantive change from baseline vessel numbers, or types of vessels in the area. As such the presence of installation vessels will not result in a significant change to the existing soundscape in the vicinity of the project, hence, this aspect does not have the potential to result in adverse underwater noise impacts on cetaceans and is not considered further.

Underwater noise emissions resulting from the cable laying and protection activities are expected to be minimal. Studies of previous cable installation projects have shown that noise emissions are typically broad band, with source levels in the region of 178dB re 1μPA (RMS) (Nedwell et al. 2003). As such, noise from cable laying and protection works do not have any potential for adverse effects on cetaceans and is not considered further.

USBL devices commonly operate in a frequency range which makes them audible to cetaceans, and hence this activity does have the potential to result in adverse effect on these receptors. The highly mobile nature of cetaceans and the temporary, localised nature of USBL noise emissions associated with the Project dramatically reduce the likelihood of interactions between Project activities and cetacean receptors resulting in significant impacts. However, as the risk of injury or disturbance to a small number of individual animals remains, hence impacts from noise emissions associated with USBL have been carried forward for further assessment

Collision risk is another potential risk to marine mammals in the project area and may cause mortality and sublethal injury (Laist *et al.* 2001). However, marine mammals are highly mobile and as all of the proposed activities associated with cable installation are due to take place from slow moving vessels operating in well-defined routes, collision risk is anticipated to be negligible. Any remaining residual risk from vessel movements will be further reduced on the basis of the embedded mitigation measures outlined in Section 4, which include the management of vessel speed and the commitment for project vessels to adhere to the SMWWC. For this reason, vessel movements have not been identified as having the potential to cause adverse or significant impacts to the Favourable Conservation Status (FCS) of any marine mammal population and has therefore been screened out from further assessment.

Vessel and human presence in the immediate vicinity of seal haul-outs may potentially impact seals. Seals are particularly susceptible to disturbance during their respective pupping and moulting seasons, when the residency of seals at haul-outs and in surrounding waters elevates the relative density of each species. The proposed cable installation works are expected to be temporary with the likelihood of temporarily overlapping with the pupping and moulting season for seals species. As discussed in Section 6.3 - the pupping season of harbour seals is mid-June to July with moulting occurring in August and grey seals breed from October through to December and then moult until early April (SCOS, 2018). Works are expected to take from October 2021 to September 2022.

That said, there are no designated seal breeding or haul-out sites within the installation corridor. As such, impacts to seals from landfall activities has not been considered further.

### 6.6.2 Impacts on Basking Sharks

The basking shark is an elasmobranch (sharks and rays) which is a group with generally low sensitivity to noise vibrations due to the fact they do not have a swim bladder. The hearing range of basking sharks is not known; however, five other elasmobranchs have been found to have a hearing range between 20 Hz to 1 kHz (Macleod *et al.,* 2011). It is acknowledged that this may not be entirely transferable to basking sharks, however since the equipment being used operates at a minimum frequency of 20 kHz which is several orders of magnitude higher than 1 kHz, it is unlikely the equipment will be audible to basking sharks. On this basis, the potential for noise emissions to impact upon basking sharks is screened out of further assessment.

Vessel collision does poses threat to this slow-moving species. Collision risk increases with increasing vessel speed. As the survey vessels will be moving slowly, collision risk is generally low, however does warrant further assessment.

### 6.6.3 Injury or Disturbance from Noise Emissions

Underwater noise generated by USBL constitutes the only source of sound with the potential to cause injury or significant disturbance to marine mammals. USBL typically operates in the frequency range of 20 – 33.5 kHz, and as such is audible to all marine mammal species likely to be present in the vicinity of the cable corridor. The USBL source level utilised during the cable replacement activities will be limited to 200dB re 1µPa (peak).

Noise modelling has been undertaken to identify the potential range (i.e. the straight-line distance from the source) in which noise impacts to marine mammals could occur. This assessment was based on the methods and thresholds provided by the current best practice guidance, as presented by NOAA and Southall (NOAA, 2018; Southall *et al*. 2019). The full noise assessment has been presented in Appendix B, a summary of the results is presented below.

The peak injury criteria were not exceeded for any marine mammal hearing group, since the source level is less than 202 dB re 1µPa (peak), as such no injury risk to marine mammals has been identified for USBL according to this metric. However, a theoretical risk of injury has been identified with regard to the cumulative sound exposure level criteria.

Under the worst-case scenario, the largest injury range resulting form USBL was 104 m for VHF cetaceans (harbour porpoises), when considering cumulative sound exposure levels for a stationary animal. For whale, dolphin, and seal receptors (LF, VHF and PW hearing groups) the potential injury ranges were significantly reduced. While a theoretical injury risk is identified by the underwater noise modelling, this is based on a cumulative exposure over an extended time period. As such, in order for a harbour porpoise to be at risk of injury, an animal would have to remain within 104 m of the USBL device for a period of several hours. The likelihood of this scenario occurring is extremely low when considering that the source is deployed from a moving vessel, and that animals will tend to move away from sources of acoustic disturbance.

As such, the assessment concludes that there is no realistic risk of injury to marine mammals, resulting from the use of USBL with source levels up to 200 dB re 1μPa (peak).

Whilst no injury impacts are expected, noise emissions have the potential to affect the behaviour of marine mammals in the vicinity of the noise source. Significant or strong disturbance may occur when an animal is at risk of a sustained or chronic disruption of behaviour or habitat use resulting in population-level effects. The potential impacts resulting from USBL noise was modelled in the noise assessment in Appendix B.

Under the worst-case scenario, it was predicted that a behavioural change may occur for marine mammals within 207 m of the cable installation vessel. As such, underwater noise emissions from the use of USBL have the potential to elicit a strong behavioural response in marine mammals which could be classed as a disturbance of EPS offence as defined under Regulations 39(1) or 39(2).

However, for the relevant biogeographical population Management Units (MU) for harbour porpoise, minke whale and bottlenose dolphin which all occur in the area, this will not result in population levels effects or adverse impact the FCS of the species. This is due to the fact that the noise assessment predicts that less than 0.1% of the biogeographic populations of relevant cetacean species will be impacted by noise-related disturbance as a result of USBL operations. Moreover, the number of animals within the disturbance range at any one time is predicted to be < 0.1. This means that on average, there will be no marine mammals within the disturbance range for 90% of USBL operations, making potential disturbance impacts at the population level arising from this equipment negligible.

As the vessel and/or the deployment craft (e.g. an ROV) will generally not be stationary during USBL operations, animals within a particular area will not be exposed to extended periods of underwater noise. Rather, individuals would have to follow the moving equipment to be subjected to lasting or prolonged periods of acoustic disturbance. As such, the exposure to disturbance from USBL operations will be extremely limited in duration, and hence does not have the potential to result in adverse effects at a population or species level.

Given the transient, highly localised and short-term nature of the USBL activities, it is highly unlikely that any disturbance offences from use of USBL would negatively impact upon the FCS of any of the cetacean species which may be present in the survey area. This is on the basis that the modelled level of disturbance is unlikely to affect the ability of any individual animal to survive or reproduce and will not have significant population-level impacts to any marine mammal. As such, no mitigation is required to limit the potential impacts on marine mammals resulting from USBL operations.

The above notwithstanding, it is possible that a small number of cetaceans may experience some level of disturbance for the short period that they encounter the proposed installation activities. As such, EPS Licences are expected to be required for the USBL-related activities which will be conducted during the installation of the Carradale – Arran cable replacement activities (as per Regulation 39(2)) (Scottish Government, 2014).

### 6.6.4 Injury or Disturbance from Vessel Presence (Basking Sharks)

Impacts on marine mammals resulting from vessel presence are screened out of this assessment. However, basking sharks are considerably less mobile than marine mammals, and are therefore identified as being more sensitive to vessel presence.

Project vessels will be moving slowly during the cable installation works reducing the risk of collision and disturbance to basking sharks, and SHEPD are committed to ensuring vessels adhere to the SMWWC (SNH, 2017). These factors considerably reduce the risk of injury or disturbance to basking sharks resulting from interaction with project vessels. Furthermore, basking shark densities are reported to be low in the vicinity of the which further reduces the risk of interactions between basking shark and project vessels occurring.

Considering these factors, and that the presence of the project vessels will not constitute a substantive change from baseline vessel activity in the vicinity of the Carradale - Arran installation corridors, it is concluded that vessel presence will not adversely affect the FCS of basking sharks. However, since the risk of disturbance cannot be entirely ruled out, a basking shark derogation licence may be required under the WCA 1981.

## 6.7 Conclusion

Underwater noise emissions are the impact mechanism most likely to affect marine megafauna in the project area.

There will be no injurious impacts to cetaceans or seals as a result of project activities, however there is potential for disturbance to cetaceans, and SHEPD will therefore apply for an EPS Licence in respect to disturbance of cetaceans. However, this disturbance is expected to be limited to one or a few individuals of the local population and will therefore not result in any adverse impact to the FCS of any marine mammal species.

Project activities will not result in the catching or killing of seals, and thus the protection provided to the two species by the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) will not be breached.

Furthermore, the short-term and localised nature of the proposed activities mean that harbour and grey seals making use of protected haul-outs is not expected to be significantly disturbed. As such, the protection given by Section 117 or the Marine (Scotland) Act 2010, and the Protection of Seals (Designation of Haul-Out Sites) (Scotland) 2014 will also not be breached.

It is acknowledged that the presence of the installation vessels does have the potential to result in adverse (injury or disturbance) interactions with basking sharks. However, considering their low abundance in the project area, behaviour of the installation vessels, and embedded mitigation the risk of this occurring is extremely remote. No adverse impact on the FCS of basking shark is therefore expected, however SHEPD will apply for a basking shark derogation licence, since the risk cannot be entirely ruled out.

Considering the temporary and localised nature of the project activities, there are not anticipated to be any significant impacts to individuals or populations of marine megafauna in the project area.

# 7 MARINE ARCHAEOLOGY

## 7.1 Introduction

This chapter describes the key characteristics of the marine historic environment along the North cable replacement cable corridor across Kilbrannan Sound between Carradale on the east coast of Kintyre, and the west coast of Arran south of Balliekine (see Section 7.4.4) and presents results from an assessment of potential impacts of the project on these characteristics (Section 7.6).

The chapter presents the results of a desk-based assessment (DBA) of marine cultural heritage below MHWS and a review and analysis of seabed geophysical survey data acquired during 2018. This chapter also provides a summary of relevant historic environment legislation (Section 7.2) and describes the criteria used to determine the importance or sensitivity of the identified historic environment assets (Section 7.4). Where potential direct or indirect impacts are identified, recommendations have been made for mitigating and managing those impacts (Section 7.7).

Marine cultural heritage in general is considered to encompass submerged landscapes, along with all evidence of human exploitation of maritime resources such as shipwrecks, aircraft wrecks, shipyards, harbours, piers, fish traps, ballast piles and anchorages.

## 7.2 Legislation and Policy Context

The project is located within Scottish and UK Territorial Waters (within 12 nautical miles of land). There are a number of international legally binding conventions, EU Directives, UK and Scottish legislation, policy frameworks and guidance to consider in relation to the historic environment. Various EU EIA Directives have been incorporated in UK and Scottish legislation, all of which include the requirement to address potential impacts on the historic environment. Relevant guidance and legislation relating to the assessment of impacts on the marine historic environment are discussed below.

### 7.2.1 International/ EU Legislation and Policy

The following conventions promote the protection of underwater heritage, with provisions for appropriate recording and recovery if disturbance is unavoidable.

> The United Nations Convention of the Law of the Sea (UNCLOS);

> Annex to the UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001; and

> The European Convention on the Protection of the Archaeological Heritage (revised), known as the Valletta Convention.

### 7.2.2 UK Legislation and Policy

Key UK legislation and policy includes:

> The Merchant Shipping Act 1995;

> The Protection of Wrecks Act 1973 (Section 1 of the Protection of Wrecks Act was repealed in Scotland on the 1st November 2013 and the wrecks around the coast of Scotland designated under this section of the Act are now protected by Historic Marine Protected Areas (HMPAs) as defined in the Marine (Scotland) Act 2010);

> The Protection of Military Remains Act 1986 has the principal concern to protect the sanctity of vessels and aircraft that are military maritime graves. Any aircraft lost while in military service is automatically protected under this Act; and

> The UK Marine Policy Statement (2011) states heritage assets should be conserved through marine planning in a manner appropriate and proportionate to their significance. Many heritage

assets with archaeological interest are not currently designated as scheduled monuments or protected wreck sites but are demonstrably of equivalent significance.

