PENTLAND EAST CABLE REPLACEMENT

Environmental Supporting Information Report

Global Offshore Ref No : 2742-GO-G-RD-0017

REVISION	DATE	ISSUE DETAILS	PREPARED	CHECKED	APPROVED
01	15-11-2019	Issue for Review	Intertek	GMSL	GMSL
02	22-11-2019	Updated following Review Workshop	Intertek	GMSL	GMSL
03	13-12-2019	Re-issued for use	Intertek	GMSL	GMSL
04	20-12-2019	Re-issued for use	Intertek	GMSL	GMSL

REVISION	SECTION	PAGES	BRIEF DESCRIPTION OF CHANGES	AUTHOR/S OF CHANGE

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GLOBAL MARINE

Pentland Firth East Cable Replacement - Marine Licence Application

Environmental Supporting information

P2291_R4837_Rev3 Redacted | 19 December 2019

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DOCUMENT RELEASE FORM

Global Marine

P2291_R4837_Rev3 Redacted

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Authoriser

Rev No	Date	Reason	Author	Checker	Authoriser
Rev 0	30/09/2019	Template for Client Review	[redacted]	[redacted]	[redacted]
Rev 0a	15/11/2019	Working draft for Client Inputs	[redacted]	[redacted]	[redacted]
Rev 1	21/11/2019	Incorporate workshop comments	[redacted]	[redacted]	[redacted]
Rev 2	11/12/2019	Addressing Client comments	[redacted]	[redacted]	
Rev 3	19/12/2019	Addressing Client comments	[redacted]	[redacted]	[redacted]

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GLOSSARY

ADM
Archives Admiralty

AFL
Agreement for Lease

AIS
Automatic Identifications System

ALARP
As Low as Reasonably Practicable

AoS
Area of Search

ATBA
Area to be avoided

BAP
Biodiversity Action Plan

BT
British Telecoms

CBD
Convention on Biological Diversity

CBRA
Cable Burial Risk Assessment

CFLO
Company Fishing Liaison Officer

CifA
Chartered Institute for Archaeologists

CLV
Cable Lay Vessel

CMS
Construction Method Statement

CPP
Construction Phase Plan

DBA
Desk Based Assessment

DSV
Dive Support Vessel

ECoW
Ecological Clerk of Works

EEZ
Exclusive Economic Zone

EIA
Environmental Impact Assessment

EMEC
European Marine Energy Centre

EMF
Electromagnetic Fields

EPS
European Protected Species

ESI
Environmental Supporting Information

EU
European Union

EUBS
European Union Biodiversity Strategy

FCS
Favourable Conservation Status

FIR
Fishing Industry Representatives

FLMAP
Fisheries Liaison Mitigation Action Plan

GB
Great Britain

GEN
General Policy

GES
Good Environmental Status

HAT
Highest Astronomical Tide

HDD
Horizontal Directional Drilling

HEPS
Historic Environment Policy Statement for Scotland

HMPA
Historic Marine Protected Area

HRA
Habitats Regulation Assessment

HVAC
High Voltage Alternating Current

ICES
International Council for Exploration of the Seas

IEMA
Institute of Environmental Management & Assessment

IMO
International Maritime Organisation

INNIS
Introduction of Non-Native Invasive Species

IPCC
Intergovernmental Panel on Climate Change

iSPM
Inorganic Suspended Particulate Material

IUCN
International Union for Conservation of Nature

JNCC
Joint Nature Conservation Committee

JNAPC
The Joint Nautical Archaeology Policy Committee

KTB
Kriegstagebücher or KTB - War Bay Books

KP
Kilometre Point

LBAP
Local Biodiversity Action Plan

MAG
Magnetic

MBES
Multi-Beam Echo Sounder

MCAA
Marine and Coastal Access Act

MMPP
Marine Mammal Protection Plan

MMO
Marine Management Organisation

MoD
Ministry of Defence

MPA
Marine Protected Area

MPS
Marine Policy Statement

MSFD
Marine Strategy Framework Directive

MS-LOT
Marine Scotland Licensing Operations Team

MSP
Marine Spatial Plan

MW
Megawatt

NCMPA
Nature Conservation Marine Protected Area

Nm
Nautical mile

NMFS
National Marine Fisheries Service

NMP
National Marine Plan

NMPi
National Marine Planning interactive tool

NRA
Navigational Risk Assessment

NRHE
National Record of the Historic Environment

NSA
National Scenic Area

OIC
Orkney Islands Council

O&M
Operations and Maintenance

PAC
Pre-Application Consultation

PFOW
Pentland Firth and Orkney Waters

PMF
Priority Marine Feature

pSPA
Proposed Special Protection Area

R/DMPA
Research/Demonstration Marine Protected Areas

RBMP
River Basin Management Plans

RoRo
Roll-on Roll-off

ROV
Remotely Operated Vehicle

RPL
Route Plan Line

RSPB
Royal Society for the Protection of Birds

RYA
Royal Yachting Association

SAC
Special Area of Conservation

SEA
Strategic Environmental Assessment

SEL
Sound Exposure Level

SEPA
Scottish Environmental Protection Agency

SHE
Scottish Hydro Electric

SHEPD
Scottish Hydro Electric Power Distribution plc

SMRTS
Scottish Marine Recreation and Tourism Survey

SNH
Scottish Natural Heritage

SNMP
Scottish National Marine Plan

SOP
Standard operating procedures

SPA
Special Protection Area

SSE
Scottish and Southern Energy

SSS
Side Scan Sonar

SSSI
Site of Special Scientific Interest

TJP
Transition Joint Pit

TPs
Trial Pits

UK
United Kingdom

UKAEA
UK Atomic Energy Authority

UKBAP
UK Biodiversity Action Plan

UKCP
UK Climate Projections

UKCS
UK Continental Shelf

UKHO
UK Hydrographic Office

UXO
Unexploded Ordinance

VC
Vibrocore

WFD
EU Water Framework Directive

WNO
Weekly Notice of Operations

WW1
World War 1

WW2
World War 2

ZOI
Zone of Influence

1. INTRODUCTION

1.1 Purpose of this document

The purpose of this document is to support a Marine Licence application being made under the Marine Scotland Act 2010 (and The Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013), by Scottish Hydro Electric Power Distribution plc (SHEPD), for the replacement of the Pentland Firth East submarine electricity cable.

1.2 Overview of the project

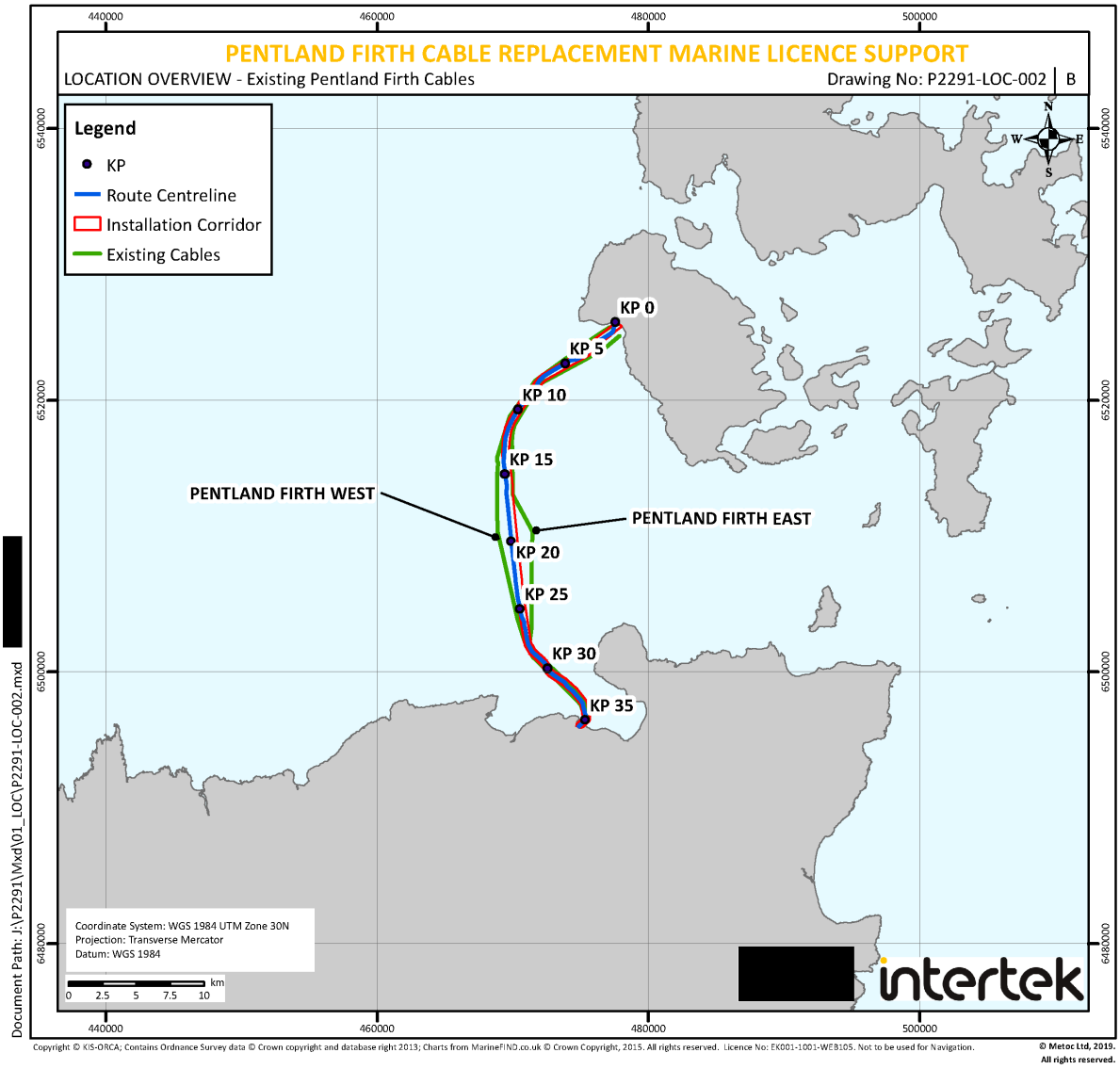
SHEPD, part of the Scottish and Southern Energy plc (SSE) group of companies, are the current licence holders (under the Electricity Act 1989) for electricity distribution in the north of Scotland, including Orkney. This region covers a quarter of the total United Kingdom (UK) landmass, with electricity being delivered to 740,000 customers. In the marine environment SHEPD maintains connections to the majority of the Scottish islands with over 100 subsea cable links totalling approximately 454km.

The Mainland of Scotland is connected to Orkney by two subsea cables each of approximately 37km in length with both operating at 33kV. Landfall for both cables is at Rackwick Bay, Hoy and Murkle Bay, Caithness, respectively. The present Pentland East cable was installed in 1982 with Pentland West being installed in 1998.

Routine inspections of the Pentland East cable have determined that the existing subsea cable is nearing the end of its operational life. Additionally, the cable has faulted twice in recent months which required emergency repairs. While both repairs were successful and the cable re-energised, it has been identified that a long-term solution is required to maintain a safe, secure and reliable electricity supply from the Scottish mainland to homes and businesses in Orkney. SHEPD therefore propose to replace the 33kv distribution submarine electricity cable across the Pentland Firth, landing at Rackwick Bay on the island of Hoy and Murkle Bay on the Scottish mainland (herein referenced as the 'Project').

A detailed project description is provided in Appendix A (Global Marine document 2742-GO-S-SW-0001).

Figure 1-1 Overview of the proposed replacement cable installation corridor



1.3 Consent requirements and relevant legislation

1.3.1 UK Marine Policy Statement

Prepared and adopted for the purposes of section 44 of the Marine and Coastal Access Act (MCAA) 2009, the UK Marine Policy Statement (MPS) was published to provide a framework for preparing marine plans and make effective decisions affecting the marine environment (HM Government, 2011). The MPS applies to all UK waters and has been adopted by the UK government and all devolved administrations, with all regional and national plans required to conform to the MPS.

The MPS also states that in relation to energy infrastructure several factors must be considered when any decision makers are examining and determining applications. Of these factors, one is relevant to this Project:

- the national level of need for energy infrastructure, as set out in the National Planning Framework which applies in Scotland.

1.3.2 Marine (Scotland) Act 2010

The Marine (Scotland) Act 2010 gained Royal Assent in 2010 and provides the legal mechanism to help protect Scotland's coastal and territorial waters through new and improved management systems (Scottish Parliament, 2010). The act comprises 5 key elements, which are:

1. A Strategic Marine Planning System
2. A Streamlined Marine Licensing System
3. Improved Marine Nature Conservation Measures
4. Improved Measures for the Protection of Seals
5. Improved Enforcement Measures

Installation and operation of submarine cables in Scottish waters requires a Marine Licence under Part 4 of the Marine (Scotland) Act (Scottish Parliament, 2010).

1.3.3 Marine Licence and supporting information requirements

Submarine cables do not require an Environmental Impact Assessment (EIA) to be conducted as they are not listed under Schedule A1 or A2 of The Marine Works (EIA) (Amendment) Regulations 2017 (HM Government, 2017).

Marine Scotland advise that a Marine Licence applicant should consider the scale and nature of the submarine cable project and consider the need for a proportionate environmental assessment. This should also include the extent to which an activity is in accordance with any marine plan for the area. Where there exists the potential for the environment, human health, legitimate uses of the sea or designated sites (i.e. Natura or Marine Protected Area (MPA)) to be impacted by the project, Marine Scotland recommends that these impacts should be assessed (Marine Scotland 2015a). The results of the assessment, along with other supporting information such as a cable-route study and cable-burial plan (if required), should be provided to Marine Scotland to support the Marine Licence Application.

This Environmental Supporting Information (ESI) Report presents an overview of the baseline environment and provides the necessary environmental assessment to support the Marine Licence Application through consideration of the potential impacts of the project to the marine environment.

1.3.4 Scottish National Marine Plan

Adopted by the Scottish Government in March 2015 (Marine Scotland, 2015d), the Scottish National Marine Plan (NMP) establishes policies and objectives to enable the sustainable development and management of Scotland's marine resources, in both Scottish inshore (out to 12nm) and offshore waters (12 to 200nm). The NMP details 21 general policies that are applicable to all future developments and uses within Scottish waters. Relevant policies to this Project include, but are not limited to: GEN 1, GEN 2, GEN 4, GEN 13, GEN 15, GEN 18 and GEN 12.

These general policies are supplemented by sector-specific policies, enabling policies and objectives to be targeted at particular industries. With regards to this Project, the two most relevant sectoral policy sections are sea fisheries (due to the potential impacts to local fishermen) and submarine cables.

1.3.4.1 Sea fisheries

The Sea Fisheries chapter of the NMP details five marine planning policies that should be taken into account when developing within the vicinity of areas utilised for fishing purposes. Of these five, three are relevant to this Project. These are: Fisheries 1, Fisheries 2 and Fisheries 3.

1.3.4.2 Submarine Cables

Relevant objectives to this Project listed in the NMP regarding submarine cables 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.

In addition to these objectives, the NMP details four planning policies to be considered in the development of new submarine cable projects. These are: Cables 1, Cables 2, Cables 3 and Cables 4.

1.3.5 Scottish marine regions

After multiple years of public consultation and specialist studies establishing the support for, and potential areas of marine regions in Scottish waters (Scottish Government, 2015), the Scottish Marine Regions Order 2015 came into force on the 13th May 2015 and details the boundaries of the final 11 Scottish marine regions (Scottish Parliament, 2015). Of these 11 marine regions, two are relevant to this Project; Orkney Islands marine region and The North Coast marine region (Section 1.3.6 and 1.3.7). Within these marine regions, Regional Marine Plans will be developed by Marine Planning Partnerships. These partnerships will be comprised of groups of local marine stakeholders, allowing for more focused decision making by the local community to target the issues specific to each marine region. The Orkney Islands Marine Planning Partnership, a local body responsible for the creation of the regional marine plan, is currently due to be established in 2019 (Orkney Islands Council, 2019).

The Pentland East project area falls within the pilot Orkney Waters and Pentland Firth Marine Spatial Plan (MSP) (Section 1.3.8).

1.3.6 Orkney Local Development Plan

The Orkney Local Development Plan sets out the vision statement, spatial strategy and general land use planning policies for Orkney over the next 10 to 20-year period, with updates to the plan occurring every five years (Orkney Islands Council, 2017). As with other regional plans in Scotland, any new planning applications will be assessed as to whether they help achieve the aims of the policies set out in the plan. The plan details 15 general policies against which any planning application will be assessed. The policies relevant to this Project include, but are not limited to, business, industry and employment, energy, natural heritage and landscape, and coastal development .

Additionally, the plan makes reference to adopting any subsequent regional marine plan developed for the region as Planning Policy Guidance.

1.3.7 Highland Council Planning Policy

1.3.7.1 Highland-wide Local Development Plan

The Highland-wide Local Development Plan was adopted in April 2012 by the Highland Council and sets out the overarching spatial planning policy for the entire Highland Council area, aside from the Cairngorms National Park Local Plan (The Highland Council, 2012). The Plan details five general policies for the region, with Sustainable Development and Climate Change being one such policy. Within this, reinforcement of the sub-sea cable link between Orkney and the Scottish mainland is specifically highlighted as development that would benefit the Highlands. Any new developments in the Highland Council jurisdiction will be assessed for the extent at which they contribute to the plan's objectives.

1.3.7.2 Caithness and Sutherland Local Development Plan

The Caithness and Sutherland Local Development Plan, adopted in August 2018, alongside the Highland-wide Local Development Plan, will be used by the Highland Council to determine new planning applications in the region (The Highland Council, 2018). The Plan aims to encourage growth and support for four key sectors: growing communities, employment, connectivity and transport and the environment and heritage. Under the broad employment policy, the Plan states that the Highland Council has adopted the non-statutory Pentland Firth and Orkney Waters Marine Spatial Plan, which is a material consideration in assessing planning applications along the north Caithness and Sutherland coastline.

1.3.8 Pilot Orkney Waters and Pentland Firth Marine Spatial Plan (MSP)

To enable the smooth development of the upcoming Regional Marine Plans around Scotland, it was decided that a non-statutory plan be developed to provide a framework for these future plans and highlight any areas that may be improved upon. The Pentland Firth and Orkney Waters region was chosen to be piloted due to the area's recent growth in marine renewables and potential for future developments (Marine Scotland, 2016a).

The MSP detailed a policy framework around which marine development, activities and management decisions could be based, while concurrently protecting the regions marine environment. The MSP will be used by the Marine Scotland Licensing Operations Team (MS-LOT) as a material consideration when determining marine licence and Section 36 consent applications, owing to the MSP's non-statutory nature.

Section 4 of the MSP details the various general policies that proposed developments or activities should adhere to in a proportional manner, with no weight being ascribed to any particular policy. Of these general policies, relevant policies to this Project include, but are not limited to, supporting sustainable social and economic benefits, safeguarding the marine ecosystem, nature conservation designations, protected species, integrating coastal and marine development, noise and invasive non-native species.

The MSP also details sectoral policies specific to particular industries. Similar to the Scottish NMP (SNMP), the two most relevant sectoral policies from the MSP are Sectoral Policy 1: Commercial Fisheries and Sectoral Policy 8: Pipelines, electricity and telecommunications infrastructure. The policies outlined in these sections reflect the same policies as outlined in their respective sections in the SNMP.

1.4 Objectives and scope of the Environmental Supporting Information (ESI) report

The approach to the ESI Report was presented in a non-statutory meeting with Scottish Natural Heritage (SNH) on the 23rd of October 2019 at SSE's Training Centre, Perth. This included an overview of the planned cable installation and discussion of the impacts identified to be assessed further in the ESI Report. The objective of the meeting was to obtain the informal opinion of SNH representatives to ascertain whether the proposed approach to the assessment was fit for purpose and proportionate.

This ESI Report provides an overview of the baseline environment within the proposed installation corridor (a 500m wide corridor within which the cable will be installed). The baseline environment includes physical and biological processes, and the human environment. The ESI Report identifies and assesses potential impacts from the proposed installation activities. A series of supporting documents are available for the Project which will be drawn upon or referenced throughout the ESI Report (listed in Table 1-1). Certain documents will be submitted to MS-LOT after the initial Marine Licence application has been made due to sections of the construction plan not being finalised until after the

submission date. Such documents will be submitted to MS-LOT for approval before any works commence.