### 7.2.3 Scottish Legislation and Policy

Relevant Scottish legislation and policy includes:

- The Marine (Scotland) Act 2010. This requires licensing activities in the marine environment to consider potential impacts on the marine environment including features of archaeological or historic interest and defines marine historic assets (Section 73);
- The Historic Environment Policy (HEP) for Scotland 2019;
- Scottish Planning Policy (SPP) 2014;
- The Scottish Government's Planning Advice Note (PAN 2/2011) Planning and Archaeology 2011; and
- The Scottish Government's Scotland's National Marine Plan: A Single Framework for Managing Our Seas (March 2015).

In principle, licensing authorities should seek to identify significant underwater historic environment resources in the early stages of the planning process and preserve them in situ wherever feasible or manage changes to them in a way that protects the historic environment. Where this is not possible, licensing authorities should require developers to mitigate and minimise any detrimental impacts.

### 7.2.4 Local Planning Policy

The Isle of Arran lies within the North Ayrshire Council area which comprises a Local Development Plan (LDP). The LDP for North Ayrshire comprises a single plan. The adopted LDP (LDP2) is North Ayrshire's second LDP. It was adopted on 28 November 2019. Under planning legislation, this LDP needs to be replaced by November 2024. This LDP contains various policies covering the safeguarding and sustainable management of the historic environment, although these relate to terrestrial rather than marine heritage (LDP2 Policies 9-13).

Carradale, Kintyre is in the Argyll and Bute Council area. The proposed LDP for Argyll and Bute was open to consultation between 14th November 2019 and 24th January 2020 - this consultation is now closed. The Argyll and Bute LDP contains various policies covering the safeguarding and sustainable management of the historic environment, although these relate to terrestrial rather than marine heritage. Argyll and Bute Council's Historic Environment Strategy 2015-2020 recognises the presence of Historic Marine Protected Areas in the council area (though there are none in the project area), and that infrastructure development (such as cable installation) could have an impact on the historic environment, including marine archaeology, so that there could be links to marine planning concerns.

The Clyde Regional Marine Plan includes Kilbrannan Sound. The plan proposes that coastal and marine cultural and heritage assets, whether visible, buried or submerged, are preserved in situ where possible, enhanced where appropriate (Objective HE1) and appropriately excavated or recorded where preservation is not possible (Policy HE1).

### 7.2.5 Codes of Practice, Professional Guidance and Standards Documents

The following codes of practice, professional guidance and standards documents informed this assessment:

- The Chartered Institute for Archaeologists (CIfA) Codes, Standards and Guidance (various) http://www.archaeologists.net/codes/cifa;
- The Crown Estate (2010.) *Model clauses for Archaeological Written Schemes of Investigation: Offshore Renewables Projects*. Wessex Archaeology Ltd (Ref 73340.05) for The Crown Estate;

- English Heritage (2012). *Ships and Boats: Prehistory to Present. Designation Selection Guide*. Swindon: English Heritage;
- Gribble, J. and Leather, S. for EMU Ltd. (2011). *Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector*. Commissioned by COWRIE Ltd (project reference GEOARCH-09);
- The Joint Nautical Archaeology Policy Committee and Crown Estate (2006). *Maritime Cultural Heritage and Seabed Development: JNAPC Code of Practice for Seabed Developmen*t. York: CBA;
- Plets, R., Dix, J., and Bates, R. (2013). *Marine Geophysics Data Acquisition, Processing and Interpretation: Guidance Notes*. Swindon: English Heritage Publishing;
- Wessex Archaeology (2014). *Protocols for Archaeological Discoveries* http://www.wessexarch.co.uk/protocols-archaeological-discoveries-pad . Salisbury: Wessex Archaeology;
- Wessex Archaeology (2006). *On the Importance of Shipwrecks: Final Report Volume 1*. Salisbury: Wessex Archaeology;
- Wessex Archaeology (2011a). *Assessing Boats and Ships 1860-1913 Archaeological Desk-Based Assessment*. Salisbury: Wessex Archaeology; and
- Wessex Archaeology (2011b). *Assessing Boats and Ships 1914-1938 Archaeological Desk-Based Assessment*. Salisbury: Wessex Archaeology.


## 7.3 Sources of Information

A review was undertaken of existing literature, data sources and databases to identify known sites in the area, and the potential for unidentified marine cultural heritage sites and areas. Marine survey data (geophysical data) for the project area was also reviewed to identify the potential presence of marine historic assets in the survey area. These reviews were combined to give an overview of the characteristics of the marine historic environment in the project area.

### 7.3.1 Desk-Based Assessment

The results of a DBA of potential submerged cultural heritage in the study area prepared by Scientific Underwater Logistics and Diving (SULA Diving) on behalf of ORCA Archaeology is incorporated into this report along with the results of ORCA's studies. The appraisal was confined to a review of key existing data sources of known submerged sites in the project area. Historic environment assets that could be sensitive to the project, if present, may include shipwrecks, aircraft wrecks, submerged landscapes and other marine cultural features such as marine dumping and mine areas. The principal reference sources examined for this appraisal were:

- The National Record of the Historic Environment (NRHE) of Scotland, using the Canmore and Pastmap database websites (https://canmore.org.uk/ ; http://pastmap.org.uk/);
- Local Historic Environment Records through the Pastmap database websites;
- Statutory lists, registers and designated areas, including List of Scheduled Ancient Monuments, Designated Wrecks and Historic Marine Protected Areas;
- The Coastal Zone Assessment Survey: Kintyre and Isle of Arran (Cressey, M. & Badger, S. 2005);
- UK Hydrographic Office (UKHO) wreck register and relevant nautical charts;
- The Pre-Consultation Draft Clyde Regional Marine Plan 2019;

- Marine Scotland National Marine Plan interactive https://marinescotland.atkinsgeospatial.com/nmpi/ ;
- Wreck site database https://wrecksite.eu/;
- Larn, R., and Larn, B., (1998). *The Ship Wreck Index of Great Britain & Ireland Vol.4 Scotland*. London: Lloyds Register of Shipping;
- Whittaker, I.G., (1998). *Off Scotland: a comprehensive record of maritime and aviation losses in Scottish waters*. Edinburgh: C-Anne Publishing;
- Further information on wrecks and on minesweeping and mine-laying activities was followed up in the National Archives Admiralty files, based at Kew in Surrey, which holds ship log books and casualty reports from wrecks (http://www.nationalarchives.gov.uk/); and
- Other readily available archaeological and historical reports, databases, websites and publications were consulted for information about the study area and, where used, are cited in the report. They are listed in the reference section.

### 7.3.2 Field Surveys

Data from the geophysical survey campaign conducted in 2018 by Briggs Marine and their accompanying reports were reviewed to inform a robust assessment of the potential impacts of cable installation on the marine historic environment in the project area. The surveys reviewed were:

- SSS;
- MBES Bathymetry;
- Magnetometry;
- SBP survey.

## 7.4 Assessment Methodology

This assessment identifies, where possible, any marine sites of archaeological or cultural heritage significance in the project area and assesses whether there is potential for these sites to be affected by the project. Where potential impacts are identified, recommendations for mitigating and managing these potential impacts are provided. It is assumed that standard mitigation by avoidance will be incorporated into the project design where appropriate and possible.

### 7.4.1 Desk Based Assessment

The DBA reviewed key existing data sources of known submerged sites within a 5 km wide corridor centred on the proposed northern cable replacement route (the study area) to MHWS at landfall. This was in order to capture information on the approximate Position Approximate[6] cultural heritage and other sites with unknown locations that have the potential to be in the area[7].

The DBA has been completed in accordance with the CIfA Standard and Guidance for historic environment desk-based assessment (2014, revised January 2017).

[6] United Kingdom Hydrographic Office (UKHO) term, used on UKHO charts, to indicate an approximate position of a wreck, where precise location is not known.

[7] Sites with unknown locations are often placed at the SW corner of the 1 or 5 km grid square in which they may be located, as in the Canmore database.

### 7.4.2 Field Surveys

The methods and resolution limitations of the subsea surveys were presented in the Briggs Marine reports (2018a and b) that accompanied the data files for review. The MBES and SSS surveys were of sufficient standard and specification for archaeological review.

The geophysical data was reviewed by an experienced marine archaeologist to identify and assess any anthropogenic anomalies, covering the entire marine area surveyed. ORCA numbers were assigned to all contacts or anomalies observed and entered onto a concordance spreadsheet correlating to contacts identified by Briggs Marine.

- MBES data was supplied as a series of geotiffs, already imported into ArcGIS. The MBES data was of high resolution and had good overall coverage of the proposed routes. It was suitable for detecting potentially anthropogenic anomalies, with little banding, rippling or other survey artefacts caused by swell and tidal effects. Identification of MBES contacts was supported by correlating with SSS and magnetometer data;
- The SSS data was supplied as SSS mosaic geotiffs, already imported into ArcGIS. The mosaics were of good quality and small contacts could be identified, down to 0.2m in size. A SSS target list for the Arran inshore was supplied with 21 targets, as was a list for the main offshore survey area, with 1700 contacts. It was not possible to conduct a SSS survey in the Carradale inshore area due to the presence of fishing gear in the shallows (a MBES survey was undertaken instead). All contacts were verified against the MBES data, which was placed as a background to the SSS images;
- The SBP survey tracks were supplied as polyline shapefiles, which enabled the start and end points of the SBP survey tracks to be ascertained. The SBP data was supplied as a geotiff of an Isopach map, which cannot be used to determine any potential anthropogenic features or palaeoenvironmnetal features such as relict channels, unlike traditional cross section sub bottom profile data; and
- The magnetometer data was supplied as 64 lines of data running north west/south east, spaced approximately 50m apart. This is a result of the Magnetometer being towed behind the Edgetech 2200 FS SSS/SBP with 50m spacing between the tow-lines (Briggs Marine 2018b, 15). Thus, the magnetometer data collected, and target list supplied was not sufficient for archaeological analysis, which requires full coverage.

### 7.4.3 Geographic Information Systems (GIS)

An ArcGIS project file, 816 Base Map.mxd, was created and assigned the coordinate system, WGS_1984_Complex_UTM_Zone_30N. Ordnance Survey Open Data mapping was used for background mapping. All Briggs Marine survey data supplied in ArcGIS file format was added to this project file, augmented by ORCA's own data. Data in Excel was imported into ArcGIS and saved as shapefile point data. New shapefile point and polyline data was created for anomalies and contacts observed in each of the geophysical survey datasets (MBES, SSS, Magnetometer) in the ArcGIS 816 Base Map.mxd project. Bathymetric and terrain data supplied as geotiffs were added to the GIS project file for detailed background mapping along the proposed cable route.

### 7.4.4 Receptor Evaluation

The importance of the marine historic environment asset is determined by the criteria as described in Table 7-1 based on the professional guidance and standards documents listed in Section 7.2.5 above. It should be noted that a site that has not been statutorily designated can still be of high importance / significance. Features that would require considerable further work to interpret them are recorded as of uncertain significance / importance.

Table 7-1 Definitions for Importance / Significance of the Marine Historic Environment Asset

| Importance | Criteria |
| --- | --- |
| High | Archaeological and historical sites, submerged prehistoric landscapes and deposits, wrecks, wreck cargos, or areas of relative international or national importance, including world heritage sites, designated wrecks (designated under UK or Scottish legislation) or HMPAs. Shipwrecks dating to the prehistoric, Norse and Medieval periods, which are very rare; wreck cargos that contain rare artefacts or artefacts representative of a particular area or time period; and vessels, including aircraft lost in international conflicts which may have involved large losses of life. Shipwrecks involved in national or international trade, which were lost before 1913, a period during which the shipping industry was a major element in Britain's world influence, particularly if their cargo survives, or the remains provide evidence of changes in construction technology or vessel design would also be considered of high importance. |
| Medium | Archaeological and historical sites, wrecks, wreck cargos and areas of relative regional importance. This would involve shipwrecks, shipwreck cargos, anchorages and fishing areas from before 1913 that would have been involved in regional industry and trade. Wrecks and cargos considered representative of the changes in naval engineering or support the identification and preservation of the diversity of vessels from this period are considered of medium importance. |
| Low | Archaeological and historical sites, wrecks, wreck cargos and areas of relative local importance. Shipwrecks dating from after 1913 relating to fishing, ferrying or other coastwise trade. Wreck cargos of limited intrinsic, contextual or associative characteristics, or that are commonly recovered are considered of low importance / significance. |
| Negligible | Features that have been recorded but assessed as having little or no archaeological or historical interest, such as recent wrecks, or those wrecks whose structure or cargos have been so damaged that they no longer have any historical merit. |
| Uncertain | Features that cannot be identified without detailed work, but potentially of some interest. Also, for example, if the date of construction or rarity of a vessel is not known but is potentially of some interest. Findspots, which may represent an isolated find, or could represent the location of a hitherto unknown site. Unidentified geophysical anomalies are also of uncertain importance and are evaluated further in Table 7-2. |

The potential for geophysical contacts (aka anomalies or targets) to be anthropogenic, and perhaps therefore of heritage value is determined as described in Table 7-2. Contacts of low geophysical potential have not been shown on Figure 5-1, and none was identified of medium potential.

Table 7-2 Definitions for Level of Geophysical Potential

| Level of Geophysical Potential | Criteria |
|---|---|
| High | Contact/Anomaly/Target appears anthropogenic (atypical in its context); or there is identifiable cultural material; or it is in the area of a known archaeological site, or another contact/anomaly identified to be of high potential |
| Medium | Contact/Anomaly/Target lies in an area of intensive human activity such as near ports or areas of peat and other features relating to submerged landscapes, and is possibly anthropogenic, but which has no definite identification. |
| Low | Contact/Anomaly/Target is likely to be a natural formation such as a sand dune, boulder or bedrock formation. It could also be a processing error of the geophysical data. |

## 7.5 Site Characterisation

### 7.5.1 Potential for Submerged Landscapes and Prehistoric Sites

Submerged landscapes are where human beings and early hominins previously lived or hunted on terrain which was at that time dry land, or where they exploited fish and shellfish on the coast which is now submerged.

However, the potential for the survival of submerged landscapes and prehistoric sites is influenced by various physical factors, processes and topography with sheltered areas with lower seabed water movements, deep sediment deposits in rocky gullies and depressions and sea caves often providing conditions suitable for good site preservation (Flemming *et al.* 2017).

The survival of submerged landscapes, organic sediments and in particular submerged peat deposits and woodland remains that contain organic microfossils (e.g. pollen, diatoms, foraminifera) and macrofossils (e.g. seeds, wood, buds, insects) are important resources in reconstructing former landscapes, the activities of past human communities and sea level change.

The likelihood of organic clays or submerged peat deposits surviving rises in shallow, more sheltered waters close to land. It is also possible for archaeological sites to survive in the intertidal zone under exposed shingle and cobble storm beaches.

The complex evidence of isostatic uplift and marine transgressions in the project area have resulted in three main relict shorelines (raised beaches composed of marine-derived gravels, sands and silts) that have been mapped and depicted by the British Geological Survey (BGS 2019 http://mapapps.bgs.ac.uk/geologyofbritain/home.html). Any evidence for hominins and early human occupation between periods of glaciation, would therefore survive onshore above such relict shorelines. The coastline at Carradale and on Arran where landfall will be made is formed of raised beaches. The potential for survival of any remains here is **low** and the risk of impacting any such evidence **negligible**.

With the retreat of the ice around 10,000 years ago, western Scotland has slowly been rising, relative to sea level, as it adjusts to the removal of the weight of the ice. The rapid relative rise in sea level after the end of the last glaciation and subsequent lowering of the relative sea level as land continues to rise means that it is unlikely that evidence of Mesolithic or Neolithic occupation or deposits from those periods exist as submerged deposits and sites in the area. Current research indicates that there has been little change of coastline in the project area in the last 8,000 years (Sturt *et al* 2013; Bickett and Tizzard 2015; Dawson *et al* 2017) and therefore a **low** likelihood of submerged remains.

The Carradale-Arran survey area seabed consists mostly of hard-packed sediments, mobile sand waves, small exposures of bedrock and boulder fields (Briggs Marine, 2018a). Therefore, it appears that there is a **negligible-low** risk of there being any seabed sediments of potential interest and a **low** potential for preservation of prehistoric remains.

### 7.5.2 Maritime Structures

There is the potential for numerous maritime structures along the coast that may extend below the MHWS mark, including piers, boathouses, warehouses shipyards and fish traps (Cressey and Badger 2005). However, the only known structure within the corridor at either shore is a low short pier at Port na Cuile (Carradale landfall) extending N-S along the reef Sgeir a' Bogha (Canmore ID 290789) on the east side of the shelving shingle that forms the landing place in this bay. The structure is of negligible-low historical significance.

Although not within the study area, because they are onshore and therefore not within the scope of this document, it should be noted that there are a number of heritage sites extending along the coast just above the shoreline north of Port na Cuile, within the area under consideration for landfall. These include the footings of an early 20$^{th}$-century shark factory, a World War II structure for storing munitions, and several charcoal burning platforms, possibly relics of west Scotland's 18$^{th}$-century iron smelting industry, although they could be earlier (entries in Pastmap database). All of these required access to maritime transport.

It should be noted that there has been no onshore archaeological walkover survey of the landfall area on the Arran coastline that has fed into the Pastmap database.

### 7.5.3 Shipwrecks and Aircraft Wrecks

This section discusses the shipwrecks and aircraft (and cables) recorded in national and local inventories along the replacement cable route, and the potential for as yet undiscovered remains to be present. Shipwreck inventories and documentary sources are usually biased towards the 18th century and later when more systematic reporting began (Pollard *et al*., 2014). Therefore, there are few known historical records of wrecks from medieval or earlier periods.

As a maritime nation with a reliance on marine based trade and exchange, and with the exploitation of marine resources from prehistoric times, there have been countless shipwrecks around UK waters from all periods – many of which remain unreported. As such, there is a high probability for unknown, unrecorded vessels to have sunk in the project area over the centuries, although most will have been destroyed by the marine environment.

The past maritime societies of the Firth of Clyde and their requirement for vessels is evidenced in general by the presence of Mesolithic sites on the raised beaches of the Ayrshire coast; by Arran's remarkable quantity and quality of Neolithic and Bronze Age remains; by Roman finds on sites in the Firth, with the maritime route being the easiest way to reach the western end of the Antonine Wall (and the lands around the Firth in general); and by the presence of Iron Age and early historic fortified rocky coastal outcrops, often succeeded by castles on the same or a nearby location. The vitrified fort on Carradale Point (Canmore ID 39221, SM 2180) is presumed to be late Iron Age, and one of several fortifications identified along the east coast of Kintyre. It is located in a defensive position and implies the need for access to the sea and boats.

The early historic period in Kintyre and the Firth of Clyde saw the settlement of Gaelic-speaking Scots from Ireland and the rise of the kingdom of Dalriada in Argyll, with the Scots eventually absorbing the British-speaking kingdom of Strathclyde. This power politics was further complicated by the Norse sailing in and taking control of much of the western seaboard, including the Kintyre peninsula, by the 9th century. A maritime region based on the Isle of Man and the islands and seaboard of western Scotland emerged under Scandinavian rule, with the Isle of Man gradually separating from this to leave the kingdom of the Isles. The Firth of Clyde was both a maritime highway and a frontier with the rulers of mainland Scotland.

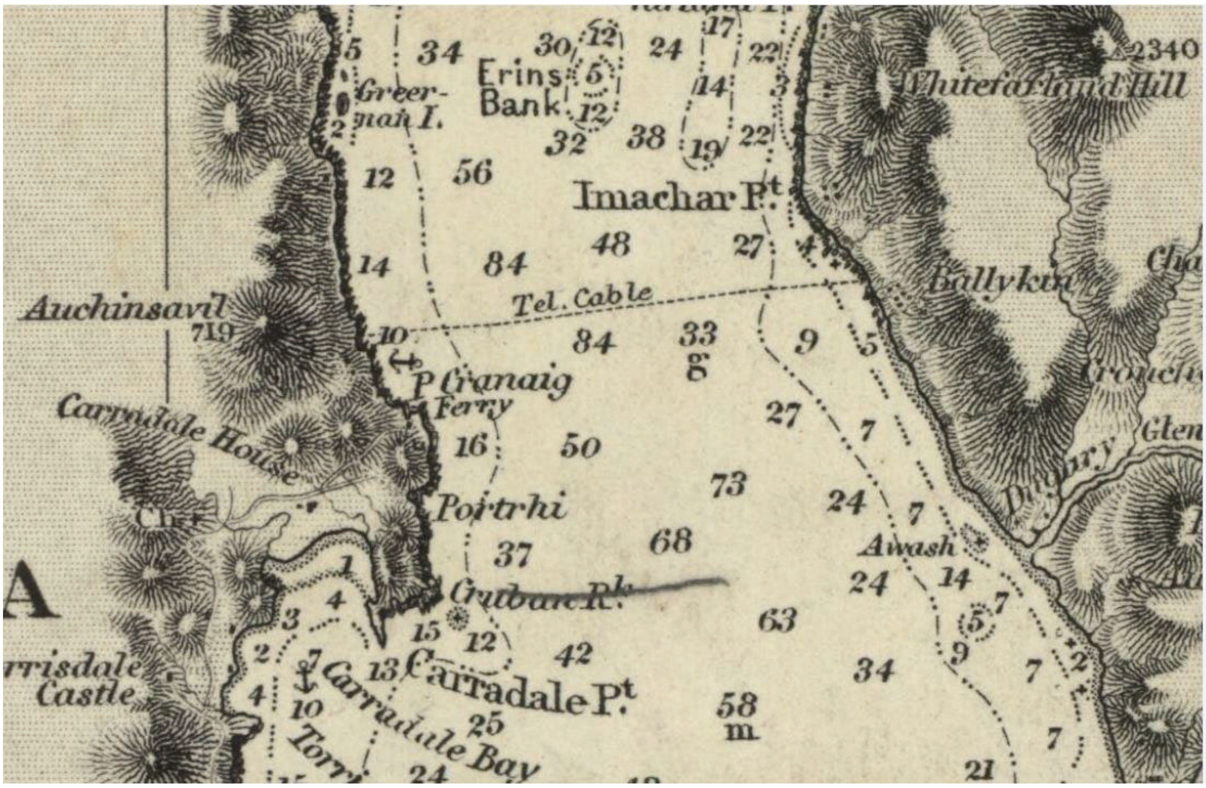
There are three small landing places identified by their Gaelic placenames at Carradale. Port Righ ('king's port') is a small bay located between the fort on Carradale Port and Airds Castle. Port Crannaich ('tree port') is the main harbour at Carradale, north of Airds Castle. Port na Cuile ('corner/nook port'), with the name perhaps reflecting the physical shape of the bay, with the only landing place formed by a shingle beach in the southern corner of this small bay, is where the present cables make landfall. The translations are derived from the Ordnance Survey website, accessed 5th July 2019 (https://www.ordnancesurvey.co.uk/resources/historical-map-resources/origins-of-placenames.html).

The maritime nature of this society is exemplified by the Gaelic-Norse Lord of the Isles, Somerled, being able to lead a fleet of 160 ships up the Firth of Clyde to do battle near Renfrew with the forces of Malcolm IV in AD 1164 (Caldwell 2015, 352). The end of what was by then nominal Scandinavian rule in 1266 was foreshadowed by the Battle of Largs in 1263, when the fleet of Norwegian King Haakon anchored off Arran, before repositioning between Great Cumbrae and the Ayshire coast where a storm battered several of the ships causing them to drag anchor and beach themselves. The Lordship of the Isles was forfeited to the Scottish Crown in 1493, but the maritime nature of medieval west Scotland was well established and continued on, with numerous clan and royal strongholds and seaways linking islands, power centres and trade networks (see Caldwell 2015 and Martin 2017 for example).

Airds Castle (Canmore ID 39222; SM3177) north of Carradale Point, between Port Righ and Port Crannaich, is the remains of a medieval castle located on the summit of a rock outcrop. It is in a strategically commanding position, controlling Kilbrannan Sound along with Skipness Castle, on the Kintyre coast some 21 km away at the northern end of the Sound. Airds Castle was held by the Lords of the Isles until its forfeiture to the Crown in the late 15th century and is particularly significant given the importance of the sea during the medieval period, lying close to the boundary between lands controlled by the Lords of the Isles and those held by the Scottish king.