Table 1-1 Supporting documents for the Marine Licence application

Appendix	Document
A	Project description (2742-GO-S-SW-0001)
B	Fisheries Liaison Mitigation Action Plan for East and Hoy (FLMAP)
C	EPS Risk and Protected Sites and Species Assessment (A-302428-REPT-001)
D	Pre-Application Consultation Report Pentland Firth East Cable Replacement (PAC) including Navigational Risk Assessment (NRA) and Cost Benefit Analysis (CBA)
E	(Offshore) Construction Environmental Management Plan (CEMP) (2742-GO-G-TB-0005)

1.5 Environmental assessment methodology

The environmental assessment presented in this document reports on the impacts associated with the licensable activities of the cable installation process and presents its findings and conclusions. The assessment process follows the standard approach to EIA and application of professional judgement. The key stages of the assessment process are listed as follows and align with the Institute of Environmental Management & Assessment (2004) guidelines which state, "*The assessment stage of the EIA should follow a clear progression; from the characterisation of 'impact' to the assessment of the significance of the effects including the evaluation of the sensitivity and value of the receptors*." (p11/2) (IEMA, 2004):

- Characterisation of the baseline environment
- Establish potential impacts from the Project and zone of influence
- Characterisation of the change in impact
- Evaluation of significant of effects
- Establish mitigation

Zones of influence have been identified with regard to the spatial extent over which the activities of the Project are predicted to have an impact on the receiving environment. These are referred to in topic chapters and identify the extent of assessment and include mobile species or mobile users of the sea with the potential to enter the zone of influence.

1.6 Work done to date

1.6.1 Cable Route Design

The Pentland Firth East cable project was initially planned to make landfall at the eastern end of Rackwick Bay, Hoy and further around the coastline to the west of Murkle Bay on the Scottish Mainland. Horizontal Directional Drilling (HDD) was originally planned to be utilised for the Scottish Mainland landfall, but after consultation with SHEPD it was concluded that landing at Murkle Bay with a floated shore end would be the more cost-effective option. At Rackwick Bay SHEPD expressed their preference for the landfall site to be positioned at the western end of the beach to better link with the terrestrial cable route. Following this recommendation, the route was re-engineered to be positioned between the existing two power cables of Pentland Firth East (cable to be replaced) and Pentland Firth West.

This final route possesses several engineering benefits, such as:

- Reducing the number of cable crossings along the route and preventing power cable over power cable crossings.
- More space to make landfall exists between the existing cables at Murkle Bay than compared to landing to the east or west of these cables.
- Moving the cable route further west in the Pentland Firth reduces the potential of unfavourable current conditions as these generally lessen in a westerly direction in the Firth. As such this will create more favourable conditions for both cable installation and the as-laid cable over its lifetime.
- As the cable will be laid between the existing cables its' security will be enhanced, with the cable being located in an area already known to other sea users. Additionally, the effective 'cable area' of the Pentland Firth will not be increased by installing between the existing cables.

1.6.2 Marine and intertidal surveys

Marine surveys were undertaken between September and October 2019. The objective of the surveys was to ascertain the seabed conditions within the 500m cable corridor prior to cable installation in relation to bathymetry, geology, ecology, marine archaeology and other seabed features detected during survey, e.g. infrastructure crossings, obstacles, wrecks, and man-made objects (MMT, 2019b).

The following surveys were undertaken:

- Geophysical survey
- Geotechnical survey
- Crossing survey
- Benthic survey
- Intertidal survey

1.6.3 Consultation and stakeholder engagement

1.6.3.1 Pre-Application Consultation (PAC)

PAC events were held in September 2019 to engage with the public and stakeholders. In accordance with Section 24 of the Marine (Scotland) Act 2010, a report has been prepared and will form part of Marine Licence Application package (Appendix D).

1.6.3.2 Fishing Liaison Mitigation Action Plan (FLMAP)

A FLMAP was prepared to identify potential impacts of the Project to commercial fisheries and other marine users. It identifies measures to manage these impacts and presents measures on how these will be mitigated where required (Appendix B).

1.6.3.3 Scottish Natural Heritage

Consultation was been undertaken with SNH on 21st October 2019 with regard to the structure of this report and results of baseline surveys.

1.6.3.4 Orkney Islands Council

A pre-PAC meeting was held with Orkney Islands Council (OIC) to present the Project on 30th April 2019.

1.6.3.5 RSPB

A meeting to discuss HRA considerations was held with RSPB on 12th February 2019.

1.6.4 European Protected Sites and Species Risk Assessment

A European Protected Species (EPS) Risk and Protected Sites and Species Assessment was prepared prior to commencement of surveys in order to support application for an EPS Licence and a Basking Shark Licence. This assessment has been subsequently updated to include cable installation operations and forms the basis of this assessment (Appendix C).

1.6.5 Navigational Risk assessment (NRA)

An NRA has been completed for the cable installation, this comprised identification and assessment of potential hazards, and presents measures to manage these. As part of this process NRA Workshops were held in Kirkwall and Thurso which were attended by shipping and navigation stakeholders. Outputs from these workshops included identification of risk mitigation measures (Appendix D).

2. PROJECT AREA OVERVIEW AND ENVIRONMENTAL SENSITIVITIES

2.1 Overview of Project area

This section of the ESI Report outlines the physical, environmental and socio-economic environment of the Pentland Firth, and the key features that are present in the vicinity of the installation corridor. These features are then assessed against the potential impacts that may result from the installation/operation of the replacement cable. Taking these impacts into account in conjunction with the Best Practice Measures the Project is committed to implementing, it will be determined whether these impacts require further investigation in this report. In some instances, impacts that require further assessment will be assessed in the separate FLMAP and NRA respectively. This environmental overview is presented travelling south from Rackwick Bay on Hoy to Murkle Bay on the Scottish Mainland.

2.1.1 Physical environment (including seabed conditions)

The Orkney Isles are characterised by their strong wind climate. Prevailing winds from between west and south-east occur for 60% of the year, with an hourly mean wind speed of approximately 4m/s being exceeded 75% of the period between 1965 – 1973 (Barne *et al.*, 1997). The months of October-March feature the strongest winds, with the summer months of June – August being the calmest, with dead-calm days occurring for less than 1% of the year.

The Pentland Firth is subject to some of the strongest tidal currents in the world, with some localised currents having been recorded as reaching 4.5m/s near the seabed at certain points in the tidal cycle (Barne *et al.*, 1997). These high speeds are due to the waters of the Pentland Firth being acted upon by the Atlantic Ocean and North Sea tidal systems, with the net flow of water occurring from west to east (Barne *et al.*, 1997). Typical current speeds along the replacement installation corridor do not reach this level however, with peak speeds reaching approximately 1.5 to 2m/s in some instances (Atkins Geospatial, 2019). During mean spring tides the tidal range varies between 2.5 and 3m, although this can vary in bays and tidal estuaries. The west of Orkney is subject to higher mean wave heights than the east, with mean wave heights exceeding 1m for 75% of the year compared to 0.5m for 75% of the year in the east respectively (Xodus Group, 2019a).

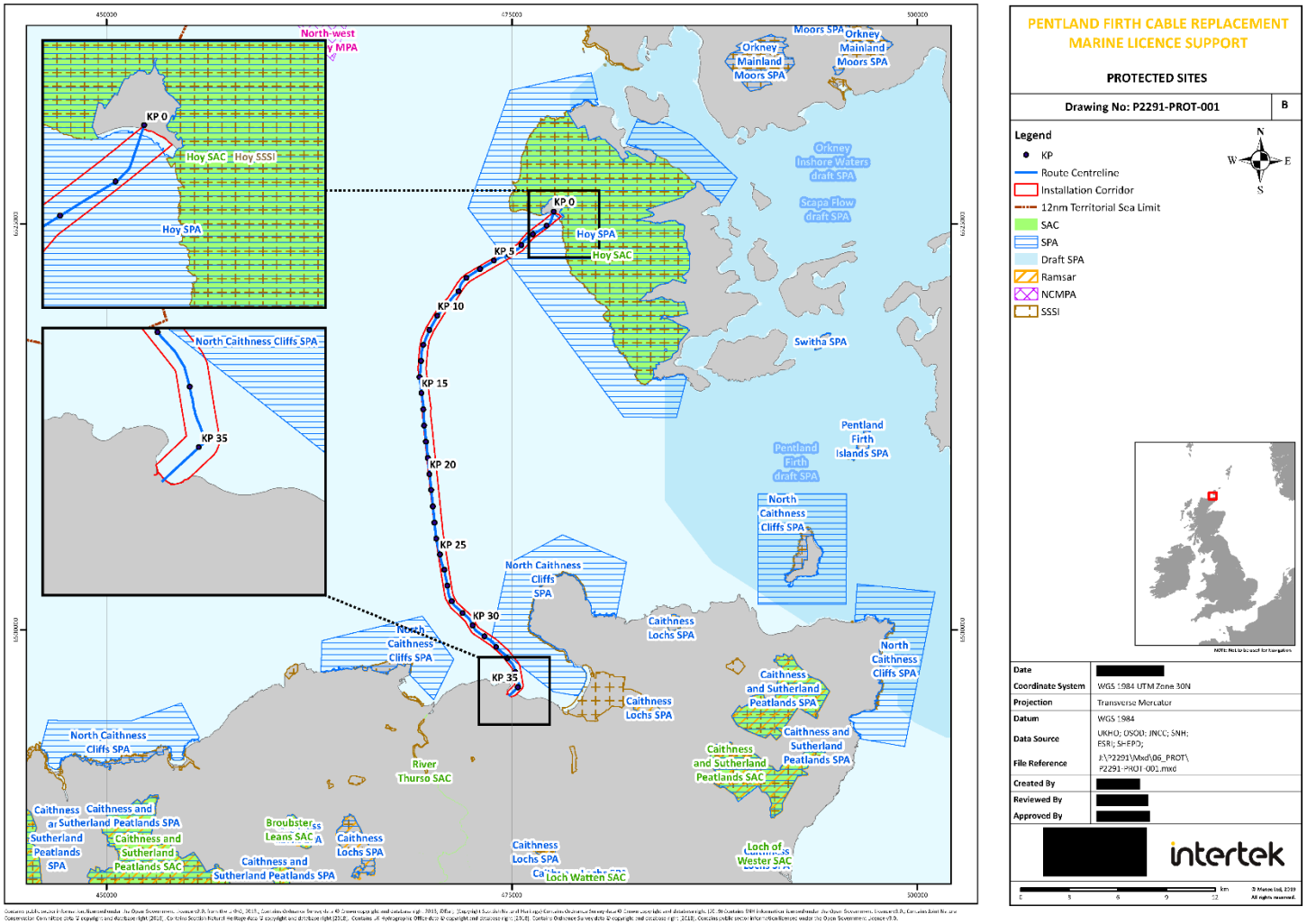
The High Level Cable Protection Study carried out for the installation corridor (Cathie Associates, 2019) indicates that sandwaves are a prominent feature of the seabed in this region of the Pentland Firth, primarily in the seabed closest to the Scottish mainland. The angle of the seabed slopes indicated a generally gentle slope of less than approximately 5°. Some instances of moderate to high angles do occur however, with an angle of 37° and 32° at KP18.5 and KP21.9 respectively being associated with sandwaves. Water depth along the route reaches a maximum of 89m below chart datum and fluctuates between approximate depths of 75m and 90m to approximately KP25, where depths gradually reduce thereafter until landfall. Outcrops of glacial till and bedrock have also been found to occur along the route, with the underlying till being deposited during the Late Devensian Period when the area was covered by an advancing ice-sheet.

The cable landfall at Rackwick Bay is surrounded by several protected areas but is not located within any of these sites. These sites are detailed in Section 2.1.2 below.

2.1.2 Protected Sites

There are several existing and proposed protected sites within or in close proximity to the cable installation corridor and landfall sites. These sites are displayed in Figure 2-1 below.

Figure 2-1 Protected sites in the vicinity of the installation corridor



Special Protection Areas (SPA)
Special Protection Areas (SPAs) are sites classified under the Conservation (Natural Habitats, & c.) Regulations 2010 (as amended), the Conservation of Offshore Marine Habitats and Species Regulations 2017 and in accordance with the Birds Directive, for the protection of Annex I or migratory breeding and non-breeding birds (JNCC, 2019c). There are three SPAs' relevant to this Project: The Hoy SPA, North Caithness Cliffs SPA and the Caithness Lochs SPA.

Proposed Special Protection Areas (pSPAs)
Proposed Special Protection Areas (pSPAs) are sites that have been identified by the Scottish Government that would provide for the protection of vulnerable bird species and further expand Scotland's network of SPAs, one of the key components of the Birds Directive (Marine Scotland, 2019a). There is one nearby pSPA relevant to this Project: the Orkney Inshore Waters pSPA.

Special Areas of Conservation (SACs)
Special Areas of Conservation (SACs) are sites classified under the Conservation (Natural Habitats, & c.) Regulations 2010 (as amended), the Conservation of Offshore Marine Habitats and Species Regulations 2017 and in accordance with the Habitats Directive, for the protection of Annex I and II habitats and species respectively (JNCC, 2019b). Habitats and species listed under these Annexes are considered to be in need of conservation at a European level. There is one SAC that is relevant to this Project: Hoy SAC.

Sites of Special Scientific Interest (SSSI)
Sites of Special Scientific Interest (SSSI) are statutory designations made by SNH under the Nature Conservation (Scotland) Act 2004 (SNH, 2019h). Under section 3 of the Act, SNH have the responsibility to designate areas of land as SSSI's that are of special interest for their flora, fauna, geology or morphology. There are two SSSI's relevant to this Project: Dunnet Head SSSI and Hoy SSSI.

Other established and potential protected sites in the vicinity of the project include an area of potential bedrock reef (an Annex I habitat), Hoy and West Mainland National Scenic Area and Caithness Lochs Ramsar site (joined with the current SPA). There are no Nature Conservation Marine Protected Area's (NCMPA's) within the vicinity of the Project.

2.1.2.2 Non-designated sites of interest

The Hoy RSPB Nature Reserve is also found within the vicinity of the cable corridor. While not a designated site, it covers a wide area of the island of Hoy (3926 hectares) (RSPB, 2019a) and is home to numerous protected bird species.

2.1.3 Benthic and intertidal ecology

The Pentland Firth is one of the most prominent examples of the UK Biodiversity Action Plan (BAP) Priority Habitat 'tide-swept channels' (formerly 'tidal rapids') in the United Kingdom (UK) (Moore, 2009). However, unlike other examples of 'tide-swept channels' in the UK that are characterised by abundant marine life (JNCC, 2016e), the benthic communities recorded in the Pentland Firth are typically of low diversity, being characterised by common, widely distributed and scour tolerant species such as acorn barnacles (*Balanus crenatus*) and the dahlia anemone (*Urticina felina*) (Moore, 2009).

During the study undertaken by Moore (2009) into the benthic environment of the Pentland Firth in relation to renewable energy developments, a single biotope was identified in the region of the installation corridor. This was the biotope *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (SS.SMx.CMx.FluHyd), a Scottish Biodiversity List Habitat. This is a common biotope around the UK coastline (JNCC, 2019a), with the site recorded here being dominated by the bryozoan *Flustra foliacea,* along with occasional occurrences of the soft coral *Alcyonium*

digitatum and crusts of the tube-worm *Pomatoceros*. Potential stony reef habitat has also been identified within the nearshore environment of Rackwick Bay.

2.1.4 Marine mammals and Otters

Cetaceans

Since 1980, seventeen cetacean species have been recorded in the Pentland Firth and adjacent Orcadian waters (Evans, Baines and Coppock, 2010). Of these species, the most commonly observed in near-shore waters (in descending order) are harbour porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorostrata*), white-beaked dolphin (*Lagenorhynchus albirostris*), Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*) and bottlenose dolphin *(Tursiops truncatus*). Four other species are considered casual visitors to the region: short-beaked common dolphin (*Delphinus delphis*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), long-finned pilot whale (*Globicephala melas*) and sperm whale (*Physeter macrocephalus*). Aside from harbour porpoise and long-finned pilot whales which are sighted year-round, sightings of other species typically occur in the summer months.

Pinnipeds

The Orkney Isles are hugely important to both the grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*), with the Faray and Holm of Faray SAC and Sanday SAC designated for the protection of grey and harbour seals respectively (Marine Scotland, 2016b). Both sites are important breeding grounds for their respective populations, with the Faray and Holm of Faray SAC supporting 9% of the annual UK grey seal pup production (JNCC, 2016a) and the Sanday SAC supporting 4% of the overall harbour seal breeding population (JNCC, 2016d). These sites are located approximately (in straight line distances) 48.2km and 57.7km from the installation corridor. As such the actual sea distances from these sites to the corridor will be even greater. Harbour seals typically forage between 11-21km from their haul-out site (DECC, 2016), so individuals from these sites are unlikely to be found foraging within the installation corridor. While grey seals are known to travel up to 100km from their haul-out site to forage (DECC, 2016), on average 43% of grey seals are found within 10km of their haul-out site (Mcconnell *et al.*, 1999). As such the likelihood of grey seals from these sites being present within the installation corridor is unlikely.

There are no recorded seal haul-out sites nearby the cable landfalls at Murkle Bay or Rackwick Bay, with the closest haul sites to the cable corridor being the Selwick site for harbour seals (found approximately 10.6km around the coast to the north of Hoy), Gills Bay for grey seals (found approximately 19.1km to the east) and Stroma for grey seals (found approximately 20.5km to the east) (Atkins Geospatial, 2019).

Otters

Within the Orkney Isles there is one protected site where otters are a qualifying feature, the Loch of Isbister SAC (JNCC, 2015b), found approximately 25km north of the installation corridor. The site was re-examined in 2011 as part of a Scottish-wide site-condition monitoring report by SNH (Findlay, Alexander and Macleod, 2015). The report concluded that otters were still present at the site, with 50% of the surveyed sites finding otters to be present. Additionally, informal accounts from local farmers reported that additional otters over those recorded in the survey had been sighted in the loch. Otters are also found around Orkney outside of this protected site and so could potentially be found at the Rackwick Bay landfall.

2.1.5 Fish and shellfish

2.1.5.1 Spawning and Nursey Grounds

Two of the most commercially important species that rely on the seabed for much of their lifetime are herring (*Clupea harengus*) and sandeels (Ammodytidae sp.). These species are also of huge conservation importance due to their position as important prey species for numerous other species

of conservation importance. Studies have indicated that there is low potential for the Pentland Firth for herring spawning (Coull, Johnstone and Rogers, 1998; Ellis *et al.*, 2012). Additionally, data presented in the Updated Fisheries Sensitivity Maps Report by Marine Scotland (2014) indicates that the probability of the presence of 0 group aggregations of herring (individuals in their first year of life) is low (Aires, González-Irusta and Watret, 2014). Similarly, while there is potential for sandeels to spawn in the Pentland Firth (Coull, Johnstone and Rogers, 1998), it has been determined to be of low intensity (Ellis *et al.*, 2012).

The Pentland Firth is known to be utilised as a nursery ground for blue whiting (*Micromesistius poutassou*) and anglerfish (*Lophius piscatorius*), which are both listed as Priority Marine Features (PMFs) in Scottish waters (MarLIN, 2019). It has also been suggested that the Pentland Firth may be an important nursery ground due to the abundance of juvenile Brown crab (*Cancer pagurus*) found here during a recent benthic survey (Moore, 2009).

2.1.5.2 Elasmobranchs and other electro-sensitive species

Elasmobranchs (sharks and rays) utilise electroreceptors to aid in detecting prey, with ampullary pores in elasmobranchs skin connecting to a gel-filled canal that contains a sensory epithelium that detect external electrical fields (Wueringer, 2012). As a result of this adaptation, there exists the potential for elasmobranchs to be disturbed by the weak electromagnetic fields (EMF) generated by power cables in the marine environment (Orr, 2016). Other fish species that are sensitive to electromagnetic fields are migratory species such as the Atlantic salmon (*Salmo salar*), which are theorised to utilise magnetite particles found in their lateral line to orientate themselves using the Earth's magnetic field (Moore *et al.*, 1990).

Within the Pentland Firth and the Project area, there exists the potential for several elasmobranch species to be present, including common skate complex (*Dipturus batis*-complex), spurdog (*Squalus acanthias*), tope shark (*Galeorhinus galeus*), spotted ray (*Raja montagui*), and thornback ray (*Raja clavata*), with the area being a low intensity nursing ground for these species (Ellis *et al.*, 2012). Basking sharks (*Cetorhinus maximus*) may also be present in the survey area. Basking sharks are discussed in Section 2.1.5.3 below.

There also exists the potential for migratory species such as Atlantic salmon and European eel (*Anguilla Anguilla*) to be present within the Project area, with studies providing evidence indicating that these species migrate through the Pentland Firth from freshwater rivers on the Scottish mainland to reach the deeper waters of the Atlantic Ocean and around Iceland (Malcolm, Godfrey and Youngson, 2010; Guerin *et al.*, 2014).

2.1.5.3 Basking sharks

A study of basking shark abundance and behaviour found that the 345 recorded sightings around Orkney showed no clear pattern or particular concentration, except that sightings were lower in the months between November and April (Evans, Baines and Coppock, 2010). Due to the low population numbers, the Northeast Atlantic population of basking sharks are listed as 'endangered' under the International Union for Conservation of Nature (IUCN) Red List OF Threatened Species (Fowler, 2009).