The rise of Glasgow in the 18th century as a hub of transatlantic trade, the development of the shipbuilding industry along the banks of the Clyde, and the development of ferries and tourism resulting from the growth of the conurbation indicates the potential for ships to have been lost during this industrial period of the 18$^{th}$ to the 20$^{th}$ centuries. This, along with the hazardous nature of Kilbrannan Sound, is reflected by the number of wrecks identified by the desk-based research known to have sunk in the vicinity for the project area (see Table 7-3). Safe anchorages are marked on 19$^{th}$-century charts at Carradale Bay and at Port Crannaich or Port na Cuile, as is a ferry at Port Crannaich (spelt Cranaig) and a telegraph cable between Port na Cuile and Balliekine on the west coast of Arran (Figure 7-1).

Figure 7-1 Scotland West Coast Sheet 3, Mull of Kintyre to Ardnamurchan, 1887 (Admiralty Chart)




Given the millennia of maritime history outlined above, the likelihood of unknown unrecorded vessels having sunk in the project area is high. Upon review of the results from the geophysical surveys conducted (see Section 7.5.5), the nature of the seabed (boulder strewn hard-packed sediments, mobile sand waves, small exposures of bedrock) and the narrow width of potential disturbance (up to 8 m), the potential risk of impacting unknown remains when laying the new cable is likely to be **low**.

No marine cultural heritage statutory designations have been identified in the project area. There are no wrecks with known locations and no UKHO charted wrecks or obstructions in the cable corridor.

There are 34 shipwrecks and five plane wrecks listed on Canmore as being in the area of Carradale and on the shores either side of Kilbrannan Sound (see Table 7-3). The location of loss stated often proves not to be as precise as that recorded. The majority of the losses were strandings, which were often sold and broken up, and it was not uncommon for local communities to utilise any materials from shipwrecks and strandings. Some of the stranded vessels may also have been refloated without being reported, and further research would be needed checking Lloyds Lists and other sources to see if these vessels continued operating after dates of stranding.

The nearest recorded wreck to the proposed cable corridor where obvious remains are likely to have survived (because it was built of steel) is the SS *Waverley* of Glasgow. This steel steamship drove ashore on Imachar Point, Arran and became a total wreck. This vessel would be approximately 0.5 miles north of the proposed cable corridor. The Greenock Telegraph and Clyde Shipping Gazette (Friday 14 December 1883) named the location of the wreck as Amanarroch Point, but this place name could not be found on maps or charts despite numerous searches. Lloyds of London named the location as Imagher Point. One crewman was washed overboard. No obvious wreck or debris was seen on any of the data sets so it is most likely just north of the survey area.

There are six shipwrecks listed on the Canmore database and Whittaker (1998) potentially lost within the study area that may be of high importance, due to their involvement in international trade and/or the technological transition between sail and steam. The others are at best of medium importance, though likely to be of low importance, due to being smashed up, salvaged or, despite their pre-1913 date, of a well-known and common type of vessel, with a cargo of low historical value. However, descriptions included within details of their circumstance of loss indicate the possibility of being located within the cable corridor (see Table 7-3). The shipwrecks that may be of high importance are:

> *Ella.* Wooden brigantine, with a cargo of pig iron and coal. The vessel was abandoned NW of Ailsa Craig because of fire and drifted ashore near Carradale. Total wreck. The date of loss cited as 5 January 1867. Capt. Morris. Vessel from St John, New Brunswick, sailing from Troon to Cuba. Transatlantic trade. (Source: Lloyds of London, No. 16,456, Wednesday, January 9th, 1867.);

> *Minerva*. Type of vessel unknown. Wood. Sank in 17 fathoms on Barmolloch Bay no such bay known, near Carradale, 15 October 1802. En route from Norway to Dublin. Capt Cornelius. Registered in Gdansk/Danzig. International trade. (Source: The Marine List, Lloyds of London, No. 4299, Friday October 15th, 1802.);

> PS *Chieftain*. Stranded and wrecked off Cour, 6 miles north of Carradale, 8 March 1854, but location unknown. On route from Glasgow to Port Phillip Australia. Wooden paddle steamship of Greenock built 1845. Capt. Gemmel. (Source: Lloyds List Shipping and Mercantile Gazette. The Marine List, Lloyds of London, No. 12,467, Thursday March 9th, 1854.);

> *Ariadne*. Wreckage reported ashore at Carradale belonging to the Norwegian brig *Ariadne* of Dram, Svendson master. The ship discharged a cargo at Garlieston in December last, and subsequently left that port for Maryport to load. It is feared the vessel foundered during the recent gales, and that all hands have perished. (Source: Shipping Intelligence, Lloyds of London, No. 21,131, Wednesday January 18th, 1882.);

> *Keatty and Margaret/Mary*. Sloop of Stornoway, with cargo of coffee, sugar and logwood. Capt MacQueen. On route from Liverpool to Leith, wrecked and totally lost off Imchar Imachar, west side of Arran February 1th 1814. (Source: The Marine List, Lloyds of London, No. 4842, Tuesday February 1th 1814.); and

> *Aron, Phoebe and Ann*. Barque of Dublin: no cargo specified, sank two or three miles South of Cour, Kintyre, 5 October 1802. (Source: Whittaker 1998).

There are five recorded losses of aircraft that have the potential to be in the study area, and there are also a number of wartime aircraft went missing without trace over south-west Scotland. The risk of finding one in the cable corridor is likely to be low. Aircraft are automatically protected under the Protection of Military Remains Act 1986 if lost on active service, even if the remains are accidentally disturbed. These would be considered to be of high importance.

> Fairey Albacore I. L7109. Fleet Air Arm. 766 Squadron based at Machrihanish. Night flying exercise 09/09/1942, aircraft flew into sea off Shiskin, Arran. Sub Lieutenant RM Wilson, Sub

Lieutenant EB Jones and Leading Airman RT Hill killed. Category Z (Total Loss) but not recorded if ever recovered (Sturtivant and Burrow 1995; Whittaker 1998);

> Fairey Albacore I. X9165. Fleet Air Arm. 766 Squadron based at Machrihanish. Was on a night anti-submarine formation exercise at Ballure Bombing Range when the aircraft flew into sea off Ardpatrick Point. Sub Lieutenant MWH Squire, Sub Lieutenant Campion and Leading Airman D Callnon killed. Category Z (Total Loss) but not recorded if ever recovered (Sturtivant & Burrow 1995; Whittaker 1998);

> Blackburn Roc. L3121. Fleet Air Arm. 772 Squadron. Was on a target towing exercise 25/05/1943. The aircraft was towing a drogue which caught in the elevator and caused the aircraft to ditch. The pilot Sub Lieutenant VH Bellamy OK. It is listed that the aircraft was salved but was Category Z (Total Loss). It is not recorded how much of the aircraft was salved (Sturtivant & Burrow 1995; Whittaker 1998);

> Grumman Tbf-1b Avenger. FN878. Fleet Air Arm. 848 Squadron based at Machrihanish. The aircraft ditched 1.5 miles East of Carradale Point on 11/04/1944. Sub Lieutenant MS Beard, Sub Lieutenant AA Temple & Leading Airman J Reed were all killed. The aircraft was listed as Category Z (Total Loss) but not recorded if ever recovered (Sturtivant and Burrow 1995; Whittaker 1998); and

> Avro 652A Anson I. N4988. 10AFU (Advanced Flying Unit) (Observers) Royal Air Force. No 1 Air Observer School based at RAF Wigtown (Baldoon) force-landed in the sea off the east of Kintyre on 9 Dec 1943. The crew were rescued taken to Campbeltown before being flown back to their base from Machrihanish. The Anson is a very lightly built aircraft, made mostly from wood and fabric. It is unlikely that very much would have survived in the marine environment (Sturtivant 1988; Whittaker 1998).

Table 7-3 List of Possible Wreck Sites Within or Close to the Project Area

| Name | UKHO Wreck Number | CANMORE | Description | Circumstance of loss | Date Lost | Proximity to Cable Corridor | Source | Significance |
|---|---|---|---|---|---|---|---|---|
| Grace Darling | | 218809 | Sloop of Greenock. Built 1842.19 tons. Wood. | Stranded on Carradale Point with cargo of coal. Two crew lost. | 13/09/1859 | Unknown | 1,2,5 | Medium |
| Isabella | | 21570 | Sloop of Greenock. Built 1798. 56 tons. Wood. | Total loss near Carradale Bay. Crew saved. | 04/03/1827 | Unknown | 1,2,5 | Medium |
| Grace Darling | | 220236 | Ketch of Fleetwood. Built 1867. 43 tons. Wood | Stranded at Carradale Beach. In ballast. | 17/10/1897 | Unknown | 1,2,5 | Medium |
| Champion | | 220430 | Motor Cutter of Irvine. Built 1880. 23 tons. Wood | Stranded one mile north of Carradale. Cargo of pit props. | 18/10/1916 | Unknown | 1,2,5 | Low |
| Mary McCall | | 260752 | Smack of Londonderry. Built 1848. 31 tons. Wood. | Stranded one mile north of Carradale. Cargo of coal. | 27/02/1882 | Unknown | 1,2,5 | Medium |
| Ella | | 113299 | Brigantine, St Johns NB. 247 tons. Wood. | Abandoned off Ailsa Craig due to fire. Drifted ashore near Carradale. Cargo Pig Iron & Coal. | 05/01/1867 | Unknown | 1,3,5,8 | High |
| Minerva | | 218170 | Craft of Dantzig. Wood. | Sank in 17 fathoms on Barmolloch Bay, near Carradale. Norway to Dublin. | 05/10/1802 | Unknown | 1,2,3,5 | High |
| Lavinia | | 218243 | Sloop of Greenock. Built 1806. 70 tons. Wood. | Wrecked at Carradale. Cargo of limestone from Newry. | 08/01/1814 | Unknown | 1,2,3,5 | Medium |
| PS Chieftain | | 218784 | Paddle steamer. Of Greenock. Built 1845. 26 tons. Wood and Iron. | Glasgow to Port Phillip. Stranded and wrecked. 6 miles north of Carradale. Possibly at Cour? | 08/03/1854 | Unknown but likely to be 4.5 miles north. | 1,2,3,5,13 | High |
| Neva | | 265870 | Craft. Wood. | Message on piece of pine board found at Carradale refers to foundering off Southend, ''Mull of Cantyre''. | 14/10/1875 | Unknown but most likely south of Carradale | 1,3,5 | Medium |

| Name | UKHO Wreck Number | CANMORE | Description | Circumstance of loss | Date Lost | Proximity to Cable Corridor | Source | Significance |
|---|---|---|---|---|---|---|---|---|
| Ariadne | | 270277 | Brig of Dram, Norway. Wood. | Wreckage at Carradale, lost with all crew. | Dec 1881 or Jan 1882 | Unknown | 3,5 | High |
| Kilberry | | 284429 | Schooner, wood. | Thought to have foundered about 8 miles north of Campbeltown. | 22/01/1859 | Unknown | 1,2,5 | Medium |
| Agnes | | 285992 | Smack (Gabbart) of Glasgow. Built 1848. 39 tons. Wood | Sank off Carradale Point. Cargo of coal. | 11/05/1870 | Unknown | 1,3,5 | Medium |
| Mary | | 286000 | Smack, of Ardrossan, Wood. | Laden with stones, broke from her moorings off Carradale, went ashore and became a total wreck. | 12/10/1870 | Unknown | 1,3 | Medium |
| Mary | | 327595 | Smack. Wood | Wrecked at Carradale. Cargo stone. | 12/10/1870 | Unknown | 1 | Medium |
| Mary | | 286540 | Smack of Ardrossan | Drove from her anchors at Carradale Pier, sank and sold as a wreck | 10/11/1861 | Unknown | 1,3 | Medium |
| Watercress | | 303305 | Motor Ketch of Greenock. Wood. | Stranded near Carradale and expected wrecked. Cargo of Coal | 08/07/1920 | Unknown | 1 | Low |
| Betsey | | 303321 | Sloop of Greenock | Stranded at Cardel (Carradale?) | 00/03/1838 | Unknown | 1 | Medium |
| Unknown | | 303378 & 328878 | Boat. Wood | Vessel capsized off Cardel (Carradale?). 4 lives lost. | 02/11/1792 | Unknown | 1,5 | Medium |
| William Gillies | | 304222 | Brig of Greenock. Wood | Vessel stranded at Carradale Bay. In ballast. | 30/11/1868 | Unknown | 1 | Medium |
| Helen | | 304420 | Smack of Glasgow. Built 1839. Wood | Lost off "Cardile" Point, near Campbeltown. (Carradale Point?) | 03/10/1845 | Unknown | 1 | Medium |

| Name | UKHO Wreck Number | CANMORE | Description | Circumstance of loss | Date Lost | Proximity to Cable Corridor | Source | Significance |
|---|---|---|---|---|---|---|---|---|
| Unknown | | 286001 & 327700 | Schooner. Wood | Laden with lime, sprang a leak off Carradale, caught fire, and is reported to have burned to the waterline. Possibly off Skipness Point. | 14/10/1870 | Unknown | 1,3,5, 9,10, 13 | Medium |
| Christy | | 303379 | Fishing Vessel. Of Campbeltown. Wood | Lost in collision. Three men lost. | 08/08/1837 | Unknown | 1 | Medium |
| Keatty & Margaret or Keatty & Mary | | 218246 | Sloop of Stornoway. Built 1813. Wood. | Wrecked off west side of Arran at Imachar. Cargo of coffee, sugar and logwood. | 10/01/1813 | Unknown | 1,2,3 | High |
| Nancy | | 112951 | Brigantine of Belfast Built 1803. 65 tons. Wood | Belfast for Ayr, in ballast. Stranded Imachar Point, | 02/10/1885 | Unknown | 1,8,13 | Medium |
| SS Waverley | | 218938 | Steamship of Glasgow. Built 1883 J. McArthur & Co., Paisley.. 220 tons. Iron | Stranded at Imachur Point, Arran. In ballast. One man lost. | 11/12/1883 | Unknown | 1,2,3 | Medium |
| Mary Mccoll | | 260752 | Smack of Londonderry. Built 1848. 31 tons. Wood | Ashore at Carradale. One mile north of pier. Cargo coal. | 27/02/1882 | Unknown | 1 | Medium |
| Aron, Phoebe & Ann | | 303137 | Barque of Dublin. | Vessel sank two or three miles South of Cour, Kintyre. | 05/10/1802 | unknown | 1 | High |
| Llama | | 257690 | Lugger, 3 tons. Wood. | Fishing, foundered off Whitefarland. | 26/08/1875 | Unknown | 1 | Medium |
| Mhairi | | 304714 | Lugger, fishing vessel CN679 of Carradale. Built 1901. 9 tons. Wood. | Vessel foundered 1.5 miles SE of Saddel. | 08/03/1911 | Unknown | 1 | Medium |
| Unknown | | 326543 | Craft. Wood | Lost on the west side of Arran. | 1860 | Unknown | 1 | Unknown |

| Name | UKHO Wreck Number | CANMORE | Description | Circumstance of loss | Date Lost | Proximity to Cable Corridor | Source | Significance |
|---|---|---|---|---|---|---|---|---|
| Pearl | | 112952 | Schooner. 44 tons. Wood | Stranded at Dougarie, Arran. | 29/09/1863 | Unknown | 1,8 | Medium |
| Jane Taylor | | 220363 | Schooner of Preston. Built 1881. 92 tons. Wood | Stranded near Torrisdale Bay | 01/01/1906 | Unknown | 1,2 | Medium |
| Priscilla | | 116542 | Brigantine of Plymouth. Built 1866. 163 tons. Wood | Vessel stranded at Rocky Pt, Torrisdale Bay | 03/01/1906 | Unknown | 1,2,8 | Medium |
| UKHO | | | | | | | | |
| Buoy | 70558 | | environmental monitoring buoy | Monitoring buoy deployed by a company which went into receivership. buoy disappeared during winter | 2006 | 4 Miles south | 4,7 | Low |
| Mine Field | 3939 | 102682 | Dummy Minefield | Dummy Mine-field laid in 1951 and reported as removed by 1992 | 1951 | 4 Miles north | 4,7 | Low |
| Aircraft | | | | | | | | |
| Aircraft | | 302788 | Blackburn Roc. L3121 | 772 sqn FAA ditched near Crossaig, Salved but listed as total loss, beyond repair. | 25/05/1943 | Unknown | 1, 11 | Very High |
| Aircraft | | 303307 | Grumman Tbf-1b Avenger FN878 | 848 sqn FAA ditched 1.5 miles East of Carradale Point. | 11/04/1944 | Unknown | 1, 11 | Very High |
| Aircraft | | 304450 | Avro Anson I. N4988 | 10AFU crashed and sank 1.5 miles off Whitestone, near Carradale. | 09/12/1943 | Unknown | 1,12 | Very High |
| Aircraft | | 328523 | Fairey Albacore I X9165 | 766 Sqn. Crashed into the sea off Ardpatrick Point. | 03/04/1943 | Unknown | 1,11 | Very High |

| Name | UKHO Wreck Number | CANMORE | Description | Circumstance of loss | Date Lost | Proximity to Cable Corridor | Source | Significance |
|---|---|---|---|---|---|---|---|---|
| Aircraft | | 304685 | Fairey Albacore I L7109 | 766 Sqn. Crashed into the sea off Shiskin, Arran. | 09/09/1942 | Unknown | 1,11 | Very High |

1 = Whittaker 1998; 2 = Larn & Larn 1998; 3 = Lloyds Loss Register; 4 = UKHO; 5 = Canmore; 6 = National Archive Kew; 7 = Wrecksite.eu; 8 = Moir & Crawford 2004; 9 = Shipping and Mercantile Gazette; 10 = Shields Daily Gazette; 11 = Sturtivant & Burrow 1995; 12 = Sturtivant 1988; 13 = Britishnewspaperarchive.com

### 7.5.4 Unexploded Ordinance (UXO)

During both World Wars a large amount of ordnance, both offensive and defensive, was used in the seas around the Clyde. However, no reports of any mine laying in the study area have been found in the WW1 Bi-Monthly Minesweeping Reports or in the reports from U Boats operating in the area in both World Wars. There have been no modern reports of discovering wartime UXO in the study area. It is not reported if any of the aircraft lost in the area had bombs or torpedoes (if any, most likely the Grumman Avenger) on board but it is highly likely that there would be ammunition for the machine guns. Fairey Albacore I. X9165 was on exercise at Ballure Bombing Range but there is no record of bombs on board.

This study for the potential of UXO in the study area was carried out for the purposes of this historical and cultural assessment only and does not replace any UXO identification study that SHEPD may undertake prior to cable installation to ensure there is no risk of encountering any UXO during the installation activities.

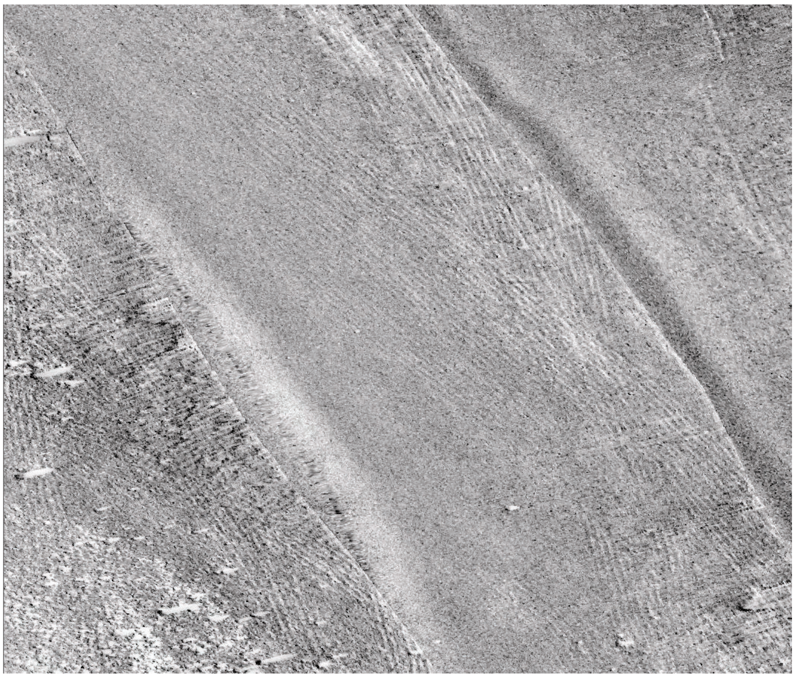
### 7.5.5 Geophysical Surveys

#### Side Scan Sonar (SSS) Contacts

The mosaic tiffs supplied were of good quality and sufficient detail to be able to pick out small rocks and boulders, which were numerous throughout the survey area. A contact list was supplied with 1770 contacts. Most were boulders or the existing cables. Two contacts were highlighted in the contact report as being of potential interest, which were assessed and are considered to be of high geophysical potential and anthropogenic. These were ORCA15 and ORCA226, probable anchor chain/rope and a small wreck or debris the size of a small fishing boat respectively. The side scan data was then further reviewed but nothing else was seen which was considered to be anthropogenic.

The SSS data shows evidence of trawling on the sand areas, most likely scallop dredging, with obvious uniform scarring on the seabed. Any archaeology in the dredged areas, apart from larger steel/iron wrecks, are likely to have been badly damaged or destroyed by this fishing activity, meaning that there is a **low** likelihood of any significant remains surviving and thus a **negligible-low** significance of impact.

Figure 7-2 SSS Image Showing Dredging Scars on the Seabed



The shallow inshore areas were surveyed separately (Briggs Marine, 2018b), and a separate file was supplied with 21 targets taken from inshore Arran. No Carradale inshore survey could be undertaken due to the presence of fishing gear in the shallows. The tiff supplied showed good detail, with targets comprising existing cables and some selected boulders. The cables are partly buried in sand. No targets of historic interest were observed.

#### Multi-beam echo sounder (MBES)

The multibeam survey was of high quality and was suitable for detecting potentially anthropogenic anomalies, with little banding, rippling or other survey artefacts caused by swell and tidal effects. Identification of MBES contacts was supported by correlating with SSS data. The data clearly shows that the seabed along the route comprises hard-packed sediments strewn with boulders, mobile sand waves and small exposures of bedrock. The Arran potential landfall area is a shingle and cobble storm beach, with rocky outcrops, whilst the Carradale landfall is along an indented rocky shore with small areas of shingle and cobbles. Apart from the existing cables, the only anthropogenic items observed were ORCA15 and ORCA226. The shallow inshore areas were surveyed separately (Briggs Marine, 2018a), in much higher definition that the offshore MBES, and nothing of anthropogenic interest noted except for ORCA15 and the existing cables. Therefore, the images for those inshore areas have not been reproduced in this chapter.

#### Magnetometer survey

No anthropogenic MAG anomalies were depicted in the magnetometer data. This is because the magnetometer data supplied was not sufficient for archaeological review or comparison of targets with anomalies identified in the MBES or SSS surveys, for the reasons described above in Section 7.4.2.

#### Sub bottom profile survey

A tiff of the sub bottom profile data was supplied as an Isopach map and although this defines the geology showing deeper sand patches and bedrock, unlike traditional cross-section SBP data, it is not useful for the identification of any potential anthropogenic or paleoenvironmental features.

## 7.6 Potential Impacts

The project will be designed to avoid charted wrecks and identified cultural heritage assets. Only two marine cultural heritage assets have been identified. The potential impacts to marine cultural heritage are identified below and summarised in Table 7-4. The potential for impacting possible organic sediments that could contain paleoenvironmental evidence is negligible with the compacted seabed sediments, mobile sands and patches of exposed bedrock.

### 7.6.1 Direct Damage to or Destruction of known Marine Historic Environment Assets and UXO

During construction and installation of the replacement cable, direct impacts to known cultural material on the seabed could be caused by vessel activities, seabed preparation and boulder clearance resulting in the removal of marine cultural heritage or removal of material that forms the context of the site.

However, there are no shipwrecks or aircraft with known locations in close proximity to the cable corridor. Apart from the existing cables identified by the Briggs Marine surveys, only two anthropogenic geophysical anomalies have been identified. The probable shipwreck, ORCA226, is located between the two cables (336 m south of the existing north cable, 292 m north of the south cable) and will be avoided by the new cable route. ORCA15 is on the existing north cable route but of negligible heritage significance.

Therefore, no impacts are predicted on known marine heritage assets.