2.1.5.4 Noise Sensitive Species

Some species of fish are more sensitive to disturbance/injury from noise than others, depending on whether the species possesses a swim bladder and the distance of this bladder from their ear. Based on these dependencies, three sperate functional groups of fish can be developed (Hawkins and Popper, 2014). These groups include:

- Fish without a swim bladder. Low sensitivity to noise as they can only detect kinetic energy. Species include sharks, common skate complex, mackerel, flounder).

- Fish that possess a swim bladder but is located far from the ear. Medium sensitivity to noise, as despite the presence of the bladder it will likely not contribute to pressure reception with species being primarily kinetic detectors. Such species include salmon and sea trout. Also included in this group are fish eggs and larvae that due to limited mobility lack the ability to move away from a noise source.
- Fish that possess a swim bladder or other air bubble close to the ear. High sensitivity to noise, as the proximity of the bladder/air bubble to the ear allows for sound pressure to be detected. This broadens the fishes' hearing range but makes it susceptible to anthropogenic noise disturbance as the noise levels are more likely to breach their hearing threshold compared to less sensitive species (Popper *et al.*, 2014). Such species include herring, sprat and cod.

As described in Section 2.1.5.1, there is low potential for species sensitive to noise such as herring, sprat, and salmon to be present within the installation corridor.

2.1.5.5 Horse mussels (Modiolus modiolus)

Horse mussels (*Modiolus modiolus*) are a bivalve species that in dense aggregations can create biogenic reef habitat that provides shelter and support for numerous other species (Marine Scotland, 2018a). Scotland holds approximately 85% of the UK population, with the waters around Orkney being home to some of the few remaining extensive horse mussel beds in the country (JNCC, 2015a). The species is a filter feeder, making tide swept channels such as the Pentland Firth a potentially ideal location for the species (SNH, 2019i).

2.1.6 Ornithology

Both the Caithness coastline and the island of Hoy are home to numerous protected species of birds, as evidenced by the number and extent of the designated sites that cover these coastlines. Relevant protected sites include the Hoy SPA, North Caithness Cliff's SPA and the Caithness Loch's SPA and Ramsar sites. The Hoy RSPB Reserve is also located in the vicinity of the installation corridor. The installation corridor passes within the Hoy SPA and North Caithness Cliffs SPA sites, which protect numerous bird species including peregrine (*Falco peregrinus*), red-throated diver (*Gavia stellate*), great skua (*Catharacta skua*), fulmar (*Fulmarus glacialis*), guillemot (*Uria aalge*) and kittiwake (*Rissa tridactyla*), along with seabird assemblages of international importance at both sites (JNCC, 2005b, 2005c). The waters of the Pentland Firth are utilised by the various breeding bird populations at varying times of year, with Table 2-1 below detailing the typical breeding seasons of the relevant species in Scotland as a whole. It should be noted however that in the north of Scotland, breeding seasons typically begin approximately one month later than breeding seasons to the south, with surveys studying the Orkney seabird population beginning in May (RSPB, 2019a, 2019b).

Table 2-1 Breeding seasons of bird species found in Protected Sites that intersected the installation corridor (Scottish-wide averages) (SNH 2014, 2017)

Protected Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Arctic skua												
Fulmar												
Great Skua												
Great black-backed gull												
Guillemot								M	M	M		
Kittiwake												
Peregrine												
Puffin		M	M									
Razorbill									M			
Red-Throated Diver										M	M	M	M

Key: White – Not present in Significant Numbers
Black – Breeding season
Light Blue – Non-breeding period
M – Flightless moult period
Dark Blue – Breeding Site Attendance

2.1.7 Human health

Dounreay Nuclear Power Station (located approximately 18km west of the Murkle Bay landfall site) was an experimental nuclear site that entered full operation in 1958, and remained open until the end of the 1990's. The site was used for testing and recycling different fuel types, with used fuel being dismantled in water-filled ponds before chemical processing was conducted to recover any material that may be re-used (Dounreay, 2016a). These processes created small radioactive metal fragments which in some cases managed to reach the marine environment through the sites effluent system. While protections were implemented in the 1980's to prevent further discharge, these particles have been identified along the Caithness coastline (including Murkle Bay), being transported along the coast by the coastal processes of the area. As such, nearby beaches are now routinely monitored with radiation detection instruments to find and remove any radioactive particles washed up.

2.1.8 Shipping and Navigation

The Pentland Firth is utilised by several different classes of vessel, being a prime route for vessels to transit between the North Sea and west coast of Scotland and the Atlantic Ocean. In a shipping study of the Pentland Firth and Orkney Waters conducted by Marine Scotland published in 2012 (Marine Scotland, 2012b), seven type categories of vessel were categorised:

- Tanker (Oil/Chemical/Gas Carrier)
- Bulk/Ore Carrier
- Cargo (including Roll-on Roll-off (RoRo)/Container)
- Passenger (Ferry/Cruise Ship)
- Offshore (Oil and Gas Renewables Support Vessels)
- Tug
- Other

Fishing vessels, military vessels and recreational vessels were not included in the study. No significant numbers of bulk/ore carriers, offshore support vessels, tugboats or other vessels were found transiting the Pentland Firth or intersecting the installation corridor.

The average number of vessels transiting the Pentland Firth each day remains fairly consistent across the year, with offshore and passenger vessels seeing increases of five and ten vessels per day during the summer respectively. Passenger vessels account for the highest numbers of average vessels per day, with the Pentland Firth being utilised by Serco NorthLink's *Hamnavoe* which operates between Scrabster and Stromness, and Pentland Ferries' *Pentalina* which operates between Gills Bay and St. Margaret's Hope. The installation corridor is located approximately 20km from the *Pentalina's* route, so is not of concern for this Project. The installation corridor intersects the *Hamnavoe* ferry route at two points, for approximately 0.71km and 2.85km between KP 8.89 and KP 9.49, and KP 22.9 and KP 25.8.

The route through the Pentland Firth between the North Sea and the Atlantic Ocean is used extensively by cargo vessels, and to a lesser extent, tanker vessels travelling in an east – west direction. The channel is utilised by these vessels year-round, with a slight increase in vessel density occurring during the summer months. According to Automatic Identifications System (AIS) data provided by the Marine Management Organisation (MMO), along the installation corridor weekly average vessel density reaches a peak of approximately 35 vessels at its busiest point (MMO, 2017).

The North Caithness Coast and Orkney waters are used by small numbers of sailing vessels each year, with the summer months seeing significantly higher numbers than in the winter. Vessels typically visit the main ports and marinas of the region including Westray, Kirkwall, Stromness and Scrabster.

2.1.9 Commercial fisheries

The replacement cable installation corridor is contained within International Council for Exploration of the Seas (ICES) rectangle 46E6, which is targeted primarily for shellfish and pelagic species, although some demersal species are also targeted within Orkney waters (Marine Scotland, 2018c). As the majority of vessels fishing in Orkney waters are below 15m in length, fishing activity data is sourced from ScotMap, a Marine Scotland Project which sourced spatial data on vessels less than 15m in length between 2007 – 2011 by conducting face-to-face interviews with 1090 fishermen (Marine Scotland, 2014).

Within the Pentland Firth and Orkney Waters, creeling is the most popular method of fishing, with 146 vessels classified as creeling vessels (of which 141 are 15m in length or less) (Marine Scotland, 2012a). Creels are utilised to target mobile scavenger crustacean species such as brown crab, velvet crab (*Necora puber*), *Nephrops* and lobster (*Homarus Gammarus*). Within ICES rectangle 46E6, creeling accounts for three-quarters of fishing effort, with the top species targeted being crab, lobster and haddock (see Section 7 of the FLMAP). Dredging effort is low within the cable corridor, with a peak of 20 to 50 hours to the western edge of the corridor. Fishing effort in the region follows a seasonal pattern with activity varying to shelter from adverse weather conditions, reacting to seasonal changes and exploiting target species (Coleman and Rodrigues, 2016).

2.1.10 Tourism and recreation

The Pentland Firth is utilised for several recreational activities such as sailing, yachting and canoeing. The Pentland Canoe Club and Pentland Firth Yacht Club are based in Scrabster and Thurso respectively, which are approximately 7km and 6km respectively around the coast from the Murkle Bay landfall site. The coastline near the Murkle Bay landfall is a known small hotspot for coasteering, according to data collated by the Scottish Marine Recreation and Tourism Survey 2015 (Land Use Consultants Ltd, 2015). In Orkney waters SCUBA diving is a popular pursuit, with areas around Orkney as well as north coast of Caithness and Sutherland are also popular with divers (Aquatera, 2015). Additionally, the island of Hoy features the Hoy RSPB Nature Reserve, which covers a large area of the north and west

of the island, including around the Rackwick Bay landfall site (RSPB, 2019a). Due to the varied habitat of the site from tall sandstone cliffs near Rackwick Bay to the inner moorland a wide variety of species may be found here. The reserve is particularly popular with tourists during the summer months as this is when the peak breeding season for the majority of birds in the site occurs (RSPB, 2019a, 2019b).

2.1.11 Marine archaeology

The Pentland Firth has throughout history been an important maritime route between the Atlantic Ocean and the North Sea. As such there exists the potential for undiscovered wrecks to be present within the Pentland Firth, and by extension the installation corridor. Due to the Royal Navy's use of Scapa Flow as a base in both World War 1 (WW1) and World War 2 (WW2) and subsequent incursions from German vessels and U-boats, sunken vessels from this era have the greatest potential to be preserved in the Pentland Firth. Two undiscovered wrecks of high importance that could potentially be located within the installation corridor are the HMT Orsino and SS Navarra, which were sunk during WW1 and WW2 respectively and if discovered would be considered as war graves. There are a further possible 63 wrecks that may be located close or within the installation corridor. Additionally, there are 16 lost WW2 era aircraft that could potentially be discovered close to or within the installation corridor. Surveys of the installation corridor did not identify any side-scan sonar (SSS), multibeam echosounder (MBES) or magnetic anomalies that represent underwater cultural heritage remains.

2.1.12 Other sea users

The Pentland Firth and Orkney Waters are utilised by several different sea users, with activities including:

- Renewable energy (Operational/Consented)
- Telecommunications/Power Cables
- Disposal sites
- Recreational activities

Due to the fast-flowing tidal conditions of the Pentland Firth, the area has seen significant interest from developers of tidal energy technologies. Two projects currently have received Agreements for Lease (AFL) from the Crown Estate for areas of seabed in the Pentland Firth: Meygen (located in the channel between the Swona and the mainland, approximately 19.3km east) and Duncansby Tidal Power (located off the north-east coast of Caithness, approximately 25.4km east) (Atkins Geospatial, 2019). Of these projects, only Meygen is currently operational, with phase 1A of the project (consisting of four 1.5MW tidal turbines) formally entering its operational phase in April 2018 (Simec Atlantis Energy, 2019). Additionally, the Dounreay Tri demonstration project, a planned floating windfarm that has received an Agreement for Lease (AFL) from the Crown Estate, is located approximately 20.1km to the west of the installation corridor. Development was halted in 2017 after Dounreay Tri Ltd, the project owner, filed for administration due to a lack of funding (reNEWS.biz, 2017). The project is currently being developed by Hexicon AB, a Swedish based developer of floating wind farm technologies (4C Offshore, 2019). The European Marine Energy Centre (EMEC) testing facility at Bilia Croo is located approximately 12.8km north of the installation corridor, around the northwest coast of Hoy.

Marine Scotland, through their work identifying potential leasing sites for new offshore wind developments in Scottish waters, has identified an Area of Search (AoS) for the North West and North of Scotland that is located approximately 2.45km to the east at its closest point (Marine Scotland, 2018b; Atkins Geospatial, 2019).

There are two telecommunications cables that intersect the installation corridor. These are:

- FARICE 1 – Operated by Farice ehf (an Icelandic state-owned telecommunications group), this telecoms cable connects between Iceland, the Faroe Islands and Scotland, making landfall at Dunnet Bay in Caithness (Farice, 2019).
- Northern Lights – Operated by BT, this telecoms cable connect the Scottish mainland (via Dunnet Bay, Caithness) to Orkney, making landfall at the Bay of Skaill on the west coast of the Orkney mainland (Fiber Atlantic, 2008).

The nearest oil and gas well to the installation corridor is Well 12/16-1, located approximately 53km around the Scottish mainland coast to the south-east.

There are three closed disposal sites in the vicinity of the installation corridor. These are Thurso, Scrabster Extension and Scrabster and which are located approximately and 0.1km, 1.05km and 1.31km from the route respectively.

2.2 Environmental overview

Potential impacts	Sensitivity of receiving environment to impact	Embedded mitigation and best practice measures*	Zone of influence / footprint	Further assessment required?
Physical Processes				
Abrasion/disturbance at the surface of the substratum.	Low due to the sediment along the route consisting predominantly of sand and gravel further offshore.	Cable will be stabilised to minimise movement on the seabed.	The immediate vicinity of the laid cable: 5m^2 per rock bag; 7m wide trenching footprint.	Yes, this will be assessed in Section 3 – Physical Processes of the ESI Report.
Water flow (tidal current) changes – local.	Medium due to potential for scour to occur at third-party cable crossing sites.	The footprint of any placed cable protection will be limited to that required to ensure cable stability on the seabed and protection at crossings.	No change to water flow (tidal current) expected.	
Changes in water suspended solids (water clarity).	Low due to the high tidal flows of the area that rapidly disperse any released sediment.	None	Sediment is expected to settle within a close distance of the installation corridor.	
Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion.	Low due to the quaternary deposits that comprise the majority of the underlying bedrock along the route.	None	1m wide trench depth to a minimum burial depth for protection to be defined by the CBRA.	
Benthic and Intertidal Ecology				
Physical change (to another substratum type).	Medium due to the presence of Annex I Stony Reef habitat identified along the route. Sensitivity of habitats outside these areas is low due to the lack of protected habitats and species.	Rock filled bags being utilised to hold the cable in position and reduce movement of the cable on the seabed. Concrete mattresses may be used for a similar purpose in areas where a rock bag would reduce the water depth by more than 5%, as well as at cable crossings.	The immediate vicinity of cable protection which in the case of individual rock bag placement will be 5m^2 per 4 tonne bags. Include footprint of individual concrete mattresses at crossings. Include footprint of individual grout bags.	Yes, this will be assessed in Section 4 – Benthic and Intertidal Ecology of the ESI Report.

Potential impacts	Sensitivity of receiving environment to impact	Embedded mitigation and best practice measures*	Zone of influence / footprint	Further assessment required?
Abrasion/disturbance at the surface of the substratum.		Deployment of anchors/anchor chains on the seabed will be kept to a minimum in order to reduce disturbance to seabed. Where possible the cable will be surface laid over Annex I habitat. Cable protection measures will be minimised in areas of Annex I habitat.	7m wide for jetting and mechanical trenching Area disturbed by anchors including anchor chains will be 12.286m². (Clump weight footprint - 12.25m², chain footprint – 0.036m²). 19 anchor deployments predicted. The immediate vicinity of cable protection which in the case of individual rock bag placement will be 5 m^2 per 4 tonne bags. Individual concrete mattress footprint – 18m². Individual grout bag footprint – 0.81m².	Yes, this will be assessed in Section 4 – Benthic and Intertidal Ecology of the ESI Report.
Smothering and siltation rate changes.		Post-lay burial will only be used if necessary, for the protection of the cable.	Sediment is expected to settle within a close distance of the installation corridor.	Yes, this will be assessed in Section 4 – Benthic and Intertidal Ecology of the ESI Report.
Accidental hydrocarbon or chemical release from installation vessel.		Control measures and shipboard oil pollution emergency plans (SOPEPs) will be in place and adhered to under MARPOL Annex I requirements for all Project vessels.	Worst case impact distance for hydrocarbon spill is 10km.	No further assessment required due to the best practice measures that will be implemented.
Introduction of Non-Native Invasive Species (INNIS)	Medium due to the potential for introduced INNIS to settle within the Pentland Firth and the potential for such settling to act as a 'stepping-stone' to reach other protected sites within Orcadian waters.	Ballast water discharges from Project vessels will be managed under the International Convention for the Control and Management of Ships' Ballast Water and Sediments standard. A non-native species management plan will be produced to mitigate against the potential release of INNIS (see Section 6 of the CEMP)	The immediate surface of placed cable protection.	Yes, this will be assessed in Section 4 – Benthic and Intertidal Ecology of the ESI Report.
Fish and Shellfish				
Electromagnetic fields (EMF)	Medium due to the recorded presence of elasmobranch species (common skate complex, spurdog, tope shark, spotted ray, thornback ray and basking shark) and migratory species such as salmon in the	In terms of potential impacts on elasmobranchs or electro-sensitive species that could be present in the immediate footprint of the cable, while there will be EMF emissions from the replacement cable, these emissions will replace those from the existing cable (once the existing	EMF is expected to reduce to background levels within a short distance from the cable.	No further assessment required due to the very limited range at which EMF changes could cause detectable disturbance

Potential impacts	Sensitivity of receiving environment to impact	Embedded mitigation and best practice measures*	Zone of influence / footprint	Further assessment required?
	Pentland Firth that may be disturbed by EMF generated by the cable (Orr, 2016).	cable is taken out of the service) and be limited to the immediate vicinity of the cable only. There will be a short period of time when both the replacement and existing cables could be operational, however even during this time, the spatially limited nature of the emissions that could potentially impact electro sensitive species indicate there are unlikely to be any significant impacts.		effects to elasmobranchs and migratory fish species.
Physical change (to another substratum type)	Medium due the Pentland Firth being identified as a potential nursery habitat for juvenile brown crab.	Rock filled bags being utilised to hold the cable in position and reduce movement of the cable on the seabed. Concrete mattresses may be used for a similar purpose in areas where a rock bag would reduce the water depth by more than 5%, as well as at cable crossings.	The immediate vicinity of cable protection which in the case of individual rock bag placement will be 5m^2 per 4 tonne bags. Individual concrete mattress footprint – 18m^2. Individual grout bag footprint – 0.81m^2.	Yes, this will be assessed in Section 5 – Fish and Shellfish of the ESI Report.
Underwater noise changes	Low due to the minimal likelihood of the presence of fish that are the most sensitive to underwater noise due to the presence of a swim bladder close to the ear (e.g. herring, sprat, cod) (Popper *et al.*, 2014).	Duration of the works will be limited, ensuring any potential noise disturbance effect is temporary in nature.	Within close proximity to the cable	No further assessment required.
Seabirds				
Presence of installation vessels	Medium - high sensitivity due to the presence of seabird breeding colonies in proximity to the cable corridor on both the Scottish Mainland and Hoy.	Duration of the works will be limited, ensuring any potential visual disturbance effect is temporary in nature.	4km divers and sea ducks. 2km all other seabird species. Based on the extent and potential consequences of seabird displacement from offshore wind farm developments published by the UK Joint Statutory Nature Conservation Bodies (SNCB) (JNCC, 2017). Disturbance will be limited in extent and duration and there is sufficient space in the surrounding environment for birds to temporarily relocate. Therefore, only sites within 2-4km of the proposed installation and maintenance activities have been	Yes, this will be assessed in Section 7 – Protected Sites of the ESI Report and is also assessed within the supporting EPS Risk and Protected Sites and Species Assessment (Xodus Group, 2019b).

Potential impacts	Sensitivity of receiving environment to impact	Embedded mitigation and best practice measures*	Zone of influence / footprint	Further assessment required?
			screened for displacement (dependant on species present).	
Marine mammals				
Death or injury by collision	Low due to the limited presence of marine mammals within the cable corridor and operations being in open water allowing for individuals to avoid collisions.	Project vessels will travel at speeds of 4 knots or less, due to speeds above this increasing the likelihood of severe injury (Laist *et al.*, 2001).	Immediate path of the installation vessel	No further assessment required.
Presence of installation vessels	Medium due to potential seal presence along the route which can be susceptible to visual disturbance at close range.	Duration of the works will be limited, ensuring any potential disturbance effect due to the presence of vessels is temporary in nature.	900m (Pinnipeds) (Brassuer and Reijnders, 1994).	Yes, this has been assessed in the supporting EPS Risk and Protected Sites and Species Assessment (Xodus Group, 2019b) the findings of which are summarised in Section 6 – Marine Mammals of the ESI Report.
Underwater noise changes	High sensitivity due to the presence of species such as harbour porpoise which are susceptible to disturbance as a result of changes in underwater noise.	There will be MMO coverage for the entire duration of activities. During daylight hours the MMO(s) will observe the sea for the presence of marine mammals and basking sharks, with work activities being delayed should an individual of these species be sighted within 500m of the activities (100m when avoiding critical delays, with definition of a critical delay being agreed with MS-LOT prior to commencement of works); Visual and (if required) acoustic monitoring will occur 30 mins prior to commencement of installation activities to determine if any marine mammals or basking sharks are present within 500m of activities (100m in event of critical delay); PAM will be utilised by a qualified MMO/PAM operator in times of poor visibility (e.g. fog); 500m mitigation zone for cetaceans;	Within close proximity to the installation corridor.	Yes, this has been assessed in the supporting EPS Risk and Protected Sites and Species Assessment (Xodus Document Reference: A-302428-S01-REPT-001), the findings of which are summarised in Section 6 – Marine Mammals of the ESI Report.