### 7.6.2 Direct Damage to or Destruction of Unknown Marine Historic Environment Assets Including UXO

During construction and installation, direct impacts to unknown cultural material on the seabed could be caused by vessel activities, seabed preparation and boulder clearance resulting in the removal of marine cultural heritage or removal of material that forms the context of the site. The potential for such an impact has been reduced during Project development by analysis of the geophysical survey data, which apart from the two anomalies mentioned above, identified nothing of archaeological interest, and is further reduced by the hard-packed nature of much of the seabed (meaning the likelihood of survival of cultural remains below the surface is low). Therefore, the likelihood of impact is considered **low**.

The cable will be buried over as much of the route as possible. As a worst-case scenario, it is assumed that this will require trenching. This has the potential to cause direct damage to unknown marine cultural heritage through damage or destruction. The potential for such an impact has been reduced during project development by analysis of the geophysical surveys and is further reduced by the hard-packed nature of much of the seabed (meaning the likelihood of survival of cultural remains below the surface is low). Therefore, the likelihood of impact is considered **low**.

Where it is not possible to bury the cable, it is assumed that it will be protected by the placement of rock filter bags or concrete mattresses at key points. This has the potential to cause direct damage to unknown marine cultural heritage through compression. The potential for such an impact has been reduced during Project development by analysis of the geophysical surveys and is further reduced by the hard-packed nature of much of the seabed (meaning the likelihood of survival of cultural remains or submerged prehistoric landscapes is low). Therefore, the likelihood of impact is considered **low**.

The cable will make landfall by HDD at the Carradale landfall, which means that it will not impact the seabed in the Carradale intertidal area, and any potential paleoenvironmental deposits or unknown remains that might survive. Once offshore, the HVAC cable will be either surface laid or buried between the offshore end of the HDD duct and the location of the shore landing at Arran.

The possible wreck sites identified in Section 7.5.3 have unknown locations. The potential for impacts on these have been reduced during Project development by analysis of the geophysical surveys, and is further reduced by the hard-packed nature of much of the seabed. Therefore, the likelihood of impacting them accidentally (if they survive at all) is considered **low**.

### 7.6.3 Direct Damage or Destruction of Known / Unknown Marine Historic Environment Assets and UXO

During operation and maintenance, it is possible that accidental direct impacts to unknown cultural material on the seabed could be caused by maintenance vessels dropping anchors on the seabed during routine inspections or preventative maintenance or by trenching for cable burial. The likelihood of such impacts is considered **negligible-low**.

Only two heritage assets were identified, one (ORCA226) will be avoided, whilst the other (ORCA15) is of no significance and will likely be avoided by default because it is on the route of the existing north cable; therefore, a **negligible** impact is predicted on known marine heritage assets.

### 7.6.4 Potential Indirect Damage or Destruction of Known / Unknown Marine Historic Environment Assets Including UXO

There is the possibility of indirect impacts on marine cultural heritage assets and their associated environment if the Project causes scour on the seabed. Scour occurs on the seafloor when sediment is eroded from an area in response to forcing by waves and currents (Quinn, 2006: 1419). It can be initiated by the introduction of an object to the seafloor such as a shipwreck or cable. Marine features such as shipwrecks and submerged landscape deposits are therefore made vulnerable to erosion due to scouring by currents or waves and scour processes can ultimately lead to the complete failure and collapse of structures on the seafloor.

However, the potential for indirect impacts to cultural material on the seabed as a result of scouring or sediment deposition during operations and maintenance is considered to be **negligible**, due to the lack of identified sites, the intention to bury the cable, and the **low** likelihood of the cable being accidentally laid over unknown sites where it is not possible to bury, and pinning any such sections of cable down by using rock filter bags, which prevent scour.

## 7.7 Mitigation

In general terms, it is preferable to manage the presence of cultural heritage sites by locating construction footprints and routing the cable to avoid them. However, where this is not possible various strategies can be put in place, although few are required for this development due to the lack of identified maritime heritage. The mitigation and management measures outlined below will result in the avoidance, reduction or offsetting of any potential impacts on marine cultural heritage by the project.

### 7.7.1 Mitigation by Design

The potential for significant impacts on marine cultural heritage has been reduced to negligible-low during the development and design of the project by conducting a DBA and geophysical surveys to identify any marine historic environment assets. The probable wreck identified as a side scan sonar contact (ORCA226) will be avoided by the new cable, whilst the chain fragment (ORCA15) is of negligible significance and need not be avoided. Therefore, it is unlikely there will be any impacts on maritime cultural heritage. Furthermore, the proposed burial of the cable, or the use of external cable protection and stabilisation measures such as rock berms, rock filter bags and concrete mattresses will significantly reduce any cable movement and potential scour over the lifetime of the cable.

### 7.7.2 Mitigation During Installation

The cable will be installed by HDD at the Carradale landfall, which means that it will not impact the seabed in the Carradale intertidal area, and any potential paleoenvironmental deposits or unknown remains that might survive. Once offshore, the cable will be either surface laid or buried between the offshore end of the HDD duct at Carradale and the location of the shore landing at Arran.

In order to manage the potential for impacting unknown heritage, a reporting protocol will be instigated for the discovery of previously unknown marine cultural material during development. The reporting protocol produced by Wessex Archaeology (2014) for the Crown Estate will be sufficient (http://www.wessexarch.co.uk/protocols-archaeological-discoveries-pad).

Unknown cultural material could come from the presence of wrecks of uncertain location and the potential for submerged landscape material, although as outlined in Section 7.6, this a low risk. However, should any cultural heritage sites be reported during the course of the project, it is recommended that they are investigated by a qualified marine archaeologist as their potential for retaining cultural heritage information could be high.

### 7.7.3 Mitigation During Operation

Because the likelihood of impacts during this phase is considered negligible-low, it is suggested that a reporting protocol is kept in place in case anything of interest is observed during maintenance operations. If any cultural heritage sites are reported, it is recommended that they are investigated by a qualified marine archaeologist as their potential for retaining cultural heritage information could be high.

## 7.8 Residual Impacts

The reduction of potential impacts by the work conducted during the design and development of the project, combined with instigating a reporting protocol for the accidental discovery of cultural remains are likely to result in impacts of negligible significance on the marine historic environment.

Table 7-4 Residual Impacts on Archaeological Receptors

| Receptor | Sensitivity | Potential Impact | Likelihood of Significant Impact | Management / Mitigation | Residual Impact |
|---|---|---|---|---|---|
| Known marine heritage assets | Negligible | **Direct:** vessel activities, seabed preparation, cable laying, post lay jet-trenching or installation of external protection measures. | None | DBA has identified none with known locations present in cable corridor. Geophysical surveys identified possible small wreck (ORCA226) and length of anchor chain/rope (ORCA15). ORCA 226 will be avoided, ORCA15 may be avoided by default, but of no importance if not. | None |
| Shipwrecks with unknown locations | Low-High | **Direct:** vessel activities, seabed preparation, cable laying, post lay jet-trenching or installation of external protection measures.<br>**Indirect**: cable movement, scour. | Low | DBA and geophysical surveys – none identified.<br>Reporting protocol for accidental discoveries.<br>Use of burial and external protection to prevent cable movement and scour. | Low |
| Aircraft with unknown locations. Aircraft legally protected and must not be disturbed, even accidentally. | High | **Direct:** vessel activities, seabed preparation, cable laying, post lay jet-trenching or installation of external protection measures.<br>**Indirect:** cable movement, scour. | Negligible | DBA and geophysical surveys – none identified.<br>Reporting protocol for accidental discoveries.<br>Use of burial and external protection to prevent cable movement and scour. | Negligible |
| UXO | High | **Direct:** vessel activities, seabed preparation, cable laying, post lay jet-trenching or installation of external protection measures.<br>**Indirect:** cable movement, scour | Negligible | DBA and geophysical surveys – none identified.<br>Reporting protocol for accidental discoveries.<br>Use of burial and external protection to prevent cable movement and scour. | Negligible |
| Unknown submerged deposits | Low-High | **Direct:** vessel activities, seabed preparation, cable laying, post lay jet-trenching or installation of external protection measures.<br>**Indirect:** cable movement, scour. | Low | DBA and geophysical surveys – none identified.<br>Reporting protocol for accidental discoveries.<br>Use of burial and external protection to prevent cable movement and scour. | Negligible |
| Unknown cultural material | Low-High | **Direct:** vessel activities, seabed preparation, cable laying, post lay jet-trenching or installation of external protection measures.<br>**Indirect:** cable movement, scour | Low | DBA and geophysical surveys – none identified.<br>Reporting protocol for accidental discoveries.<br>Use of burial and external protection to prevent cable movement and scour. | Negligible |

# 8 COMMERCIAL FISHERIES AND OTHER SEA USERS

## 8.1 Introduction

Through good communication and understanding of viewpoints, SHEPD aim to minimise any potential impacts by agreeing mitigation strategies before the works begin. This approach continues through all phases of the project for each submarine electricity cable, thus enabling co-existence with other marine users as SHEPD and their Contractors carry out the cable replacement activities.

Works are planned to keep unnecessary interference with other legitimate sea users to a minimum. SHEPD achieve this by actively engaging with legitimate sea users and those with consented development rights close to the operations.

SHEPD's consultations and agreements are tracked through the Fishing Liaison Mitigation Action Plan – Clyde (FLMAP). This is a key document which shows the associated risks to the commercial fishing industry and other legitimate sea users, addresses the potential effects and identifies how to minimise and mitigate potential impacts.

SHEPD will give as much notice as is practicably possible for the operations and provide updates when things change.

## 8.2 Supporting Documents

### 8.2.1 FLMAP Clyde Region

The purpose of the FLMAP Clyde Region is to

- Illustrate the associated risks to the commercial fisheries industry (and other legitimate sea users), address the potential effects (highlighted in the marine licenced evidence);
- PAC Report to cover all pre-application engagement with fisheries interest; and
- Identify how to minimise and mitigate potential impacts on local communities.

A summary assessment of all the potential marine interactions and activities which could influence or affect the proposed cable works is given in Chapters 6, 7 and 8 of the FLMAP.

### 8.2.2 FLMAP Delivery Programme

The *FLMAP Delivery Programme* sets out how the Liaison Officer (CFLO) and Fishing Industry Representative (FIR) will communicate during the proposed works and how the deliverables, set out in the Fishing Liaison Mitigation Action Plan, will be measured and fulfilled. This document will also highlight any regional specific communication and consultation that is required, which may extend the notice period required to issue notice to mariners and communicate upcoming works. It will also highlight any ongoing issues which may arise throughout the cable replacement works.

### 8.2.3 How Scottish Hydro Electric Power Distribution Co-Exists with Other Marine Users

*How Scottish Hydro Electric Power Distribution co-exists with other marine users* details how we plan to co-exist with other marine users as SHEPD carry out the proposed works and follow on from the recent consultations with fishermen in 2021.

## 8.3 Approach to Mitigation

A summary of SHEP's approach to mitigating interactions with commercial fisheries and other sea users during the installation and operation of the proposed cable replacement is presented in Table 8-1 below.

Table 8-1 Summary of mitigation for commercial fisheries and other sea users

| Measure | Details |
|---|---|
| Avoidance of Trawling | In line with guidance provided by the UKHO and International Convention for the Safety of Life at Sea (SOLAS), SHEPD recommend that fishing vessels should avoid trawling over installed seabed infrastructure. Vessels are also advised in the Mariners Handbook not to anchor or fish (trawl) within 500m of the cable.<br><br>Considering the proximity to the existing Carradale – Arran North cable, the installation of the proposed cable does not constitute a change in baseline conditions in this regard. |
| A Fisheries Liaison Officer (FLO) will be employed to manage interactions between cable installation vessels, personnel, equipment and fishing activity. This will be managed through the Fisheries Liaison Mitigation Action Plan. | Employment of a FLO will ensure all commercial fisheries operators in the vicinity of the Project will be proactively and appropriately communicated with in terms of proposed Project operations. |
| Notice to Mariners (including local), Kingfisher bulletins, Radio Navigational Warnings, and/or broadcast warnings will be promulgated in advance of any proposed works. The notices will include the time and location of any work being carried out, and emergency event procedures. | Ensure navigational safety and minimise the risk and equipment snagging. |
| Compliance with International Regulations for the Prevention of Collision at Sea (IRPCS) (IMO, 1972) and the International Regulations for the Safety of Life at Sea (SOLAS). | IRPCS are the international standards designed to ensure safe navigation of vessels at sea. All installation vessels will adhere to these rules, including displaying appropriate lights and shapes.<br><br>SOLAS is an international maritime treaty which sets minimum safety standards in the construction, equipment and operation of merchant ships. The convention requires signatory flag states to ensure that ships flagged by them comply with at least these standards. In relation to the Project its compliance will ensure navigational safety. |
| Guard Vessels | A guard vessel may be used during the installation campaign where a potential risk to the asset or danger to navigation has been identified. |
| Profiling of rock berms | All rock berms will be profiled with shallow side slopes and constructed of appropriate materials to minimise snagging risk. |
| As built survey data will be provided to the UKHO and Kingfisher for inclusion on Admiralty Charts and the Kingfisher Information Service – Offshore Renewable and Cable Awareness (KIS-ORCA) charts. | Ensure navigational safety and minimise the risk and equipment snagging. |

# 9 CONCLUSIONS

Following the MEA of the potential impacts on each of the topics outlined, conclusions are presented below.