Potential impacts	Sensitivity of receiving environment to impact	Embedded mitigation and best practice measures*	Zone of influence / footprint	Further assessment required?
		500m mitigation zone for seals, reducing to 100 m in the event of a need to avoid critical delay to the Project; During hours of darkness and poor visibility when visual observation is not possible, equipment must not be started within 100m of any seal haul-out site or SAC designated for seals; All recordings of cetaceans, seals and basking sharks will be made using JNCC Standard Forms. See Section 6.5 for full mitigation descriptions		
Protected Sites and Species				
Disturbance of seabirds from the presence of vessels.	Medium – high sensitivity due to the installation corridor passing within protected sites designated for breeding seabird colonies on both the Scottish Mainland and Hoy.	Cable installation activities will be as limited in duration as is practicable to reduce any impact vessel presence may have.	4km divers and sea ducks. 2km all other seabird species. Based on the extent and potential consequences of seabird displacement from offshore wind farm developments published by the UK Joint SNCB (JNCC, 2017). Disturbance will be limited in extent and duration and there is sufficient space in the surrounding environment for birds to temporarily relocate. Therefore, only sites within 2-4km of the proposed installation and maintenance activities have been screened for displacement (dependant on species present).	Yes, this will be assessed in Section 7 – Protected Sites of the ESI Report and is also assessed within the supporting EPS Risk and Protected Sites and Species Assessment (Xodus Group, 2019b).
Marine Archaeology				
Abrasion/disturbance at the surface of the substratum	Medium due to the number of known/unknown wrecks found in the Pentland Firth, increasing the possibility of notable archaeological features/wrecks being found along the installation corridor.	A project specific written scheme of investigation (WSI) and protocol for archaeological discovery will be implemented during the installation phase of the Project. The use of rock filter bags to hold the cable in place will significantly reduce any cable movement and potential scour.	7m wide for jetting and mechanical trenching Area disturbed by anchors including anchor chains will be 12.286m². (Clump weight footprint - 12.25m², chain footprint – 0.036m²). 19 anchor deployments predicted.	Yes, this will be assessed in Section 8 – Marine Archaeology of the ESI Report.

Potential impacts	Sensitivity of receiving environment to impact	Embedded mitigation and best practice measures*	Zone of influence / footprint	Further assessment required?
			The immediate vicinity of cable protection which in the case of individual rock bag placement will be 5m² per 4 tonne bag. Individual concrete mattress footprint – 18m² Individual grout bag footprint – 0.81m²	
Human Health				
Resuspension of radioactive particles	Medium due to the use of Murkle Bay and beach by the local population or various recreational activities, as well as fishing purposes	No mitigation measures proposed	2.095km (length of corridor that may be trenched within Dunnet Bay and the cable burial by excavator from Mean Low Water Neap to Murkle Bay Joint Transition Bay.	Yes, this will be assessed in Section 9 – Human Health of the ESI Report.
Shipping and navigation				
Presence of installation vessels	Medium sensitivity due to the Pentland Firth being utilised by shipping vessels and the installation corridor overlapping the *Hamnavoe* ferry route.	Limited duration of cable installation activities. A 500m safety zone will be enforced around the installation vessel when in operation. Due to the linear nature of the cable installation route however, the duration of time where other vessels will be displaced will be minimal. Notices to Mariners to be issued prior to cable installation. Cable lay vessel to be fitted with AIS so that it can be easily detected by other vessels transiting through the area. Provision of details of the schedule for cable lay activities to local ports, ship operators, fishermen and recreational sailing organisations.	0.79km² (based on a transient 500m safety zone surrounding the vessel).	Yes, this has been assessed within Section 10 – Shipping and Navigation of the ESI Report, utilising information from the NRA (AECOM, 2019a, 2019b, 2019c).
Commercial fisheries				
Presence of installation vessels	Medium due to areas in the vicinity of the cable corridor being utilised by creeling vessels.	Notice to Mariners will be issued before works commence and after completion of the installation activities. A 500m safety zone will be enforced around the installation vessel when in operation. Due to the linear nature of the cable installation route however, the duration of time where fishing vessels will be displaced will be minimal.	0.79km² (based on a transient 500m safety zone surrounding the vessel).	Yes, this has been assessed within the Fishing Liaison Mitigation Action Plan (SHEPD, 2019) and Section 11 – Commercial Fishing of the ESI Report.

Potential impacts	Sensitivity of receiving environment to impact	Embedded mitigation and best practice measures*	Zone of influence / footprint	Further assessment required?
		The as-laid position and route of the cable will be provided to the UKHO for inclusion on all marine charts in the region so fishing vessels can take care along the installation corridor.		
Tourism and recreation				
Presence of installation vessels	Medium due to the presence of several recreational groups within the vicinity of both landfall sites and the Rackwick Bay landfall site being located within the Hoy RSPB Nature Reserve.	Limited duration of cable installation activities.	A 500m safety exclusion zone will be maintained surrounding the installation vessel. This will be transient with the vessel as it moves across the installation area. The Zone of Influence is therefore approximately 0.79km² surrounding the installation vessel offshore at any time.	Yes, this has been be assessed within the NRA (AECOM, 2019a, 2019b, 2019c) and Section 12 of the ESI.
Other sea users				
Presence of installation vessels	Low due to the lack of other infrastructure and other sea users within the vicinity of the cable corridor.	Limited duration of cable installation activities.	A 500m safety exclusion zone will be maintained surrounding the installation vessel. This will be transient with the vessel as it moves across the installation area. The Zone of Influence is therefore approximately 0.79km² surrounding the installation vessel offshore at any time.	Yes, this has been be assessed within the NRA (AECOM, 2019a, 2019b, 2019c).
Damage to third-party assets	Medium due to the installation corridor crossing other third-party cable infrastructure, increasing the potential for damage to occur.	Early consultation with relevant contacts to warn of impending activity, will be undertaken. Vessels will be requested to remain at least 500m away from cable vessels during installation and repair works. Notice to Mariners will be issued before works commence and after completion of the installation activities.	At crossing locations	Yes, this has been be assessed within the NRA (AECOM, 2019a, 2019b, 2019c).

* Further measures are detailed in their respective chapters
Sensitivity Definitions
Low – Receiving environment is tolerant to change without significant detriment to its character.
Medium – Receiving environment has moderate capacity to absorb change without significantly altering its character.
High – Receiving environment has little to no ability to absorb change without fundamentally altering its character.

3. PHYSICAL PROCESSES

3.1 Introduction

This Section provides further description of the physical processes (e.g. metocean conditions, underlying geology and superficial sediments) influencing the baseline environment, identifies impacts associated with the installation corridor on physical processes and presents findings of the environmental assessment.

3.2 Data collection, sources and methodology

MMT were commissioned to undertake geophysical,geotechnical and environmental surveys and report on the findings to provide an overview of the seabed conditions along the installation corridor. The following MMT reports were used to inform the physical processes baseline description:

- Environmental survey Report, (MMT, 2019a)
- Marine Survey Report, (MMT, 2019b)

Envision were commissioned to undertake intertidal shore surveys of the proposed cable landfall areas to collect information on the biology and physical nature of the intertidal areas and provide inputs for habitat mapping in the following report:

- Intertidal Survey Report, Hoy – Caithness Cable Route, (Envision, 2019)

The Project documents have been supplemented where necessary. The data sources used to inform the baseline include, but are not limited to, the following:

- Pilot Pentland Firth and Orkney Waters Marine Spatial Plan, Regional Locational Guidance (Marine Scotland, 2016b).

3.2.1 Marine survey

Surveys of the marine installation corridor were carried out between September and October 2019. The objective of the survey was to establish conditions with regards to bathymetry, geology and other seabed features (such as crossing of infrastructure and other obstacles) within the marine installation corridor. The scope of the survey works included:

- Geophysical route survey (nearshore, 15m; offshore, 15m LAT)
- Geotechnical survey (offshore and landfall)
- Crossing survey
- Landfall topographic survey
- Reporting and charting
- Environmental survey, including sampling, was also undertaken and reported separately as part of the marine survey campaign. The geophysical survey comprised of MBES, SSS, sub-bottom profiler, magnetometer and gradiometer. Geotechnical survey included testing and sampling using vibrocore (VC) and cone penetration testing (CPT).

Data quality is described in Table 3-1.

3.2.2 Survey data quality

Data quality from all reports was acceptable for purposes of determining the physical characteristics of the seabed along the installation corridor (see Table 3-1).

Table 3-1 Data quality

Survey	Offshore				Intertidal	
Method	**Acoustic**	**Photo**	**Grab- PSA**	**Grab - Chemistry**	**Visual**	**Photo**
Planned Samples	Continuous	15 (duplicate)	15	-	-	Habitat specific
Samples Obtained	Continuous	15 (duplicate)	14	-	-	32
Data Available	Yes	Yes	Yes	Not available	Yes	Yes
Data Quality*	Acceptable	Acceptable	Acceptable	-	Descriptive	Acceptable

*Acceptable – Data is of sufficient quality to enable a sufficient assessment to be made.

3.3 Physical processes description

3.3.1 Metocean conditions

The Pentland Firth is characterised by highly energetic conditions, resulting from strong tidal currents and frequent severe storms. As a result, sediments largely consist of sands and gravel, with exposed rock, boulders and, while the associated benthic community is adapted to frequent disturbance.

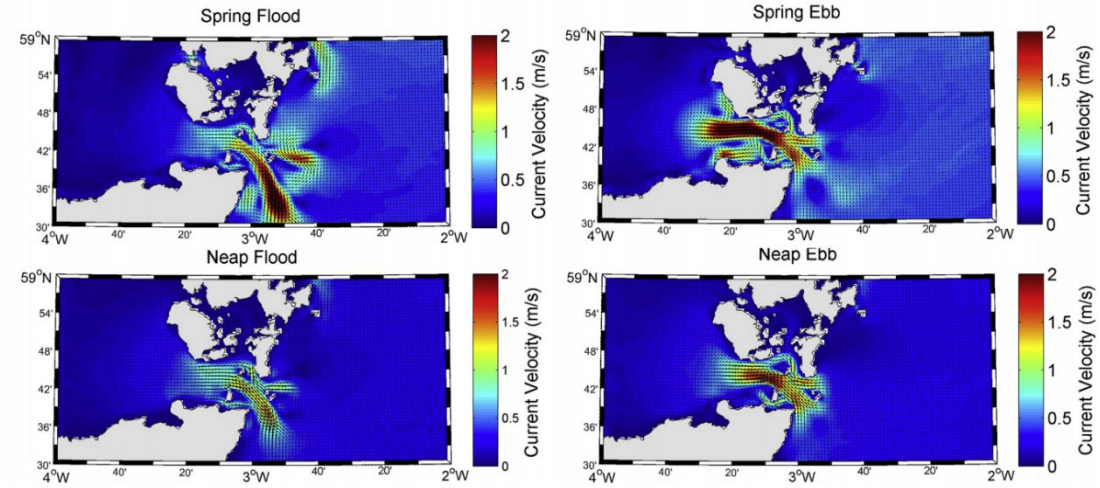
3.3.1.1 Water levels and currents

The tides around Scotland are strongly semi-diurnal and can be described by the principal semi-diurnal lunar (M2) and semi-diurnal solar (S2) constituents (Neill *et al.*, 2017). The tidal currents in Pentland Firth are some of the strongest in the world, which has attracted interest from a number of tidal energy developers over the years. The timings of high and low water at either end of the Pentland Firth differ; on the Atlantic side, the semidiurnal Kelvin wave sweeps northward and arrives approximately two hours prior to the same wave travelling south on the North Sea side (Easton, Woolf and Bowyer, 2012). This results in a phase difference of 50-60° between co-tidal lines and a difference between the tidal ranges, with smaller tidal amplitudes on the North Sea side. The mean spring tidal range on the western end of the Pentland Firth varies between 3-3.5m while on the eastern side, it varies between 2-2.5m (Marine Scotland, 2015a).

Although the tidal range is relatively low the large elevation phase difference between the western and eastern approaches to the Pentland Firth generates very strong currents within the channel (Neill *et al.*, 2017), which can exceed 5m/s (Adcock *et al.*, 2013). Tidal streaming due to topographical constrictions and islands help strengthen these currents. The mean spring velocity in the Outer Sound is around 3m/s, with current speeds exceeding 1m/s for 80% of the time (Martin-Short *et al.*, 2015). Figure 3-1 shows the velocity magnitude at mid-depth in the vicinity of the Pentland Firth during both spring and neap tides. It is evident that there is a strong ebb-dominated tidal asymmetry in the western portion of the Pentland Firth in the vicinity of the installation corridor.

Across the mouth of Thurso Bay, tidal currents peak at 0.75m/s, however, these currents weaken towards Dunnet Bay with an anticlockwise eddy forming between Dunnet Head and Rough Head during the westerly ebbing tide (Ramsay and Brampton, 2000). It is noteworthy that sailing directions for Pentland Firth (Plexus, 2010) refer to very strong eddies and violent races within the area. These conditions will result in strong turbulent mixing in the water column.

Figure 3-1 Velocity magnitude in the vicinity of the Pentland Firth at mid-depth (Goward-Brown *et al*., 2017)



3.3.1.2 Waves

Waves are directly driven by winds, modified by currents and shallow sea-floor topography. In UK waters, wave climate is strongly seasonal; mean wave heights peak around January, with a high risk of high monthly-mean wave heights and extreme wave heights from October to March (UKMMAS, 2010).

The wave resource in Scotland is generally influenced by conditions in the North Atlantic due to the predominantly south-westerly prevailing winds, with a fetch sufficient to generate swell (Neill and Hashemi, 2013). The annual mean significant wave height in the vicinity of the Pentland Firth is approximately 1.5m, which equates to an annual mean wave power of approximately 12.7kWm^{-1} (Marine Scotland, 2015b). According to Xodus (Xodus Group, 2019a) the mean wave height in the east of Orkney is higher than 0.5 m for 75% of the year and higher than 1.5m for 10% of the year, while the west of Orkney is characterised by a mean wave height exceeding 1m for 75% of the year.

The dominant wave direction along the north coast of Scotland is between 240°N and 320°N, with an average of over two thirds of the offshore wave climate being within this zone. Extreme wave conditions (i.e. > 8m) can occur from any directional sector with the exception of the south east quadrant (Ramsay and Brampton, 2000).

Off the west coast of Orkney, the wave climate is generally more severe than that on the eastern side, with extreme events occurring more frequently. The total sea wave climate is dominated from a narrow wave window between 240°N and 300°N with over 50% of conditions experienced from this zone (Ramsay and Brampton, 2000). However, wave conditions over 8m can be experienced from any direction between south west and north. The swell wave climate occurs in a similar window, with 70% of conditions experienced from between 260°N and 320°N (Ramsay and Brampton, 2000).

3.3.1.3 Wind

Northern Scotland and Orkney are subject to strong winds, with prevailing winds from the west and south-east for 60% of the year (Xodus Group, 2019a). Winds are strongest between October and March. Barne *et al*. (1997) noted that wind speeds greater than 8m/s occur 30% of the year, with an hourly mean speed of 4 m/s recorded during 1965-1973. The wave direction in this area is principally between 240° and 320°, which accounts for two thirds of the offshore climate (Ramsay and Brampton, 2000).

3.3.1.4 Temperature and salinity

The North Atlantic Drift current carries oceanic water along the north coast of Scotland through the Faroe – Shetland Channel to the Norwegian coast. The has a cooling effect on temperatures in the

summer and a warming affect in the winter with average temperatures along the north coast of 12.5°C – 13°C in the summer and 6.5°C – 7.0°C in winter (Xodus Group, 2019a).

Salinity in this region is approximately 34.85, which is marginally lower than the salinity of normal sea water (35) due to the mixing of Atlantic water with lower salinity coastal waters (Barne *et al.*, 1997).

3.3.2 Coastal processes

As noted in Section 2.1.1, the north coast of Scotland and Orkney are subjected to high wave energy and to strong tidal currents, particularly in the Pentland Firth. Much of the coastline comprises of hard rock geology with sand beaches confined to embayments and sheltered regions (Xodus Group, 2019a). Large areas of mobile sand exist offshore, however, in the energetic channels and nearshore regions, the substrate is generally swept bedrock or boulders and cobbles (Xodus Group, 2019a).

The littoral processes acting on the bays and beach areas along this stretch of coastline between Duncansby Head and Cape Wrath are highly dependent on the solid geology outcropping the coastline with the majority of the beaches (including Murkle Bay) comprising a pocket beach type constrained between two rocky headlands (Ramsay and Brampton, 2000). Each of these bays can be considered independent of one another with little or no interaction of littoral sediments between them. There is little sand within the subtidal areas of Rackwick and Murkle Bay due to the strong tidal currents that exist. The sandy beach at Dunnet (and most likely Murkle Bay) has formed from a plentiful supply of glacial deposits offshore of the bay, although the present-day supply is limited with very little sediment loss (Ramsay and Brampton, 2000).

At Rackwick Bay, there is little evidence of fluvio-glacial deposits, either onshore or around the immediate nearshore zone with such deposits restricted to the valley behind (Ramsay and Brampton 2000). Therefore, offshore or fluvial deposits are unlikely to have provided any significant source of beach material here. Furthermore, although the western coastline of the Orkney Islands are subjected to ongoing marine erosion, the supply of fresh sediment to the beach areas is limited (Ramsay and Brampton, 2000).

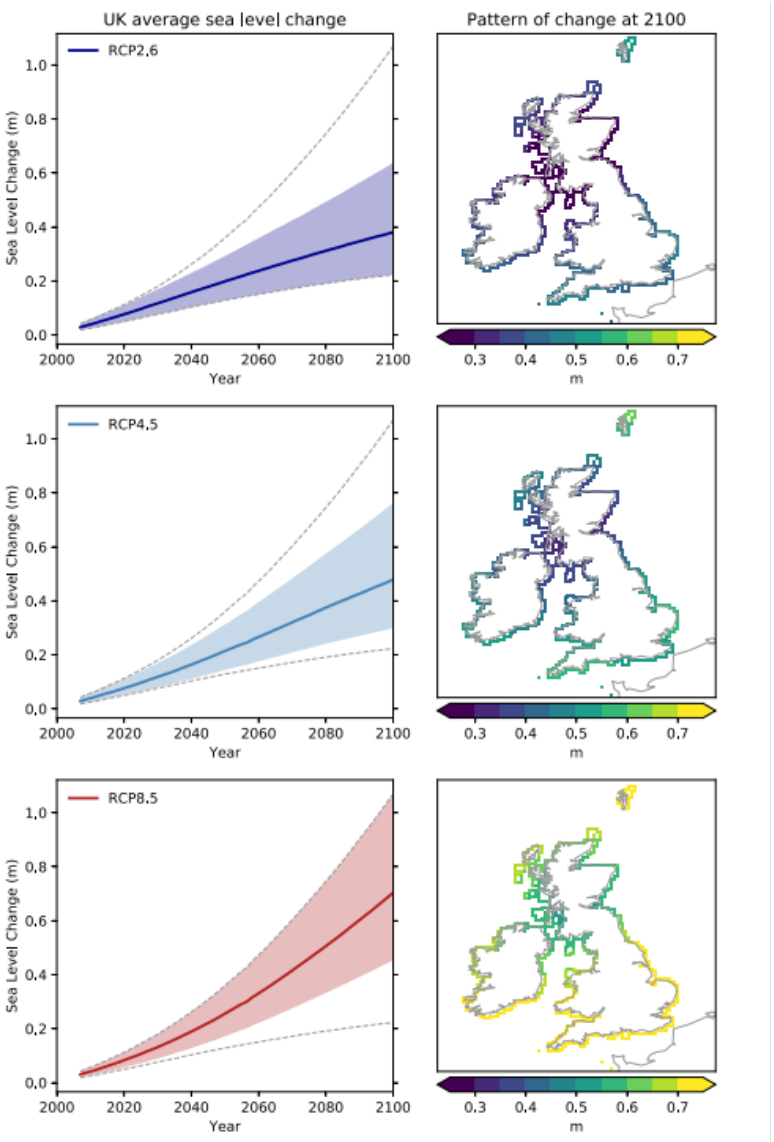
The tidal currents to the east of the installation corridor, i.e. between Dunnet Head and Duncansby Head are more complex and energetic, reaching speeds of up to 5 m/s in places, with large eddies forming in the lee of islands and outcrops, i.e. Stroma and the Pentland Skerries (Ramsay and Brampton, 2000). These currents do not affect the coastal processes in the surf zone: however, eddies can create tidal currents closer to the shore. A relatively weak net easterly residual flow occurs along the coastal regions in this area (Ramsay and Brampton, 2000). With limited supply and loss of material, there is very little longshore transport with the plan shapes of these pocket beaches dominated by swell wave conditions.