### 9.1.1 Ecological Protected Sites

There are a number of protected sites with marine components located in the vicinity of the subsea cable route and landfall locations. Given the distance from the project area to the closest protected site (South Arran NCMPA 7.7 km south-east), the localised, temporary nature of the project would not have any significant impacts on the designated features of this site or any others listed as within 40 km of the project area. Therefore, the project is not considered to be Capable of Affect (CoA) on any protected sites due to the distance of the project to these sites. The only Natura 2000 sites that was taken forward for assessment of LSE was the Sound of Gigha SPA. Upon assessment no potential LSE has been identified on any Natura 2000 site. Additional protected sites have been assessed within the topic specific sections as required. The only other protected sites that have the potential to be impacted by the proposed works include the North Arran NSA which transects the cable route and the seal haul-outs in the vicinity of the project area protecting harbour and common seal. The conclusion of the assessment is that there is no potential for significant impacts on this landscape area or seals, respectively. Therefore, the conservation objectives of the seal haul-outs will not be compromised by the proposed works.

### 9.1.2 Water Quality

Trenching of the cables and the formation of the HDD receptions pits and open cut trench at the Carradale and Arran landfalls respectively have the potential to affect water quality through the resuspension of sediments. This will result in highly localised and short-lived increases in suspended sediment in the vicinity of the works, however given localised and transient nature of these effects no significant impacts on water quality were identified. Best practice will be followed by all installation vessels, therefore the likelihood of an accidental hydrocarbon release from one of the installation vessels is extremely remote. The level of impact is therefore considered minor and not significant.

### 9.1.3 Benthic Ecology

Briggs was commissioned by SHEPD to undertake geophysical, geotechnical and environmental surveys in November 2018 within a survey corridor between Balliekine on the Isle of Arran and Carradale in Kintyre, Mainland Scotland. An intertidal walkover survey and the drop-down video ground truthing were undertaken by Ocean Ecology. The geophysical and the benthic survey reports (Briggs Marine, 2018a, b); Ocean Ecology, 2018a, 2018b) were the main sources of information used to prepare the benthic environmental baseline and impact assessment.

Fugro was also commissioned by Global Marine Group (GMG) to undertake a geophysical (Fugro, 2021b) and geotechnical (Fugro, 2021a) survey for the proposed Carradale-Arran power cable system connecting the Isle of Arran to Carradale. The survey comprised the collection of MBES, SSS, magnetometer and SBP data within the cable corridor; utilising the Fugro Frontier, Fugro Seeker survey vessels and the SeaCat AUV. Additionally, the Fugro Frontier was also utilised for the offshore geotechnical operations performed on the Carradale-Arran cable route.

There are no designated sites with benthic features in the immediate vicinity of the proposed works. The benthic surveys conducted (as outlined above) revealed that the seabed sediments along the survey corridor included circalittoral mud, high energy circalittoral rock, mixed sediments, and muddy mixed sediments. They were areas of kelp communities, classified as PMF in Scottish waters, identified in the nearshore areas, at the two ends of the cable. A large area of burrowed mud, a Scottish PMF, was identified in the central section of the survey corridor. Other sensitive habitats that were identified during the benthic surveys include areas of bedrock reefs, classified as Annex I habitat due to the spatial extent and elevation of the rock areas observed. The potential impacts on nearshore and offshore benthic ecology have been found to be minimal based on the following:

- HDD installation will prevent any interaction with the seabed in the intertidal zone at Carradale;

> Very small area of impact from deposits and installation methods, with minimal impact to associated kelp beds, bedrock reef, ocean quahog or burrowed mud;

> Cable installation activities will be temporary and any increase in suspended sediments will quickly revert back to background levels; and

> All cable landfall works undertaken in line with standard best practice and general environmental management plans as detailed in the Embedded Mitigation (Section 1.3.5).

### 9.1.4 Marine Megafauna

A review of the available resources and data suggests that various species of cetacean may occur in the project area, with species such as minke whale, bottlenose dolphin and harbour porpoise being the most abundant. In addition to this, harbour and grey seal may also frequent the area.

Basking sharks could also occur in the vicinity, but such instances are expected to be remote and therefore this species is not expected to be impacted by the proposed installation activities.

Underwater noise is considered the impact mechanism most likely to affect marine megafauna in the Project area. Noise modelling used to inform the assessment, presented in Appendix B, demonstrates no realistic risk of injury to any species exists resulting from USBL operations. While there may be some disturbance, this is likely to be limited in space and time and should only affect a few individuals of any species.

There will be no injurious impacts to marine mammals as a result of project activities and no requirement to apply for an EPS Licence in that respect. However, there is potential for disturbance to cetaceans, and SHEPD will therefore apply for an EPS Licence in respect to this. However, this disturbance is expected to be limited to one or a few individuals of the local population and will therefore not result in any adverse impact to the FCS of any cetacean species, and no mitigation is proposed for USBL operations.

The risk of injury or disturbance of basking sharks resulting from the cable installation vessels is minimal. This is due the low prevalence of the species in the vicinity of the installation corridors, the fact that vessels will be slow moving and not constitute a change from baseline vessel activity, and adherence to the SMWWC. No adverse effects on the FCS of basking sharks are expected. However, a basking shark derogation licence will be sought, since the risk disturbance cannot be entirely ruled out.

Considering the transitory nature of the Project activities, there are not anticipated to be any significant impacts to individuals or populations of marine megafauna in the Project area.

### 9.1.5 Marine Archaeology

A review was undertaken of existing literature, data sources and databases to identify known sites in the area, and the potential for unidentified marine cultural heritage sites and areas. Marine survey data (geophysical data) for the project area was also reviewed to identify the potential presence of marine historic assets in the survey area.

There are no shipwrecks or aircraft with known locations in close proximity to the cable corridor. Apart from the existing cables identified by the Briggs marine surveys, only two anthropogenic geophysical anomalies have been identified. The probable shipwreck, ORCA226, is located between the two existing cables (336 m south of the existing north cable, 292 m north of the south cable) and will be avoided by the new cable route. Apart from the two anomalies mentioned above, there are no other features of archaeological interest, and the hard-packed nature of much of the seabed mean that the likelihood of survival of cultural remains below the surface is low. The potential impacts identified as a result of the project are:

> Direct damage to or destruction of known marine historic environment assets including geophysical anomalies and UXO; and

> Potential indirect damage to or destruction of known and unknown marine historic environment assets including UXO.

The cable will avoid known sites and there is a low likelihood of the cable being accidentally laid over unknown sites. Procedures will be in place for reporting accidental discoveries. A pre-installation ROV survey may be carried out where deemed necessary with data inspection by an experienced marine archaeologist prior to cable lay or trenching to inform any micro-routing.

### 9.1.6 Commercial Fisheries and Other Sea Users

The cable installation works have the potential to disrupt the activities of commercial fisheries and other legitimate sea users. The proposed cable route design, installation methodology and protection measures seek to minimise impacts on commercial fisheries and other legitimate sea users to As Low As Reasonably Practicable (ALARP). SHEPD is committed to ongoing consultation to minimise any remaining disruption.

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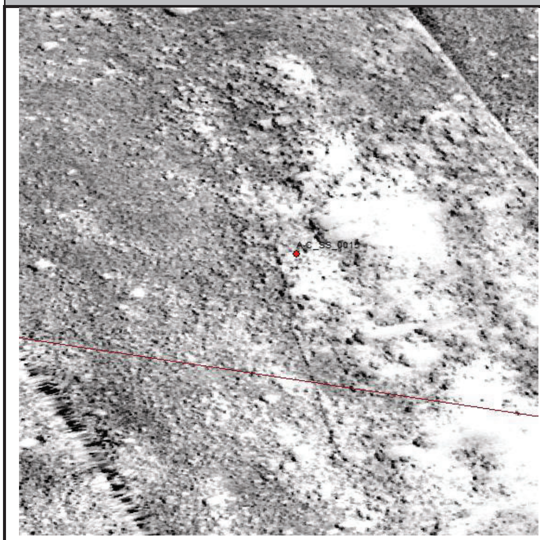
# APPENDIX A HIGH POTENTIAL SIDESCAN SONAR CONTACTS

| Anomaly | ORCA15 | |
|---|---|---|
|  | | |
| **Source** | A-C_SS_0015 | |
| **WGS UTM Zone 30N** | X= 349573.9 | Y= 6163906.2 |
| **Description** | Possible anchor chain or rope. Power cable Cable runs east/west but this runs NNW/SSE. Good return. L= 45.7m B = 0.2m W = 0.1m. | |
| **Level of geophysical potential** | High | |
| **Proximity to development** | 385m South cable, 000m North Cable | |

| Anomaly | ORCA226 |
|---|---|
|  | |
| **Source** | A-C_SS_0226 |
| **WGS UTM Zone 30N** | X= 348691.6 Y= 6163761.2 |
| **Description** | Possible small wreck or debris. Shows good return on SSS and on MBES. L = 5.7m B = 3.0m W = 0.7m |
| **Level of geophysical potential** | High |
| **Proximity to development** | 366m North Cable 292m South Cable |

# APPENDIX B NOISE IMPACT ASSESSMENT

During the cable lay and HDD break out, an ROV with USBL will be utilised, deployed from the CLV, to monitor the cable at the touch down locations with the seabed. This will capture seabed information at the contact point and helps observe the lay tension that is applied to the cable from the vessel. This will also help to minimise the potential for cable suspensions along the route. If rock bags or mattresses are required, the ROV with USBL will be used for these activities too.

This section describes the potential frequency impacts and disturbance to marine mammal species in the area as a result of utilising USBL.

## 10.1 Acoustic Injury or Disturbance Criteria for Marine Mammals

### 10.1.1 Injury

A dual-metric approach has been adopted which identifies the range of potential injury to marine mammals from both the peak sound pressure level ($SPL_{Peak;}$ also called the source level) and cumulative SEL for each equipment type identified to require consideration for noise-related injury (see Table 1-1). The thresholds above which each marine mammal hearing group may experience noise-related injury are presented in Table 1-1 below. These thresholds are derived from measurements of marine mammal hearing using weighting functions which account for peak hearing abilities for each hearing group (NOAA, 2018).

**Table 1-1 Criteria Considered in this Assessment for the Onset of Injury in Marine Mammals from Impulsive Noise (NOAA, 2018; Southall *et al.,* 2019)**

| Marine mammal hearing group | Impulsive noise | | Non-impulsive noise |
|---|---|---|---|
| | Peak pressure (dB re 1 µPa) | Cumulative SEL (dB re 1 µPa²s) | Cumulative SEL (dB re 1 µPa²s) |
| Low-frequency (LF) cetaceans | 219 | 183 | 199 |
| High-frequency (HF) cetaceans | 230 | 185 | 198 |
| Very high-frequency (VHF) cetaceans | 202 | 155 | 173 |
| Phocid pinnipeds (underwater) | 218 | 185 | 201 |

### 10.1.2 Disturbance

#### *10.1.2.1 Disturbance Regulations*

There are two regulations which govern disturbance to EPS: Regulation 39(1) and Regulation 39(2). Regulation 39(1) from the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) defines disturbance for all EPS in UK waters and individuals which are vulnerable to disturbance due to biological or environmental circumstances. Regulation 39(2) goes beyond the disturbance guidelines provided in Regulation 39(1) by making it an offence to deliberately or recklessly disturb any cetacean in Scottish Territorial Waters (i.e. up to 12 nm) (Marine Scotland, 2014). The definitions of disturbance are provided in Box 1 below.