With the anticipated onset of climate change, sea levels are predicted to change around UK, which is likely to result in coastal flooding/erosion. The UK Climate Projections (UKCP18) project presents a new set of sea level projections, rooted in the climate models and methods from the IPCC AR5, which includes projections for a range of climate phenomena (temperature, rainfall, sea levels, etc.) under different emission scenarios. The study found that sea level rise will occur for all emission scenarios and at all locations around the UK, with possible changes in tidal characteristics and waves. Due to the uncertainty in future sea levels, a number of different scenarios exist (Palmer *et al.*, 2018). The UKCP18 sea level projections are consistently larger than in the previous set of UK climate projections, UKCP09, for similar emissions scenarios. However, UKCP18 also includes a lower emissions scenario that assumes more mitigation. The amount of sea level rise depends on the location around the UK and increases with higher emissions scenarios. Based on exploratory results to 2300, sea levels continue to increase beyond 2100 even with large reductions in greenhouse gas emissions. Sea level rise over the coming centuries may affect tidal characteristics substantially (including tidal range). However, the atmospheric contribution to storm surges is unlikely to change. Extreme sea levels will

increase due to the rise in mean sea level. However, the estimates presented suggest no additional change due to the atmospheric contribution to extreme sea level.

When combined with local information on sea defences and coastline structure, the sea level and storm surge projections enable vulnerability assessments along the UK coastline to be made. The UKCP18 sea level projections of future changes in sea water level around the UK coastline are calculated on a 12 km grid around the coastline. These are provided in Figure 3-2 below.

Figure 3-2 Three emissions scenarios against the relative sea level rise in the UK and Ireland, with further detailed (Palmer *et al*, 2018)

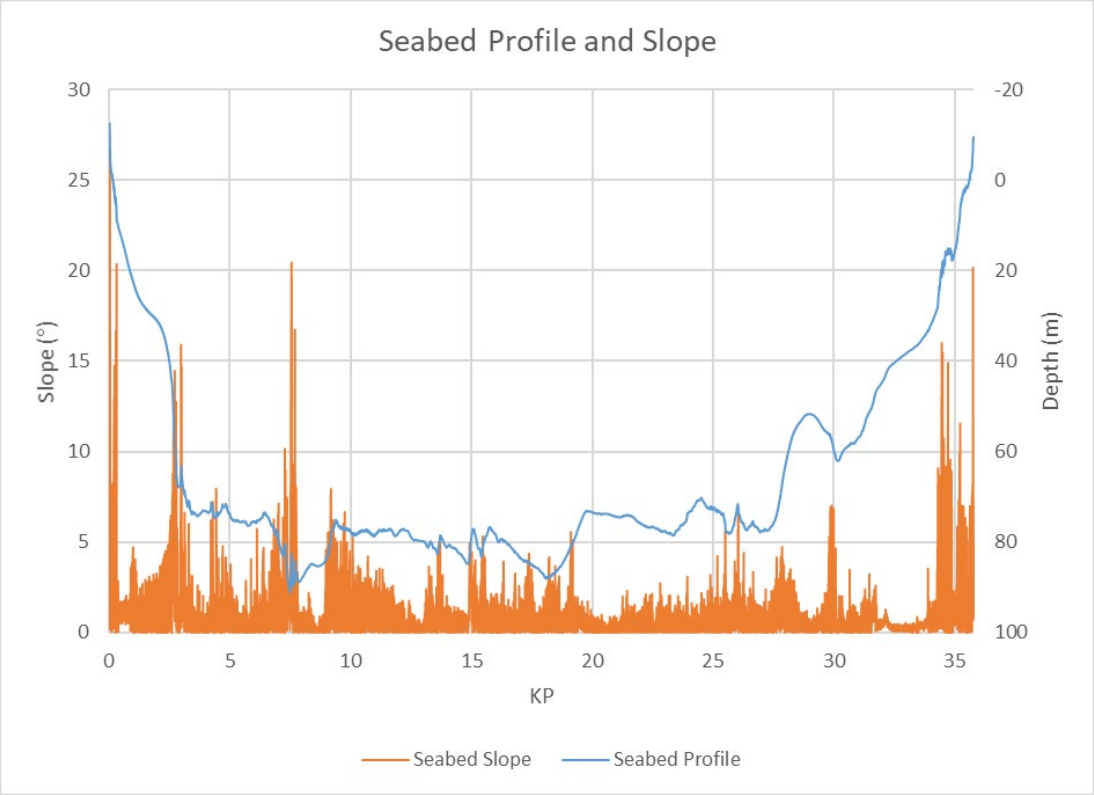


3.3.3 Bathymetry, geology, seabed sediments and features

3.3.3.1 Bathymetry

Route survey results (Figure 3-3, (MMT, 2019a)) show a general U-shaped profile, steeper on the north side than to the south. In the central part of the route depths vary between approximately 75m and 90m, the deeper portions forming shallow V shaped troughs, the most notable of which are centred on KP 7.5 and KP 18, with one example on the southern slope at KP 30. These could have been formed by sub-glacial water courses or may be post-glacial features.

Figure 3-3 Seabed profile and slope (MMT 2019b)



Note: KP 0 is at Rackwick Bay landfall

3.3.3.2 Underlying geology

The bedrock of the installation corridor is Devonian Old Red Sandstone. This bedrock is overlain by Diamicton till, which is a Quaternary glacial deposit composed nixed particles ranging from clays to boulders (MMT, 2019b).

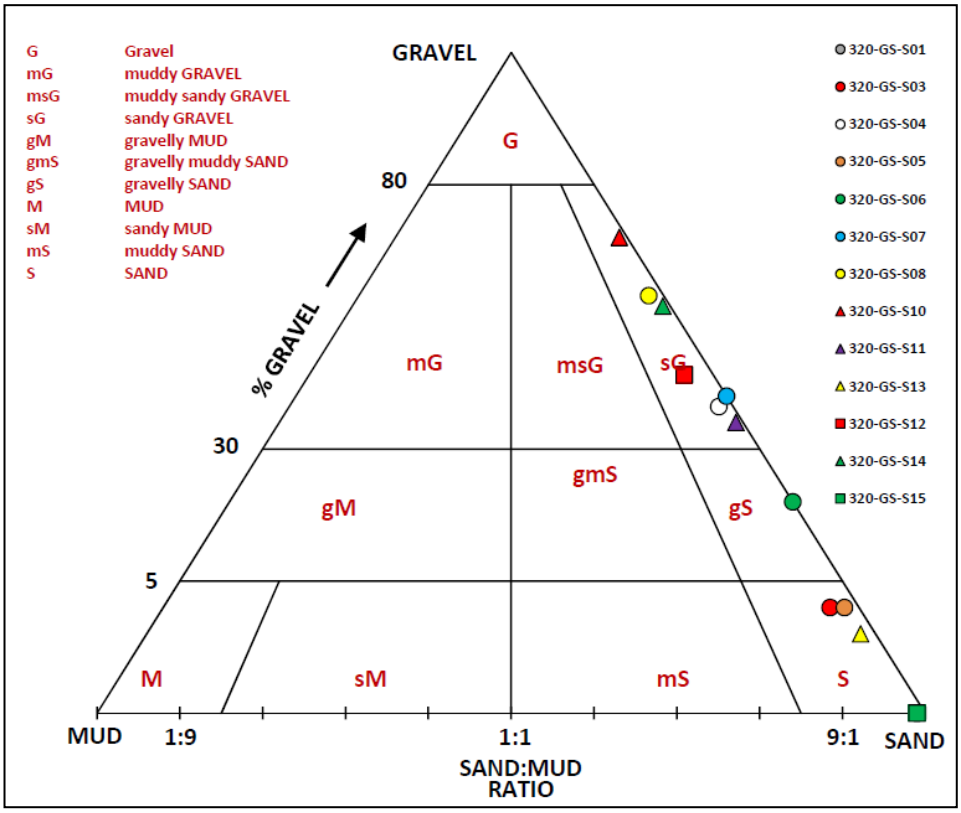
3.3.3.3 Seabed sediments and features

The sediments in the vicinity of the installation corridor are composed predominantly of gravelly sand with sandy gravel present in the central portion of the route. Fines (silts and clays) formed a small fraction (4% or less) of the surficial deposits, consistent with the high energy environment (Figure 3-4).

Sand is present at the Rackwick Bay (KP 0) landfall, although the majority of the intertidal zone is comprised of sandstone cobbles and boulders. The Murkle Bay (KP 35.79) landfall the intertidal zone comprises of coarse sand, interspersed with pebbles, cobbles and areas of finer sand (Envision, 2019).

Bedrock outcrops were observed close to the landfall sites (KP 0 to KP 0.311 and KP34.291 to KP35.789) (MMT, 2019b). Diamicton, which underlies the central section of route) is exposed at numerous points between KP 2.835 and KP 30.250. It is likely that the degree and sites of exposure vary as a result of movement of the surficial deposits. Where the diamicton has eroded the residual deposits consist of pebbles and boulders, which have the potential to constitute stony reef structures.

Figure 3-4 Seabed sediment classification along installation corridor (MMT, 2019)



3.3.4 Water and sediment quality

Water and sediment quality at any particular location on the UK continental shelf is the result of a combination of source, transport and removal mechanisms for the individual chemical species under consideration. There are many routes by which substances with the potential to affect water quality enter the Pentland Firth, both through natural processes and as a result of anthropogenic inputs over the past few decades (UKMMAS, 2010).

3.3.4.1 Water quality

The EU Marine Strategy Framework Directive (MSFD) adopted in 2008 requires that the UK takes "the necessary measures to achieve or maintain "Good Environmental Status" in the marine environment by the year 2020 at the latest" (UKMMAS, 2010). The report concludes that good progress has been made towards this with significant contamination restricted to industrial estuaries and coastal areas.

The requirement for monitoring UK rivers and near-shore waters has increased as a result of the implementation of the EU Water Framework Directive (WFD), with more stringent criteria for water quality in rivers applied. River Basin Management Plans (RBMP) are being developed as a requirement of the WFD and report on the 'ecological status' of surface and ground water in coastal waters (out to 1 nm from the baseline) and 'chemical status' of surface and ground waters in territorial waters (out to 12 nm from the baseline). The Scottish Environment Protection Agency (SEPA) is responsible for producing RBMPs for the Scotland and the Solway Tweed River Basin Districts. The MSFD assessments are carried out at subregion level, i.e. the Greater North Sea and the Celtic Seas. The MSFD and WFD overlap in coastal waters as the WFD extends to three nm seaward from the Scottish territorial baseline. Any proposed development within these waters must have regards to the WFD and ensure that all surface water bodies achieve 'Good Ecological Status (GES)' and that there is no deterioration in the status.

The installation corridor passes through three WFD waterbodies: the Dunnet Bay waterbody at the Murkle Bay landfall (ID: 200217) with an overall waterbody status of Good; the Strathy Point to Dunnet Head waterbody (ID: 200224) just beyond Murkle Bay out to approximately 5nm with an overall waterbody status of Good; and the Tor Ness to Breck Ness waterbody at the Rackwick Bay landfall (ID: 200231) with an overall waterbody status of High (Atkins Geospatial, 2019).

The two closest designated bathing waters to the installation corridor are at Dunnet Bay and Thurso, approximately 4km and 5km to the east and west of the Murkle Bay landfall respectively.

As previously mentioned, the north coast of Scotland is influenced by the North Atlantic Drift current. The chemical composition of the water in the vicinity of the installation corridor is expected to be similar to that recorded for typical unpolluted coastal/offshore water on the continental shelf to the west of Scotland.

3.3.4.2 Suspended sediments

Particulate matter in the water column is composed of organic and inorganic fractions. Organic fractions are predominantly the result of biological activity in the water column and is primarily composed of planktonic material, including bacteria. This will not be influenced by any activities associated with the cable laying and will, therefore, not be discussed further. Inorganic suspended particulate material (iSPM) is derived from fluvial inputs (derived from both erosion in the river catchments and from chemical reactions in the estuarine zone), fallout from the atmosphere and coastal erosion combined with re-suspension of existing sediments and chemical reactions in the water column. As a result, iSPM loads vary widely, generally increasing with proximity to the coastline (UKMAAS, 2010). These are also highly dependent on energy inputs (i.e. storms).

Available measurements of iSPM, whether from vessels or by satellite imagery, are largely restricted to near-surface data obtained under non-storm / cloud free conditions and are limited for the Pentland Firth. Average measured iSPM for the period 1998-2015 within the Pentland Firth is low (approximately 0-1mg/l) (CEFAS Report, 2016). However, iSPM concentrations vary widely with season, wave action, tidal conditions and freshwater discharges. As a result, water clarity and seabed and water column light intensity are also highly variable.

3.3.4.3 Seabed quality

Sediment contamination can result from natural and anthropogenic inputs and can be harmful to biota. The level of both organic and inorganic contaminants in sediments is largely related to the proportion of fine material present, as a result of deposition processes. In a predominantly coarse sediment area, such as Pentland Firth, contamination levels are expected to be low. However, operations at Dounreay Nuclear Power Development Establishment, approximately 16km west of the closest approach of the installation corridor, resulted in the discharge of radioactive (predominantly, sand sized, particles). Survey data and modelling (PRAGD, 2012) suggests that significant (i.e. potentially hazardous and persistent) contaminated particles are unlikely to be found beyond 2km from the Dounreay outfall. As a result. they are not expected to be present at the installation corridor. As detailed in Section 9 of this ESI, radioactive particles have been reported on the foreshore at Murkle Bay; however, these were classified as minor (i.e. not considered to represent a risk).

3.4 Potential impacts and zones of influence

Table 3-2 Potential impacts and zone of influence

Activity	Impact	Receiving environment	Zone of influence	Source of Information
Trenching	Physical change (to another substratum type)	Superficial sediments, cover depth >10mm	20m	Estimate, based on sediment properties settling velocity of particles and currents
Trenching/cable in place	Abrasion/ disturbance at the surface of the substratum	Superficial sediments,	<5m	Based on cables already in place and scientific judgement
Cable in place	Water flow (tidal current) changes locally	Oceanography	Not sensitive	Scientific judgement
Cable in place	Seabed movement	Flow induced features (e.g. sandwaves)	<5m	Scientific judgement
Trenching	Changes in suspended solids	Water quality	300m	Estimate, based on sediment properties, settling velocity of particles and currents – likely to be a considerable over-estimate given conditions in the area. More likely to be undetectable
Trenching	Penetration and/or disturbance of the substrate below the surface of the seabed including abrasion	Quaternary deposits	Not sensitive	Scientific judgement

3.4.2 Mitigation

Impacts on the physical environment during construction can be mitigated by minimising the areas selected for cable burial.

3.4.3 Impact assessment

As described in Section 3.3.3.3 the sediments of the Pentland Firth are typical of highly energetic conditions, with a low percentage of fines (silt and clay). It is likely that fine material is derived from local erosion of the underlying glacial deposits and is transitory in nature.

Following disturbance, e.g. by jetting to bury exposed cable only fine material is expected to remain in the water column for more than a few minutes (Table 3-3).

Table 3-3 shows that:

- Only gravel and (to a lesser extent) sand are likely to form an appreciable depth of deposits, but this is generally likely to be limited to within 20m of the trench, even in extreme current conditions.
- Silts could be transported a considerable distance before deposition; however, significant concentrations of suspended material are limited to approximately 300m from the jetting site as a result of dilution in the water column.

- Silts could remain in the water column in excess of 6 hours; however, during this period currents would be expected to range between <0.5m/s (at slack water) and between 2.5 and 5m/s during full tidal flow, with additional mixing due to wave action. Under the generally turbulent conditions within Pentland Firth and the surrounding waters, particulates are expected to rapidly disperse through the water column. Thus, even under calm conditions the plume is expected to be transient.

Table 3-3 Sediment settling and zone of influence following disturbance

Fraction (maximum % in sediment)	Mean settling velocity	Mean Settling time	Mean distance (m) before settling, at current speed shown:			Mean deposit depth (mm) at current speed shown:			Zone of influence
	ms-1	s	0.5m/s	2.5m/s	5m/s	0.5m/s	2.5m/s	5m/s	m
Silt (4%)	0.0001	20300	5060	25300	50640	0.012	0.002	0.001	300* (water column)
Sand (95%)	0.028	71	18	89	177	16	3.2	1.6	20 (deposition)
Gravel (70%)	0.25	8	2	10	20	106	21	10.6	

* Zone of influence for silt based on BERR 2008

Assumptions:

Trench volume is 1.5m^3 per metre, based on a worst-case trench zone 1.5m wide by 1m deep

100% of silt enters water column, assuming fine material is mobilised by jetting

20% of sand and gravel enters water column, representing a reasonable worst case

4. BENTHIC AND INTERTIDAL ECOLOGY

4.1 Introduction

This section describes the baseline environment for the intertidal and subtidal benthic ecology within the installation corridor and identifies potential impacts associated with the installation of the replacement cable on the subtidal benthic and intertidal environment. Potential impacts on species communities and habitats from the proposed installation activities are assessed, along with the mitigation and management measures that will be utilised to remove or reduce these impacts.

The proposed installation corridor refers to the cable route in the Pentland Firth and includes the subtidal environment between Hoy, Orkney and mainland Scotland as well as the intertidal environments up to the mean high-water springs (MHWS) mark at both landing sites at Rackwick Bay in Hoy, Orkney and Murkle Bay, Caithness (Mainland).

The Project includes the following phases, both of which are assessed within this Section:

- Installation;
- Operation

Where relevant, any limitations related to the baseline conditions, data sources or scientific understanding / interpretation within the process of assessing the effects have been highlighted.

4.2 Data sources

Baseline conditions have been partly established by undertaking a desktop review of published information and through consultation with relevant bodies. The data sources used to inform the baseline description and assessment include but are not limited to the following:

- Marine Survey Report (MMT 2019a)
- Environmental Survey Report (MMT 2019b)
- Intertidal Survey Report (Envision 2019)

4.3 Site characteristics

4.3.1 Intertidal areas

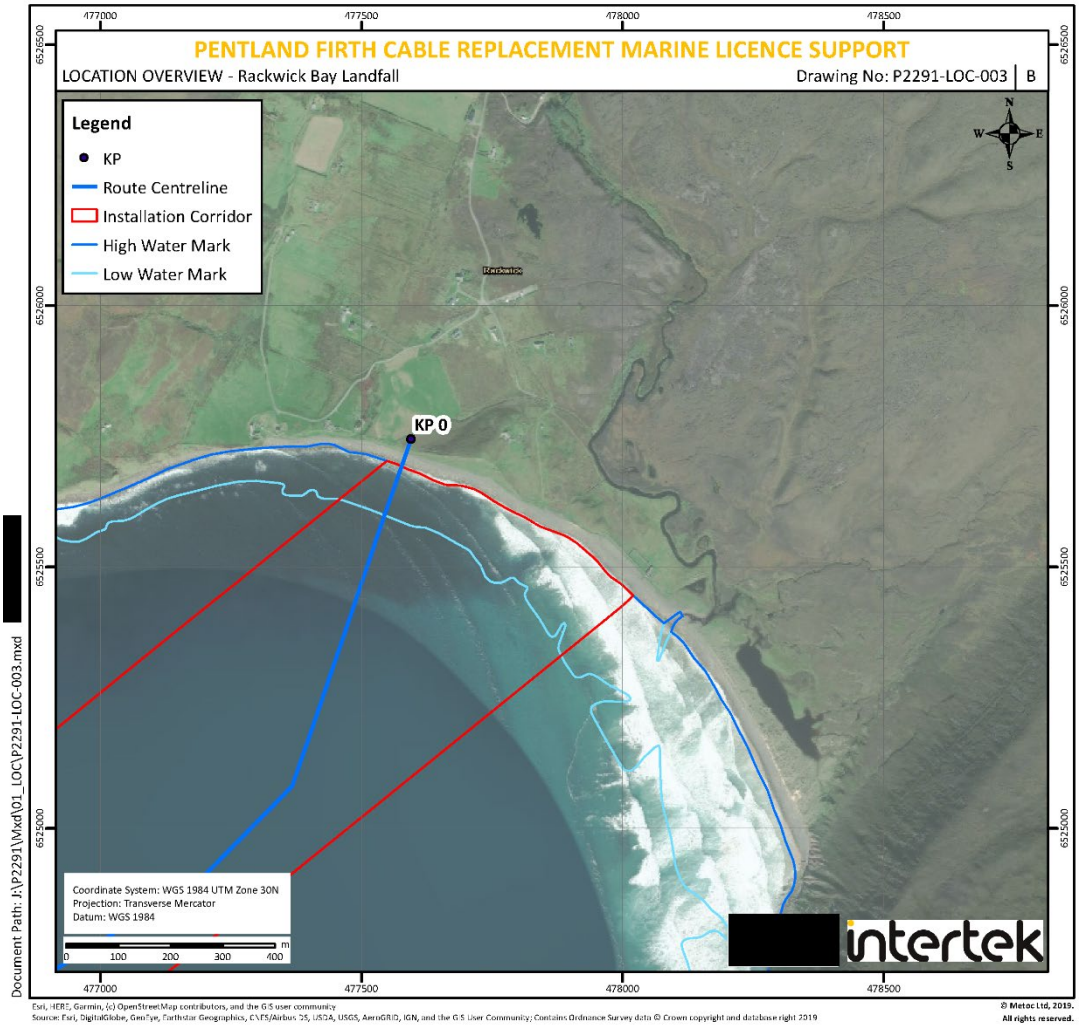
The intertidal survey data, collected by a combination of core samples (three samples were taken at each landfall site) and camera photographs, have been used to inform on the presence of intertidal habitats.

4.3.1.1 Rackwick Bay (Hoy)

The baseline intertidal ecology at Rackwick Bay in Hoy, Orkney is detailed further in the intertidal survey report (Envision 2019). An aerial image of the beach is shown below in Figure 4-1.

The existing cable runs ashore at Rackwick, Hoy, a highly exposed bay situated between high cliffs to the east and west, the majority of which is comprised of sandstone cobbles and boulders.

Figure 4-1 Aerial image of Rackwick Bay (Hoy) (Drawing Number: P2291-LOC-003-A)



The habitat map produced from the intertidal survey is provided as Figure 4-2.

The uppershore at Rackwick Bay (Hoy) consists predominantly of barren cobbles and boulders at a fairly steep gradient. The midshore area consists of a thin band of cobbles and boulders with *Enteromorpha* and ephemeral green seaweeds. Concomitant with the flattening of the beach profile, towards the waterline, a large zone of fucoid and underboulder communities was identified. This zone was characterised by barnacles (*Semibalanus balanoides*), limpets (*Patella vulgata*) and whelks (*Nucella lapillus*) on the uppermost and vertical surfaces. In addition, fucoids, dark green hair algae (*Cladophora*) and other robust seaweeds interspersed with ephemeral green and coralline algae in small rockpools. Other molluscs observed included periwinkles (*Littorina saxatilis*) and top snails (*Gibbula spp*.).

High densities of anemones and the encrusting bread crumb sponge (*Halicohondria panicea*) were observed amongst the crevices and lower surfaces of the boulders. *Fucus vesiculosus* was observed in the range from the mid- to lower-shore (often lacking the characteristic twin air bladders, indicative of environmental stress i.e. wave exposure). The lower shore is also inhabited by *F. serratus*, while *Himanthalia elongata* is present at the low water mark and extending further into the infralittoral together with kelp communities.

A total of eight biotopes were identified within the intertidal survey area at Rackwick as presented in Table 4-1 and shown in Figures 4-3 and 4-4.

Table 4-1 Key biotopes identified at Rackwick Bay (Hoy)

MNCR Code	EUNIS code	Biotope/Habitat description (MNCR Classification)
LS.LCS.Sh.BarSh	A2.111	Littoral coarse sediment
LS.LSa.St	A2.21	Strandline
LR.FLR.Eph	A2.82	Ephemeral green or red seaweed communities (freshwater or sand-influenced)
LR.MLR.BF.FvesB	A1.213	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
LR.FLR.Rkp.Cor	A1.4111	Coralline crust-dominated shallow eulittoral rockpools
LR.MLR.BF.Fser.Bo	A1.2142	*Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders
LR.HLR.FR.Him	A1.123	*Himanthalia elongata* and red seaweeds on exposed to moderately exposed lower eulittoral rock
IR.HIR.KFaR	A3.11	Kelp with cushion fauna and/or foliose red seaweeds

Notes:
MNCR = Marine Nature Conservation Review (JNCC)
EUNIS = European Nature Information System

Figure 4-2 Distribution of intertidal habitats at Rackwick Bay (Drawing Number: P2291-HAB-002-A)

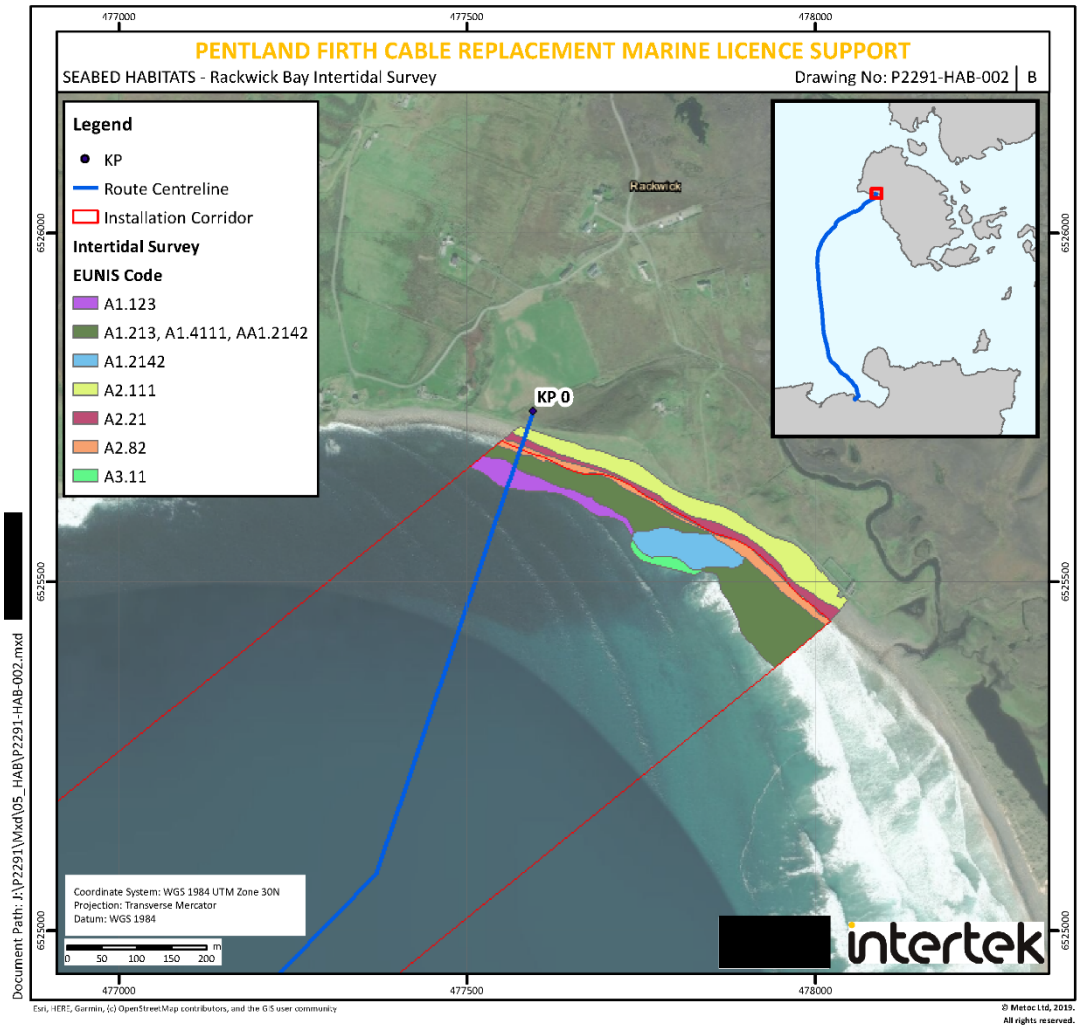


Figure 4-3 Habitat photographs from Rackwick Bay (Hoy) showing; (a) Coralline crust-dominated shallow eulittoral rockpools, MNCR: LR.FLR.Rkp.Cor and (b) *Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock, MNCR: LR.MLR.BF.FvesB.

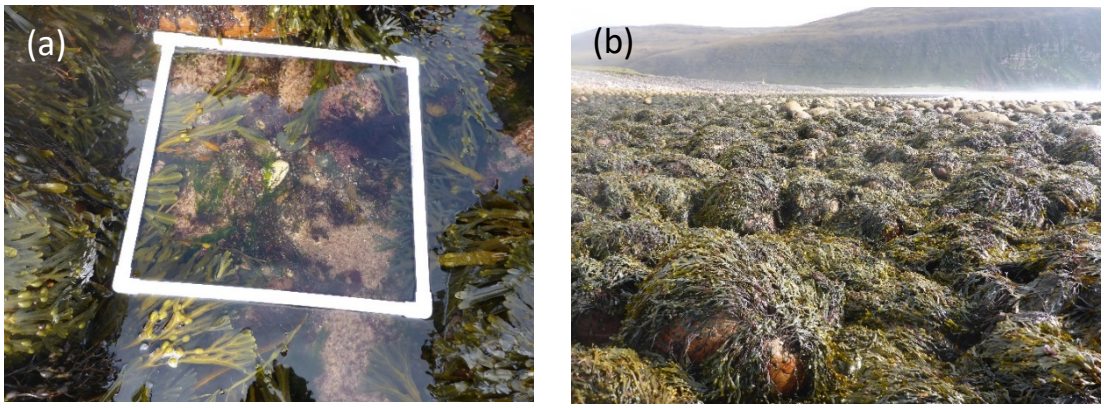


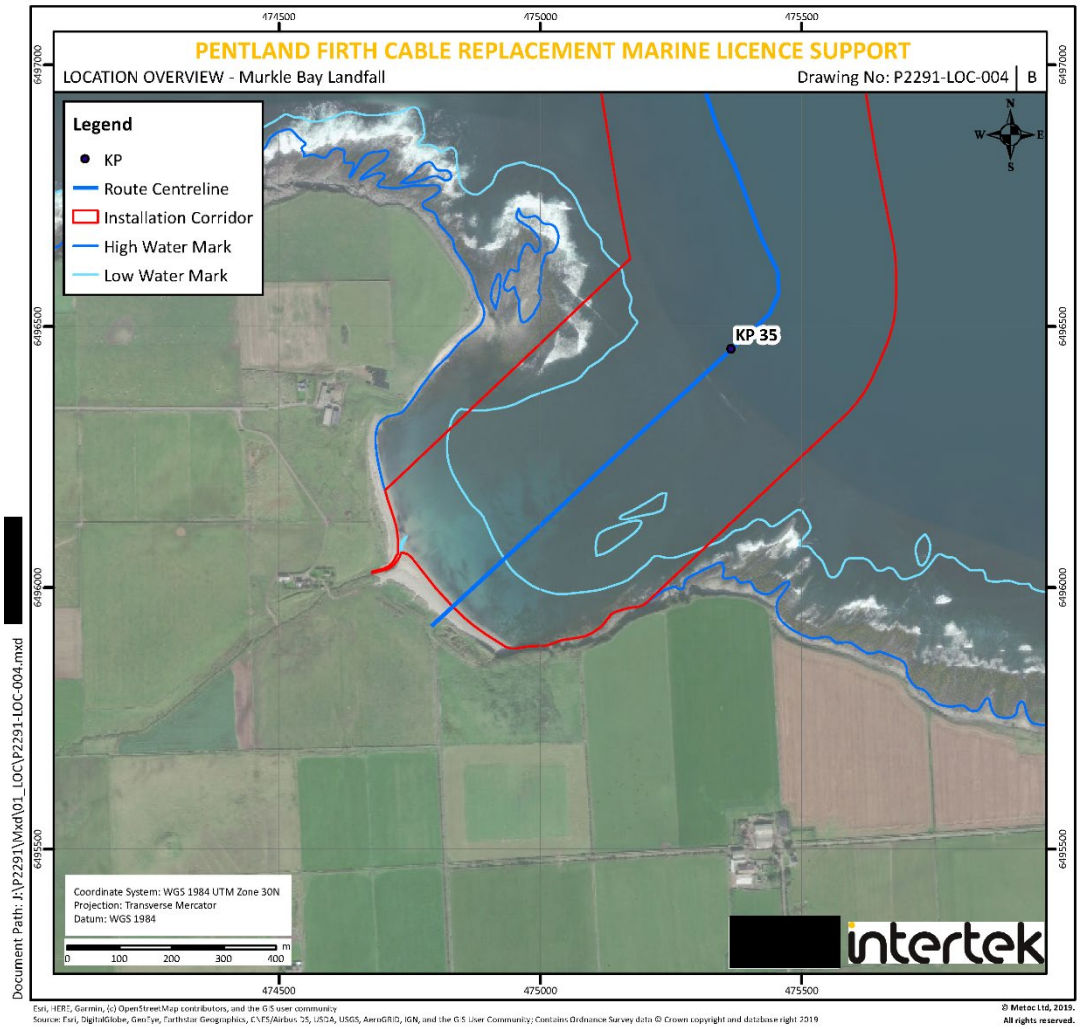
Figure 4-4 Habitat photographs from Rackwick Bay (Hoy) showing; (a) Kelp with cushion fauna and/or foliose red seaweeds, MNCR: IR.HIR.KFaR and (b) *Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders, MNCR: LR.MLR.BF.Fser.Bo.

4.3.1.2 Murkle Bay (Mainland Scotland)

The baseline intertidal ecology at Murkle Bay, Caithness is detailed further in the intertidal survey report (Envision 2019). An aerial image of the beach is shown below in Figure 4-5.

The habitat map produced from the intertidal survey is provided as Figure 4-6

Figure 4-5 Aerial image of Murkle Bay, Caithness (Drawing Number: P2291-LOC-004-A)



The landfall at Murkle Bay is situated on a beach within an exposed to moderately exposed bay. Murkle Bay consists of coarse sand, pebbles/cobbles, and areas of finer and rippled sand.

The upper shore consists of mobile coarse sand with some overlying pebbles, followed by a band of pebbles and cobbles on sand with ephemeral green seaweeds. The midshore is generally composed of finer sand, occasional ripples, with polychaete worm casts. The lower shore consists of coarser mobile sand, with some patches of overlying pebbles, and occasional polychaete casts and Tellin shells. A freshwater source empties on to the beach, its path varying with beach profile, at the time of survey the flow was approximately central (i.e. between transects three and four). The existing cable at Murkle Bay is visible under the water at low tide, emerging from the sand between two marker points (submerged metal structures).

To the north of the beach, an area of lower shore rock extends within the cable route area. Here, the shoreline extends from small grassy banks with coastal defences and vertical rock faces, through a thin stretch of coarse sand and pebbles to gently sloping sedimentary rock (cobbles and boulders) interspersed with areas of shingle, which persist to the lower shore. A mid-shore shingle bar is elevated with boulder communities, consisting of black, yellow and grey lichens. Towards the waterline, barnacles, limpets, periwinkles and whelks inhabit the rocky shore, interspersed with rockpools supporting ephemeral and green seaweeds, and abundant growth of algae, including *Pelvetia*

canaliculata, fucoids *Fucus spiralis*, *Fucus vesiculosus*, and, *Fucus serratus* and the thongweed *Himanthalia elongata* (nearer the water).

South of the beach is another rocky shore with small vertical cliff faces at the upper shore. At the transition zone between beach and rock is an area of freshwater influence, mediating bands of green/brown/orange gelatinous algae on vertical cliff faces and ephemeral green algae on bedrock below. The bedrock is interspersed with sandy patches with sand-binding red seaweed algae (*Rhodothamniella*) and fucoids towards the lower shore. The main rocky shore comprised of bedrock, boulders and cobbles with successional zonation

The main rocky shore was comprised of bedrock, boulders and some cobbles, with a succession of lichens, fucoids, barnacles and limpets. White lichens were seen on the rock in the spray zone, along with moss, vegetation and grass amongst the cobbles, before a strandline which was observed on boulders. *Verrucaria maura* was then observed on bedrock with white and yellow lichens, which then moved to an area of *Pelvetia canaliculata* further down the shore. Whilst elevated areas of bedrock maintained a growth of barnacles, limpets and *V. maura*, fucoid algae were also present, with *F. vesiculosus* and then *F. serratus* (with an understory of branching and flat red algae) appearing nearer to the waterline.

A total of 17 biotopes were identified within the intertidal survey area at Murkle Bay as presented in Table 4-2 and shown in Figures 4-7 to 4-10.

Table 4-2 Key habitats identified at Murkle Bay, Caithness (Mainland)

MNCR Code	EUNIS code	Biotope/Habitat description (MNCR Classification)
LS.LSa.MoSa	A2.22	Barren or amphipod-dominated mobile sand shores
LS.LSa.St	A2.21	Strandline
LS.LSa.FiSa.Po	A2.231	Polychaetes in littoral fine sand
LR.FLR.Eph	A2.82 / A1.45	Ephemeral green or red seaweed communities (freshwater or sand-influenced)
LR.FLR.Lic	B3.11	Lichens or small green algae on supralittoral and littoral fringe rock
LR.FLR.Lic.Ver.B	B3.1131	*Verrucaria maura* and sparse barnacles on exposed littoral fringe rock
LR.FLR.Lic.Ver.Ver	B3.1132	*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock
LR.FLR.Rkp.G	A1.421	*Green seaweeds* (Enteromorpha spp. and Cladophora spp.) in shallow upper shore rockpools
LR.HLR.MusB.Sem	A1.113	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
LR.HLR.FR.Him	A1.123	*Himanthalia elongata* and red seaweeds on exposed to moderately exposed lower eulittoral rock
LR.MLR.BF.FspiB	A1.212	*Fucus spiralis* on exposed to moderately exposed upper eulittoral rock
LR.MLR.BF.FvesB	A1.213	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
LR.MLR.BF.Fser	A1.214	*Fucus serratus* on moderately exposed lower eulittoral rock
LR.MLR.BF.Rho	A1.215	*Rhodothamniella floridula* on sand-scoured lower eulittoral rock

MNCR Code	EUNIS code	Biotope/Habitat description (MNCR Classification)
LR.MLR.BF.PelB	A1.211	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock
LR.LLR.F.Asc	A1.3141	*Ascophyllum nodosum* on full salinity mid eulittoral rock
LR.FLR.CvOv.ChrHap	A1.441	Chrysophyceae and Haptophyceae on vertical upper littoral fringe soft rock

Notes:

MNCR = Marine Nature Conservation Review (JNCC)

EUNIS = European Nature Information System

Figure 4-6 Distribution of intertidal habitats at Murkle Bay, Caithness (Drawing Number: P2291-HAB-003-A)

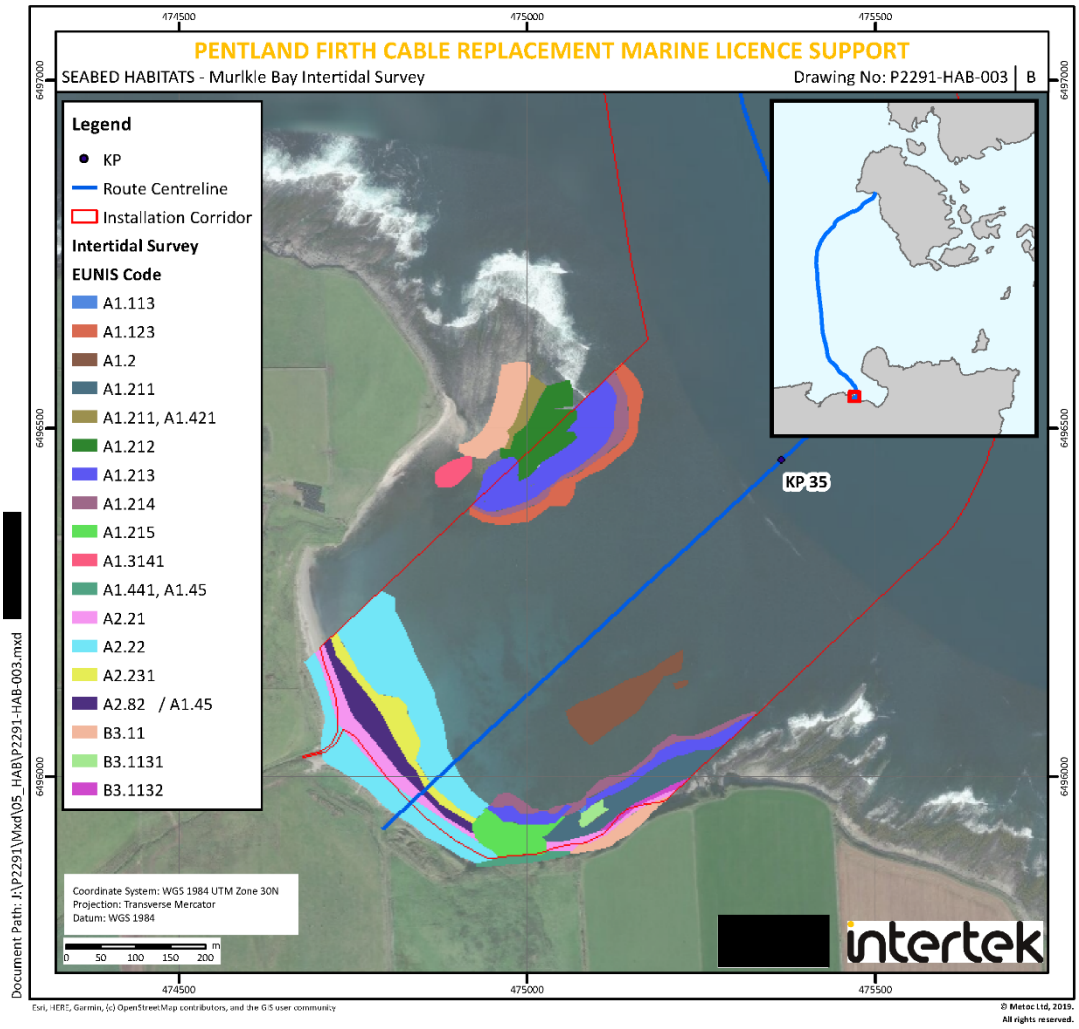


Figure 4-7 Habitat photographs from Murkle Bay, Caithness showing; (a) Strandline, MNCR: LS.LSa.St and (b) Ephemeral green or red seaweed communities (freshwater or sand-influenced), MNCR: LR.FLR.Eph.