Box 1 Disturbance Regulations in Scottish Territorial Waters

The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)

**Regulation 39 (1)** makes it an offence —

*(a) deliberately or recklessly to capture, injure, or kill a wild animal of a European protected species;*

*(b) deliberately or recklessly –*

*(i) to harass a wild animal or group of wild animals of a European protected species;*

*(ii) to disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;*

*(iii) to disturb such an animal while it is rearing or otherwise caring for its young;*

*(iv) to obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place;*

*(v) to disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs;*

*(vi) to disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young; or*

*(vii) to disturb such an animal while it is migrating or hibernating.*

**Regulation 39(2)** provides that it is an offence —

*to deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean).*

To consider the possibility of a disturbance offence resulting from the proposed activities, it is necessary to consider the likelihood that the activities would generate a non-trivial disturbance based on the sensitives of the species present and whether the number of individuals impacted would generate population-level consequences. Where there is a possibility of disturbing an individual animal, it is necessary to apply for a Marine EPS Licence to ensure that an offence is not committed. However, in issuing a Marine EPS Licence, Marine Scotland must consider whether the FCS of any species will be affected. Consequently, the impacts of proposed activities on the FCS of all protected species must be considered to satisfy both Regulation 39(1) and 39(2). The impact assessment below addresses the impacts of the activities on the existing conservation status of protected species within the area.

#### *10.1.2.2 Acoustic Disturbance Criteria*

Auditory thresholds for disturbance, as defined by NMFS (2014), coupled with behavioural response criteria detailed in Southall *et al.* (2007) have been adopted for the assessment of potential marine mammal disturbance from both non-impulsive and impulsive noise sources. These thresholds and behavioural response severity ratings are provided in Table 10-1 below.

Table 10-1 Disturbance threshold criteria for impulsive sounds (Southall *et al.*, 2007; NMFS, 2014).

| Behavioural Effect | Threshold Criteria $SPL_{rms}$ (dB re 1 µPa) |
|---|---|
| Potential strong behavioural reaction (6 or more on the severity scale) | 160 |

## 10.2 Noise Modelling Approach

Noise modelling has been undertaken to identify the potential range (i.e. the straight-line distance from the source) in which noise impacts to marine mammals could occur. The dual-metric modelling approach disseminated in NOAA (2018) has been used to identify impacts from: (1) the peak SPL; and (2) the cumulative SEL, where necessary these values are derived from the root-mean-square (rms) pressure level ($SPL_{rms}$). The SEL represents the total energy produced by a noise-generating activity standardised to a one-second interval.

This enables comparison of the total energy attributed to different activities with different inter-pulse intervals. As described above, empirically-based weighting functions (NOAA, 2018; Southall *et al.*, 2019) have been applied to the modelling outputs to account for peak hearing sensitivity for the respective marine mammal hearing groups.

The following assumptions have been applied to the models:

1. Maximum sound pressure levels have been used for all calculations;
2. Maximum pulse length and minimum turn around has been used where provided;
3. Where source frequencies occur across a range of frequencies, a flat 3$^{rd}$ octave spectrum has been used;
4. Where data is unavailable, the time between pulses has been calculated as 1.5 times the ping length;
5. Mammals swim at seabed depths (this represents the worst-case);
6. Vessels are moving at slow speeds; and
7. Survey equipment likely to be used in the nearshore shallow water environment (i.e. <10 m) will be very high frequency to provide better resolution and will have a lower SPL, and so does not constitute a worst-case scenario.

It is important to note that the rms value associated with the $SPL_{rms}$ depends upon the length of the integration window used. Using a longer duration integration window results in a lower rms than produced by a shorter integration window.

An acoustic phenomenon results from the elongation of the waveform with distance from the source due to a combination of dispersion and multiple reflections. Measurements presented by Breitzke *et al.* (2008) indicate elongation of the T90 window up to approximately 800 m at 1 km. This temporal “smearing” reduces the rms amplitude with distance by elongating the rms window and has been included within the disturbance modelling scenarios. Since the auditory organs of most marine mammals integrate low frequency sounds over an acoustic window of around 200 ms (Madsen *et al.*, 2006 and references therein), this duration was used as a maximum integration window for the received $SPL_{rms}$.

The directivity characteristics of the sound sources are also an important factor affecting the received sound pressure levels from noise-generating activities. In geophysical surveys, source arrays are designed so that the majority of acoustic energy is directed downwards towards the ocean floor for data collection purposes. As such, the amount of energy emitted across the horizontal plane is significantly less (20 dB +) than that emitted directly downwards. Due to the frequency-dependent nature of sound, the loss of pressure on the horizontal plane is more pronounced at higher frequencies than at lower frequencies. Directivity corrections can be applied to the model outputs, which provide broadband normalised amplitudes at varying angles of azimuth[8] and dip angle[9]. Directivity corrections have been applied to the modelling outputs under the assumption that the animal is directly in-line with the vessel (i.e. at the 0º azimuth).

## 10.3 Injury Impacts

The expected frequency range for USBL overlaps with the hearing range of all cetacean hearing groups (Table 7-2 of the Main Report). Potential injury to cetaceans (i.e. injury which results from a permanent threshold shift in hearing abilities) is limited to impulsive noise sources which exceed the injury thresholds defined in Table 1-3.

Modelling of ranges at which injury impacts may result from the USBL operations has been undertaken, as described in Section 1.1. Impacts from noise sources which are strictly behavioural in nature (i.e. disturbance impacts) are covered in Section 10.4.

[8] The azimuth is taken as the angle of circumference around the boat which lies parallel to the surface of the water, progressing around the boat from port to starboard.
[9] The dip angle is taken as the angle under the boat, progressing from prow to stern.

Table 1-3 Noise Modelling Results for Injury Impacts from Impulsive Noise Sources (*N/E = no exceedance of thresholds*)

| Activity | Depth (m)[10] | Frequency (kHz) | Source Level $SPL_{Peak}$ (dB re 1µPa) | Injury range (m) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cumulative SEL (Static Mammals) | | | | Cumulative SEL (Moving Mammals) | | | | Peak SPL | | | |
| | | | | VHF | HF | LF | PW | VHF | HF | LF | PW | VHF | HF | LF | PW |
| **USBL** | 100 | 20 – 33.5 | 200 | 104 | 98 | 73 | 86 | 104 | 56 | 36 | 44 | - | - | - | - |
| | 10 | 20 – 33.5 | 200 | 12 | 11 | 11 | 11 | 12 | 11 | 11 | 11 | - | - | - | - |

10 Depth refers to depth below the survey activity, which has been assumed to be hull-mounted or towed at the surface.

The model outputs suggest that there is a potential for USBL at 200 dB re 1μPa (peak) to result in injury to marine mammals. Across all modelling scenarios and metrics, the injury ranges were generally highest for the VHF hearing group (Table 1-3), which is represented by harbour porpoise in UK waters. Conversely, HF cetaceans seemed to constitute the hearing group with the lowest potential impact. No exceedances of the $SPL_{Peak}$ injury criteria are expected, since the source level is below 202 dB re 1μPa (peak) (the lowest peak injury threshold).

The deployment of a hull-mounted USBL in 100 m depths elevated the potential range of impact to a maximum of 104 m for VHFs, when considering cumulative SEL metric. However, the likelihood of a cetacean being this close to operational equipment is extremely low when considering that the source is deployed from a moving vessel and, in some cases, is being towed at depth (e.g. a USBL may be mounted on an ROV within a few metres of the seabed).

The injury ranges were at least slightly reduced when considering animal movement during cumulative SEL estimation. Swim speeds of the species most likely to be observed in the area have been shown to be several $ms^{-1}$ (e.g. cruising minke whale swim speed is 3.25 $ms^{-1}$ and harbour porpoise may swim up to 4.3 $ms^{-1}$) (Blix and Folkow, 1995; Otani *et al*., 2000). Further, SNH (2016b) has provided standard values for mean swimming speeds of various marine mammal species likely to occur in the project area, including harbour porpoise (1.4 $ms^{-1}$; Westgate *et al.*, 1995); harbour seal / grey seal (1.8 $ms^{-1}$; Thompson, 2015); and minke whale (2.1 $ms^{-1}$; Williams, 2009). To offer a representative model of the predicted noise exposure ranges of marine mammals moving away from the sound source, a mean swim speed of 1.5 $ms^{-1}$ has been used in the calculations. Considering that the surveys themselves will take place while the vessel is moving, the cumulative SELs of all equipment types are expected to be even lower based on the premise that animals are likely to move away from the mobile noise source at some angle opposite to the direction of travel of the vessel.

It should also be noted that the modelling scenarios are meant to define the worst-case injury ranges associated with the deployment of the project's survey equipment. The *in-situ* deployment of the noise-generating survey equipment will most frequently occur in waters of intermediate depths (i.e. somewhere between 10-100 m). Moreover, the frequency ranges depicted constitute the lowest and highest reasonably practicable settings for the survey activities modelled, meaning that the spread of sound in the marine environment is also likely to fall somewhere between the modelled extremes. The injury ranges anticipated to result from equipment use are thus likely to fall within the spectrum of those defined by the model outputs, thereby reducing the impact ranges associated with the low frequency survey equipment.

As such, the assessment concludes that there is no realistic risk of injury to EPS which may result from the use of USBL with $SPL_{Peak}$ source levels of up to 200 dB re 1μPa.

## 10.4 Disturbance Impacts

Whilst no injury impacts are expected, noise emissions have the potential to affect the behaviour of cetaceans in the vicinity of the noise source. Significant or strong disturbance (see Southall *et al.*, 2007) may occur when an animal is at risk of a sustained or chronic disruption of behaviour or habitat use resulting in population-level effects. An assessment of potential disturbance impacts from USBL is provided in the below. The outputs of the noise modelling assessment against the disturbance thresholds are provided in Table 1-5

Table 1-5 Noise Modelling Results for Disturbance Impacts from Impulsive Noise Sources

| Activity | Depth (m) | Frequency (kHz) | $SPL_{rms}$ (dB re 1μPa) | Range of Behavioural Change (m) |
|---|---|---|---|---|
| **USBL** | 100 | 20 – 33.5 | 197 | 182 |
| | 10 | 20 – 33.5 | 197 | 207 |

The USBL activities have the potential to generate a strong disturbance event (i.e. a disturbance offence) as described in Section 10.1. The sound generated by the USBL has the potential to generate disturbance impacts on the order of a couple hundred metres (Table 1-5).

The number of individuals which may experience disturbance from the worst-case scenario for USBL has been calculated in Table 1-6 below, based on the population parameters supplied in Table 6-1 of the main report. In these calculations, the impact range serves as a radius with which to calculate the total area of coverage for a potential disturbance event associated with each survey activity.

Table 1-6 Number of Cetacean Individuals and Proportion of the MU Which May Experience a Disturbance Offence from USBL Activities, Based on Known Population Parameters of the Most Frequently Occurring Species

| Species name | Number of individuals which may incur a strong disturbance | Maximum proportion of the MU potentially affected by project activities |
|---|---|---|
| | USBL ($0.13\ km^2$ area) | |
| Harbour porpoise | < 0.1 | < 0.1% |
| Minke whale | < 0.1 | < 0.1% |
| Bottlenose dolphin | < 0.1 | <0.1% |

The source levels associated with USBL have the potential to elicit a strong behavioural response in EPS which could be classed as a disturbance offence as defined under Regulations 39(1) or 39(2) (Box 1). However, for the relevant biogeographical population Management Units (MU) for harbour porpoise, minke whale and bottlenose dolphin which all regularly occur in the area, this will not incur significant impacts. For these species, less than 0.1% of the biogeographic population will be impacted by noise-related disturbance (Table 1-6). Moreover, less than a tenth of any cetacean will be potentially disturbed by USBL deployment at any given time, making potential disturbance impacts from this survey equipment negligible.

Given the transient and short-term nature of the survey and vessel activities, it is highly unlikely that any disturbance offences from the use of USBL would negatively impact upon the FCS of any of the cetacean or seal species which may be present in the survey area. This is on the basis that the modelled level of disturbance is unlikely to affect the ability of any individual animal to survive or reproduce and will not have significant population-level impacts to any EPS. Regardless, it is possible that a small number of animals may experience some level of disturbance for the short period that they encounter the proposed survey activities.