Figure 4-8 Habitat photographs from Murkle Bay, Caithness showing; (a) Green seaweeds (Enteromorpha spp. and Cladophora spp.) in shallow upper shore rockpools, MNCR: LR.FLR.Rkp.G and (b) *Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock, MNCR: LR.HLR.MusB.Sem.

Figure 4-9 Habitat photographs from Murkle Bay, Caithness showing; (a) *Himanthalia elongata* and red seaweeds on exposed to moderately exposed lower eulittoral rock, MNCR: LR.HLR.FR.Him and (b) *Fucus spiralis* on exposed to moderately exposed upper eulittoral rock, MNCR: LR.MLR.BF.FspiB.

Figure 4-10 Habitat photographs from Murkle Bay, Caithness showing; (a) *Fucus serratus* on moderately exposed lower eulittoral rock, MNCR: LR.MLR.BF.Fser and (b) *Ascophyllum nodosum* on full salinity mid eulittoral rock, MNCR: LR.LLR.F.Asc.

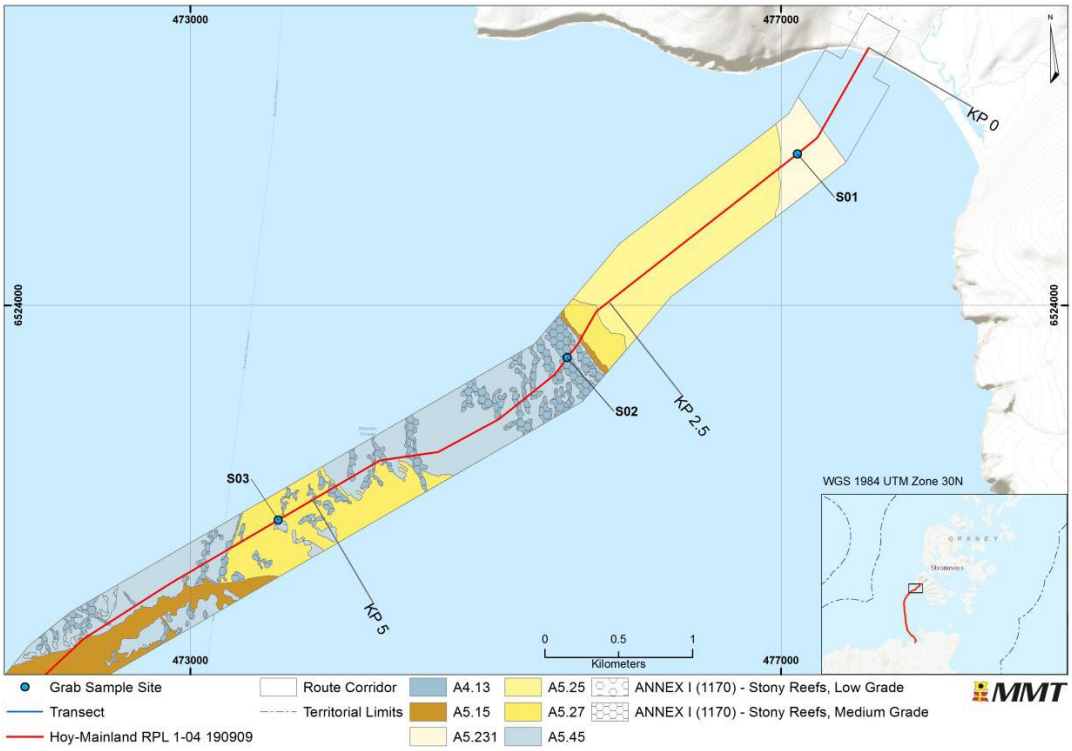
4.3.2 Subtidal area

A total of 14 habitats were identified within the survey corridor between Rackwick Bay, Orkney and Murkle Bay, Scotland. The subtidal habitats were identified from photograph, video and infaunal grab samples, and are mapped and presented in Figures 4-11 to 4-16.

The initial sections of the survey corridor, from KP 0.636 to KP 2.814, were dominated by rippled sands. The seabed from KP 0.638 was classified as **A5.231** - Infralittoral mobile clean sand with sparse fauna, to KP 1.031 from where a long section of **A5.25** - Circalittoral fine sand dominated the seabed to KP 2.592. The route between KP 2.592 to KP 2.814 was classified as **A5.27** - Deep circalittoral sand. The grab sample S01 (KP 0.877; Figure 4-11) was scarce in terms of abundance and diversity and was dominated by the amphipod *Bathyporeia elegans* and the annelid *Scolelepis bonnieri*.

A band (KP 2.814 and KP 2.835) between the large ripples of sand and sand waves and the following mixed sediments was classified as **A5.15** - Deep circalittoral coarse sediment.

Figure 4-11 Distribution of habitats between KP 0.6 and KP 7.1



From KP 2.835 southwards to KP 6.909 the seabed was very variable with a mixture of sediments, cobbles and boulders in sands and gravel. Areas of outcropping diamicton were scattered throughout the survey corridor. From KP 2.835 to KP 4.798 the seabed was classified as **A5.45** - Deep circalittoral mixed sediments with the outcropping diamicton features classified as **A4.13** - Mixed faunal turf communities on circalittoral rock based on the density of boulders. Associated fauna included *Echinus sp.*, *Flustra foliacea*, *Securiflustra securifrons*, *Tubularia sp.*, serpulid worms, *Crossaster papposus*, encrusting poriferans, hydrozoans, *Caryophyllia smithii,* and squat lobsters (grab sample S02; KP 2.980). One brown crab, *Cancer pagurus*, was identified in video footage.

Grab sample site S02 was classified as **A4.13** and assessed to meet the criteria of "Medium resemblance" to a stony reef (Irving, 2009) thus qualifying as an Annex I (1170) – Reefs as described within the Habitats Directive (EUR 28, 2013). The grading assessments from S02 were extrapolated, based on textural similarity and elevation, to the surrounding outcropping features.

From KP 4.798 to KP 5.658 the seabed was predominantly classified as **A5.27** - Deep circalittoral sand with scattered outcrops of diamicton classified as **A4.13**, as well as Annex I (1170) – Medium grade Stony Reefs. A few scattered areas within the surrounding **A5.45** habitats were classified as Annex I (1170) – Low grade Stony Reefs.

Grab sample site S03 (KP 5.271) comprised of sand with isolated patches of boulders and cobbles. Visible fauna was associated to the boulders and included serpulid worms, *Alcyonium digitatum*, and *F. foliacea*. The faunal sample was scarce in terms of species abundance and was dominated by annelids, bryozoan and molluscs. The molluscs were dominated by *Goodallia triangularis*, *Glycymeris glycymeris*, *Venus casina* and *Spisula elliptica*. The mollusc species identified in this sample were present throughout the majority of the grab samples taken within the installation corridor, in variable abundances.

Coarse sands and gravel with sand waves dominated the installation corridor between KP 5.658 and KP 13.812 and were classified as **A5.15** (Figure 4-12).

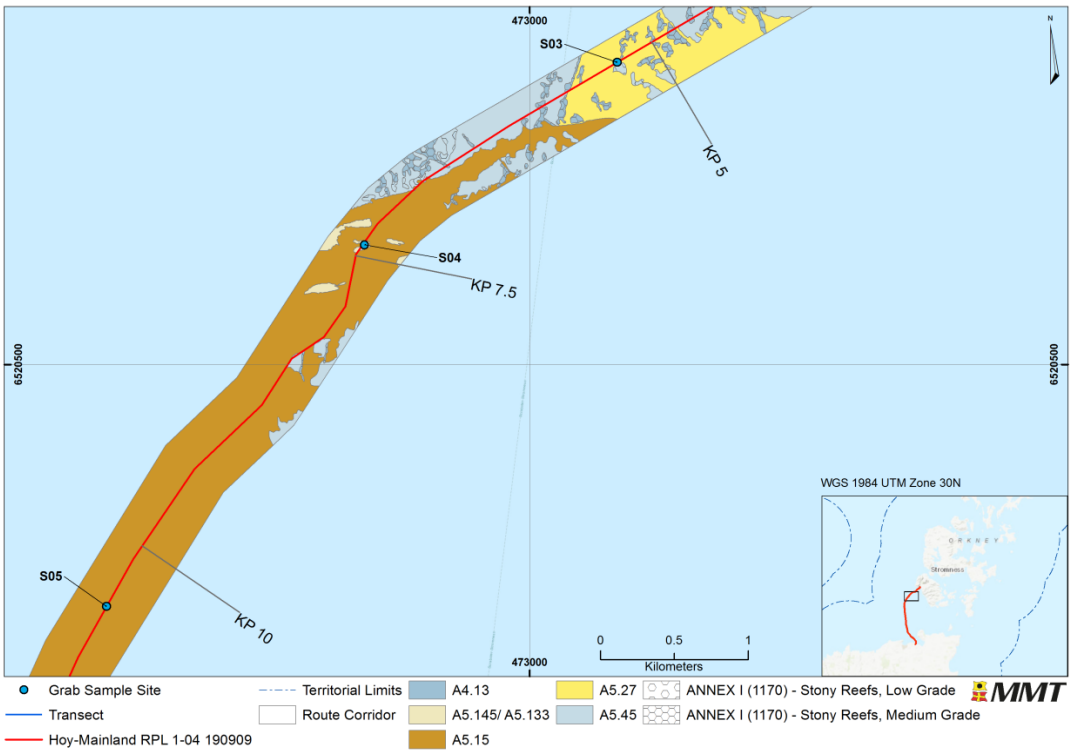
Patches of **A5.133** - *Moerella spp*. with venerid bivalves in infralittoral gravelly sand with an epibenthic overlay of **A5.145** - *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel was interpreted between KP 7.209 and KP 7.806.

Habitat **A5.145**/ **A5.133** (grab sample S04) was composed of different species of annelids, arthropods, molluscs, and echinoderms as well as *B. lanceolatum*. In terms of molluscs, the sample contained *Timoclea ovata*, *G. triangularis*, *G. glycymeris*, *Spisula sp.,* and *Asbjornsenia pygmaea.*

Gravelly sand (grab sample site S05; KP 10.480) (Figure 4-12) was dominated by the barnacle *Verruca stroemia*, the bivalve *G. triangularis* and nematodes and classified as **A5.15**.

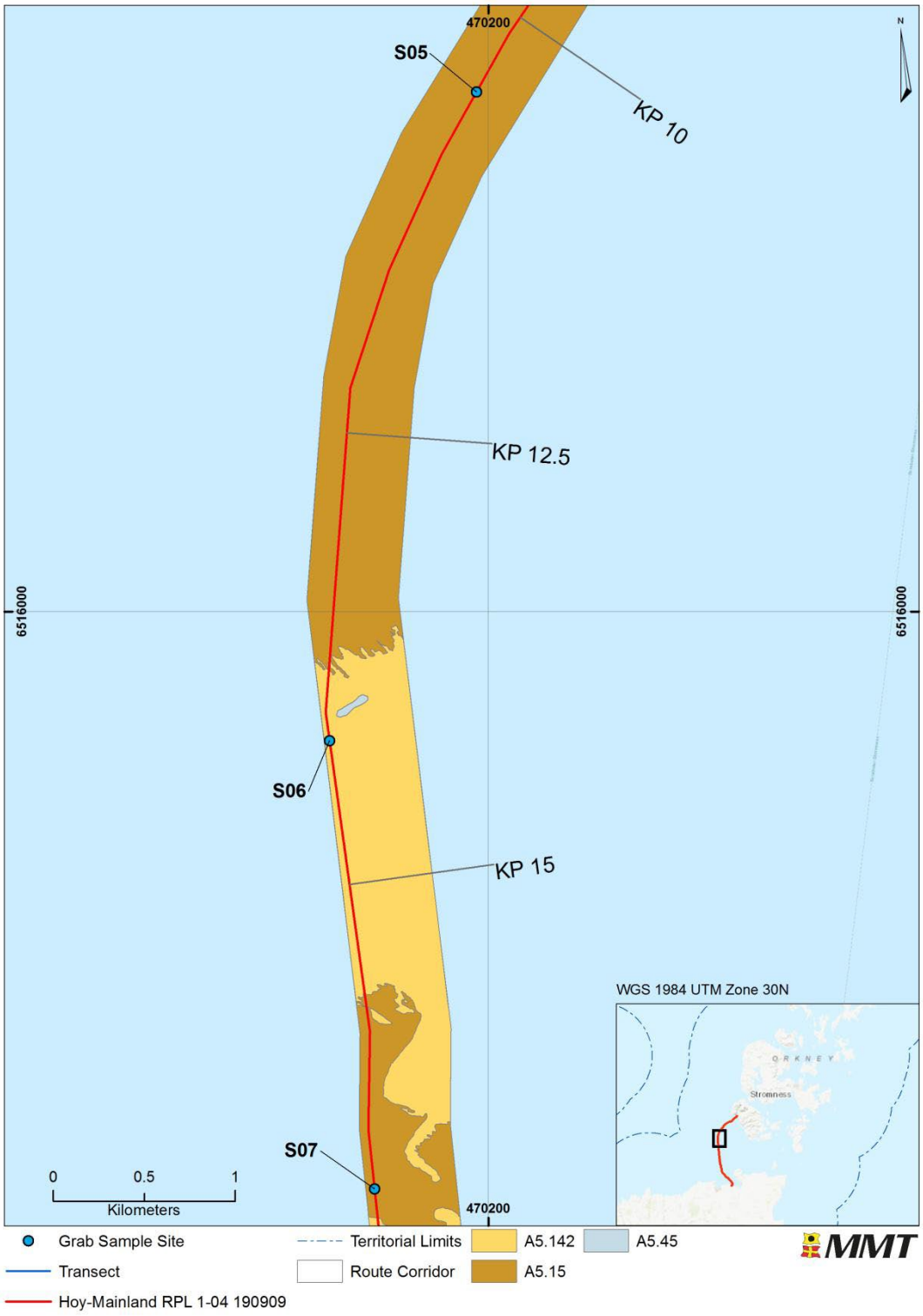
Between KP 13.812 and KP 19.735 the seabed alternated between sections classified as **A5.142** - *Mediomastus fragilis*, *Lumbrineris spp*. and venerid bivalves in circalittoral coarse sand or gravel and **A5.15**.

Figure 4-12 Distribution of habitats between KP 4.9 and KP 11.0



Grab sample site S06 (KP 14.205) (Figure 4-13) was comprised of gravelly coarse sand with extensive amounts of shell debris. Fauna included hydrozoans, barnacles, and the sea star *Henricia sp*. Faunal groups present included bryozoans, annelids, venerids, echinoderms, and arthropods, and was classified as **A5.142** - *Mediomastus fragilis*, *Lumbrineris spp*. and venerid bivalves in circalittoral coarse sand or gravel.

Figure 4-13 Distribution of habitats between KP 10.0 and KP 17.0

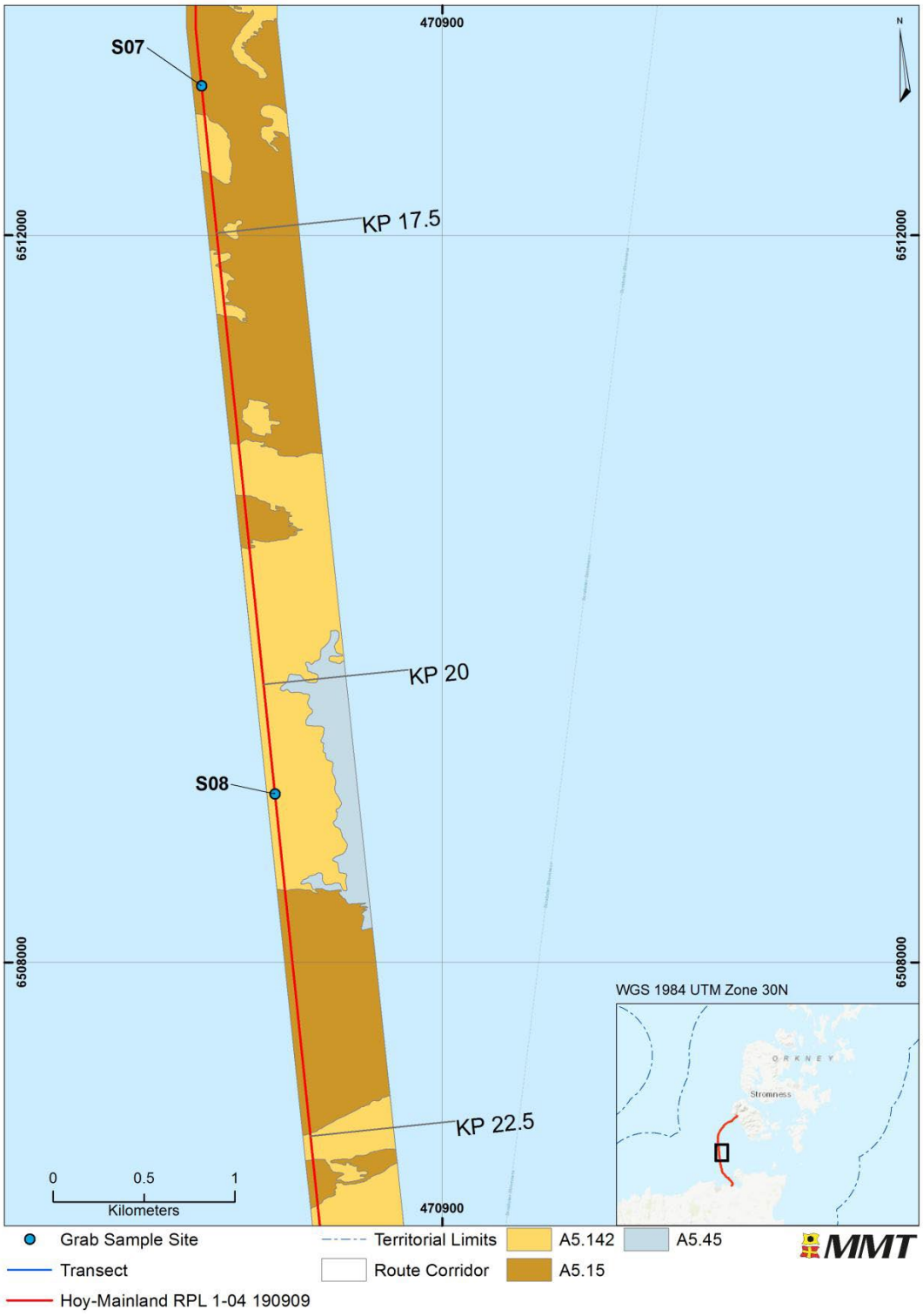


Grab sample site S07 (KP 16.686) (Figure 4-14) comprised of sandy gravel with occasional cobbles and ripple features. Epifauna was scarce with the occasional hydrozoan. The grab sample was dominated by the bivalve *G. triangularis* and other bivalve species and was classified as **A5.15**.

From KP 19.735 to KP 23.353 the installation corridor was dominated by **A5.142** and **A5.45**. Scattered patches of **A4.13**, assessed as stony reefs were present between KP 23.057 and KP 23.353.

Grab sample S08 (KP 20.604) (Figure 4-14) was comprised of sandy gravel with large amounts of shell debris. The grab sample was dominated by the barnacle *V. stroemia* and nematodes. In addition, three sand eels *Ammodytes sp.* were found in the grab. The grab sample was classified as **A5.142**.

Figure 4-14 Distribution of subtidal habitats between KP 17.0 and KP 23.0



From KP 23.353 to KP 27.238 the seabed comprised cobbles, boulders and coarse sediments, and was classified predominantly as **A5.444** - *Flustra foliacea* and *Hydrallmania falcata* on tide-swept

circalittoral mixed sediment **A5.451** - Polychaete-rich deep Venus community in offshore mixed sediments. Small intrusions of **A5.15** were delineated from the geophysical data.

Numerous diamicton outcroppings, between KP 23.353 and KP 27.238, were interpreted from the geophysical data as well as at grab sample S09. The outcropping diamicton was interpreted to comprise components of both **A4.13** - Mixed faunal turf communities on circalittoral rock and **A5.141** - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.

These outcropping features were assessed as "Low" and "Medium resemblance" to a stony reef (Irving, 2009) thus qualifying as Annex I (1170) – Reefs as described within the Habitats Directive (EUR 28, 2013).

Grab sample site S09 (ca. KP 24.780) (Figure 4-15) contained boulders encrusted with serpulid worms with sand in between boulders. Epifauna was present in high densities and dominated by *F. foliacea*. Other species included echinoderms (*Echinus sp.*, *C. papposus,* and *Asterias rubens*), cnidarians (different hydrozoan, *C. smithii,* and *A. digitatum*), and arthropods (squat lobsters and crabs).

Grab sample site S09 was assessed to meet the criteria of "Medium resemblance" to a stony reefs (Irving, 2009) thus qualifying as an Annex I (1170) – Reefs as described within the habitats directive (EUR 28, 2013).

Sample site S10 (KP 25.996) (Figure 4-14) comprised of sandy gravel with extensive amount of shell debris and occasional boulders. The fauna was diverse and dominated by *F. foliacea* and *A. digitatum*.

The grab sample was characterised by the barnacle *V. stroemia,* numerous polychaetes and bivalves *Gibbula tumida*, *Modiolula phaseolina*, *Kellia suborbicularis, Leptochiton asellus, G. glycymeris* and *Gouldia minima*. The horse mussel *Modiolus modiolus* was identified in the grab sample as well as juveniles of *Modiolus sp*. Grab sample S10 was classified as **A5.444**/ **A5.451**.

Grab sample site S11 (Figure 4-15) was located at KP 26.988 and comprised sandy gravel with cobbles and boulders encrusted with serpulid worms. Dominating fauna was *F. foliacea*. Other visible species included Asteroidea, *Echinus sp., and Ophiocomina nigra*.

The grab sample was characterized by the barnacle *V. stroemia* and nematodes with numerous polychaetes and bivalves *G. tumida*, *M. phaseolina*, *K. suborbicularis, L. asellus, G. glycymeris* and *G. minima*. Juveniles of *Modiolus sp.* were also identified.

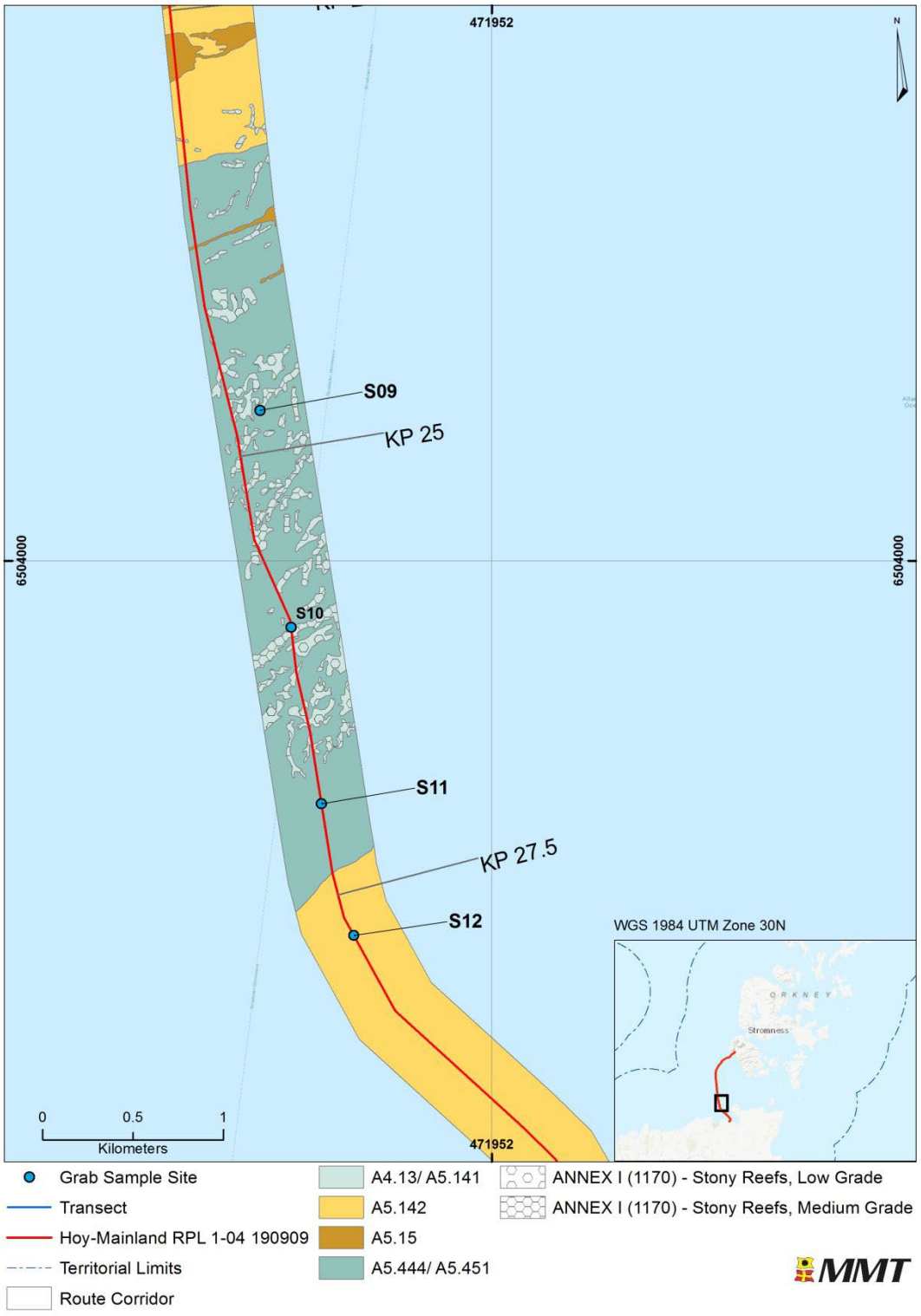
The infaunal composition was similar to that of S10 with regards to the spectrum of species and grab sample site S11 was classified as **A5.444**/ **A5.451**.

From KP 27.238 to KP 29.482 the seabed is characterised by shell, gravel and coarse sands classified as **A5.142**. From KP 29.482 to KP 30.074 the seabed comprised rippled sands and was classified as habitat complex **A5.133** - *Moerella* spp. with venerid bivalves in infralittoral gravelly sand/ **A5.25** - Circalittoral fine sand.

Grab sample site S12 (Figure 4-15) was located at KP 27.743 and comprised gravelly sand with extensive amounts of shell debris. Visible fauna included *F. foliacea*, *Echinus sp.*, and *Urticina sp.*

The grab sample was dominated by nematodes, the barnacle *V. stroemia,* and the sipunculid *Nephasoma minutum*. Numerous species of molluscs were identified such as *M. phaseolina, G. triangularis*, *Gari telinella*, *G. glycymeris*, *G. tumida* and *T. ovata*. Juveniles of *Modiolus sp.* were also identified. Grab sample site S12 was classified as **A5.142.**

Figure 4-15 Distribution of subtidal habitats between KP 17.0 and KP 23.0



Grab sample site S13 (Figure 4-16) was located at KP 30.050 and comprised clean rippled sand with frequent *F. foliacea*. The grab sample comprised very few species and was dominated by the bivalves *A. pygmaea*, *G. triangularis* and *T. ovata*. Grab sample site S13 was classified as **A5.133/ A5.25**.

At KP 30.074 the substrate fractions shifted to from fine sand to coarser sand with pebbles and cobbles, occasionally covered by dense *F. foliacea* and *A. digitatum*. From KP 30.074 to KP 30.517 the seabed was predominantly classified as **A5.15** with patches of outcropping diamicton classified as **A5.45**. From KP 30.517 habitat **A5.45** dominates until KP 31.814 and includes bands of **A5.15**.

The outcropping diamicton was assessed (geophysical interpretation and grab sample site S09 and S14) as "Low" and "Medium resemblance" to a stony reef (Irving, 2009) thus qualifying as an Annex I (1170) – Reefs as described within the Habitats Directive (EUR 28, 2013).

The grab sample S14 was diverse and dominated by numerous bivalves such as *G. triangularis*, *G. glycymeris*, *G. telinella*, the barnacle *V. stroemia*, and nematodes, as well as juvenile *Modiolus sp.*, and was classified as **A5.45**.

In addition, grab sample site S14 was located on the edge, as interpreted from the geophysical data, of an area with numerous boulders. A section of habitat **A5.45**, between KP 31.265 to KP 31.078, has therefore been delineated as a potential Stony Reefs area as it could hold reef areas based on the 25 m^2 extent criteria (Irving, 2009).

Habitat complex **A5.231** - Infralittoral mobile clean sand with sparse fauna/ **A5.25** - Circalittoral fine sand was classified between KP 31.814 and KP 33.895 based on the geophysical interpretations and extrapolation from grab sample S15.

Grab sample site S15 (KP 32.449) (Figure 4-16) comprised of rippled sand with no apparent fauna. The grab sample contained very few species and predominantly single occurrences. The sample was characterised by the bivalve *G. triangularis*. Grab sample site S15 was classified as **A5.231**/ **A5.25**.

An isolated area of rippled coarse sand was classified as **A5.14 -** Circalittoral coarse sediment and located between KP 33.895 and KP 34.268.

Transect T02 (KP 34.006) (Figure 4-16) contained sand with shell and macrofaunal debris. No apparent fauna was observed throughout the transect and was classified as **A5.14**.

An area of bedrock was classified as Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock (**A3.125**) between KP 34.268 and KP 34.438. The bedrock was assessed as to meet the criteria of a Bedrock Reefs thus qualifying as an Annex I (1170) – Reefs as described within the Habitats Directive (EUR 28, 2013).

Transect T01 (KP 34.263) (Figure 4-16) comprised of sand scoured bedrock with occasional patches of sand and shell gravel in the crevices. The bedrock was occasionally covered in foliose and encrusting red algae, and *Laminaria digitata*. Fauna observed included *C. smithii*, *Echinus sp.*, *A. rubens*, *Luidia ciliaris*, hydrozoans, Ascidiacea, and *Membranipora membranacea*. The transition between encrusted bedrock and the occurrences of kelp was visible, with denser aggregations of kelp occurred on the upper parts of the bedrock, while robust species and coralline algae dominated the deeper parts.

Figure 4-16 Distribution of subtidal habitats between KP 17.0 and KP 23.0

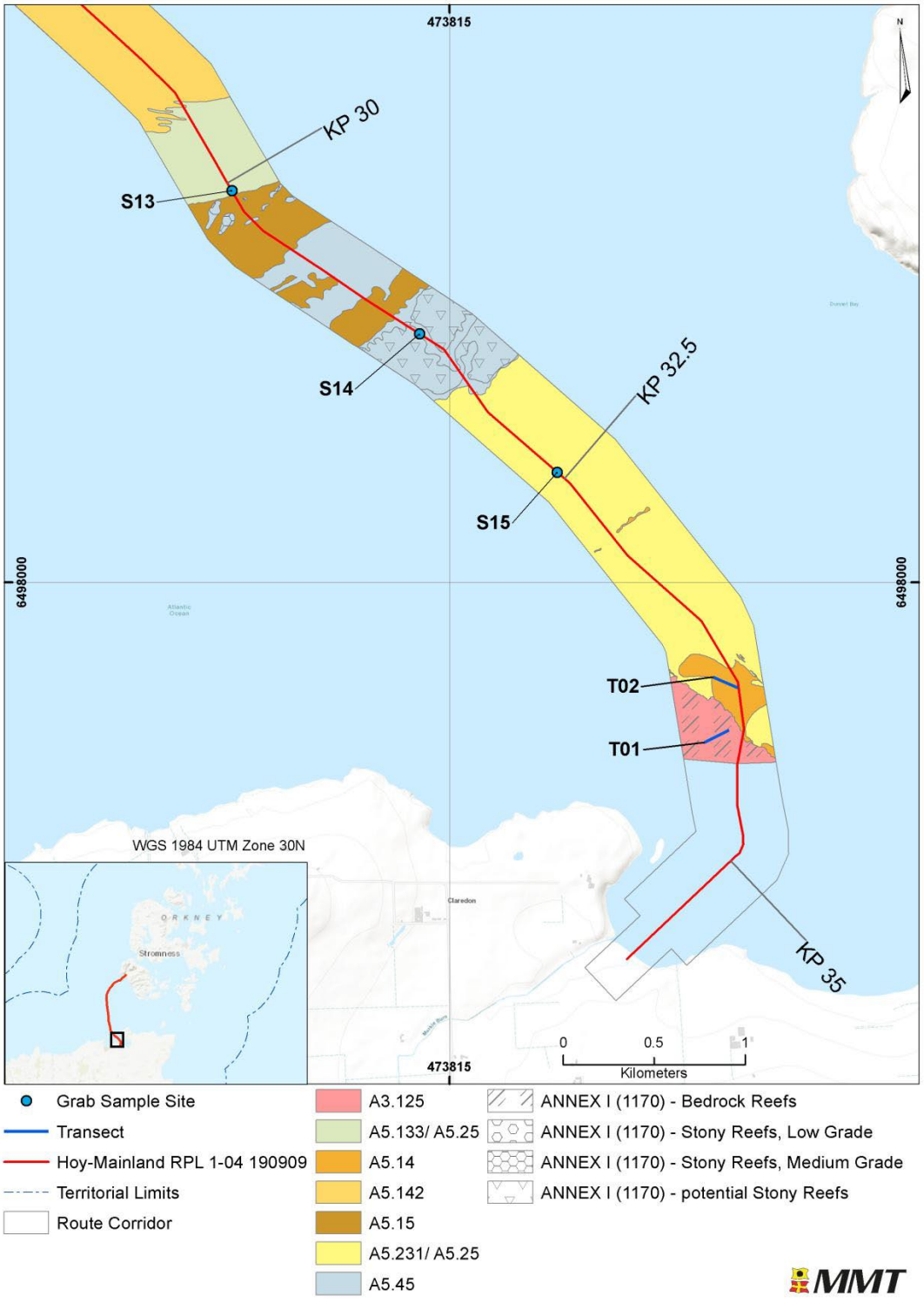
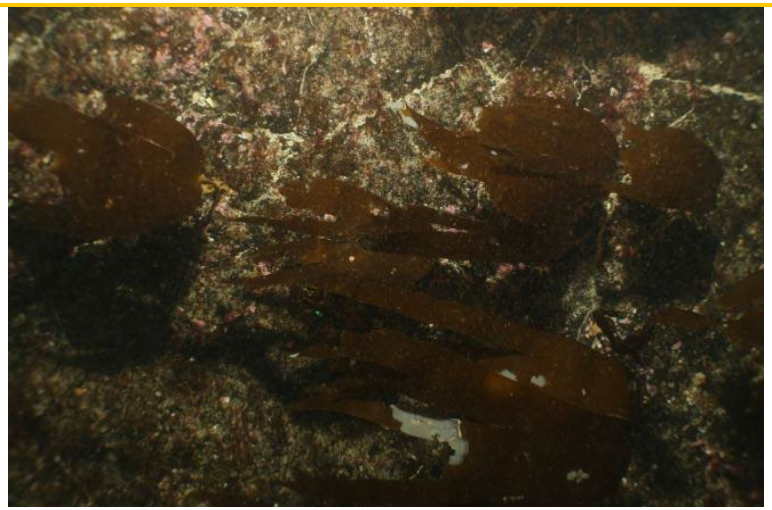
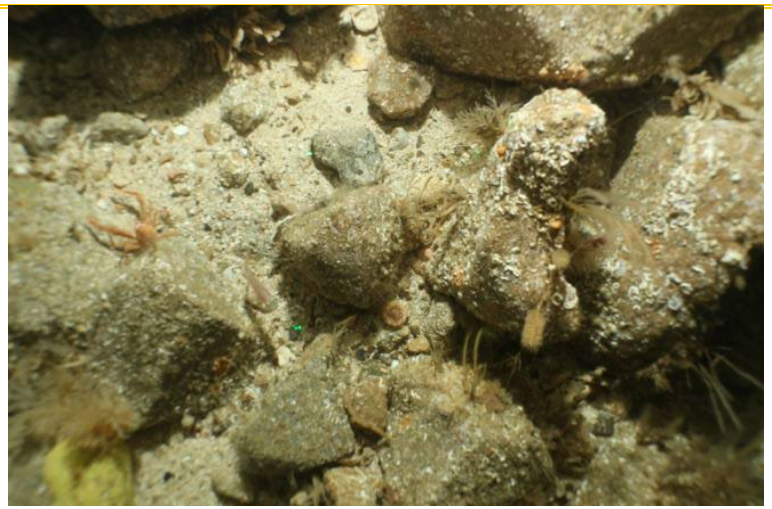
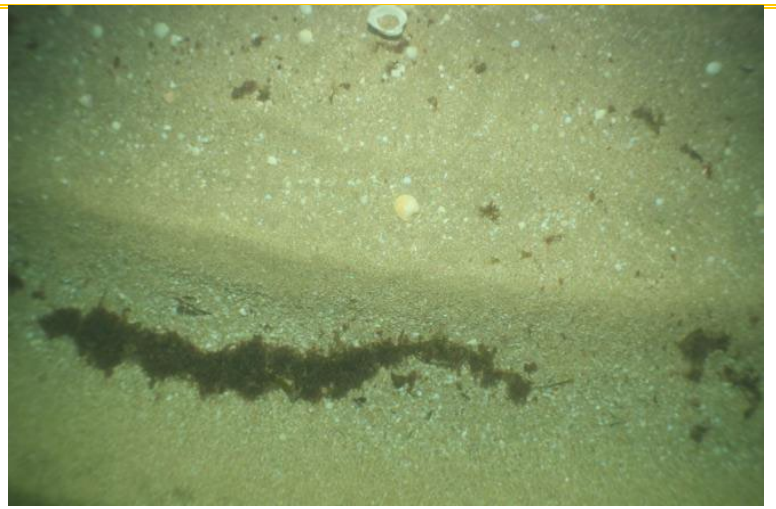


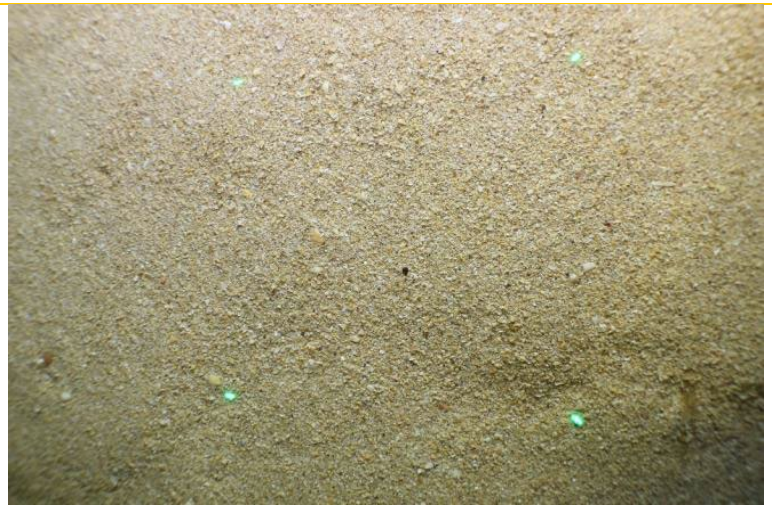
Table 4-3 presents a description of each habitat identified with images. One Annex I habitat, including two sub-types as well as three Priority Marine Features detailed in the SNH list, including kelp beds, tide-swept coarse sands with burrowing bivalves and Sand eel *Ammodytes sp.* These are discussed in detail in Section 4.5.1.

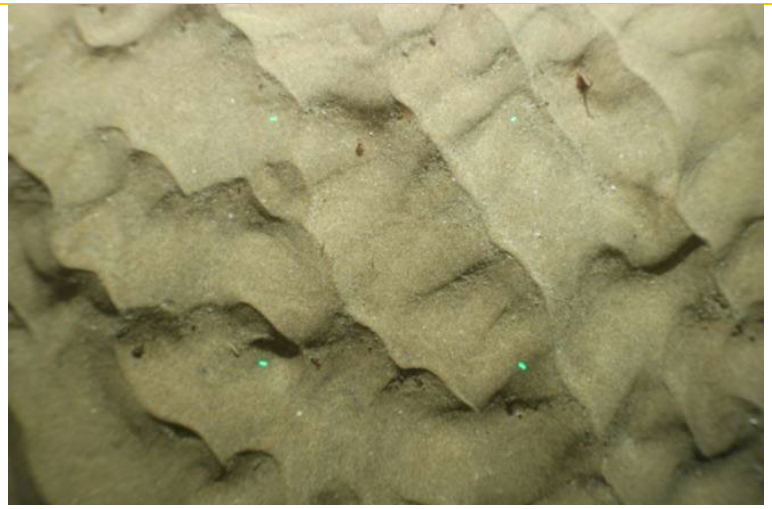
Table 4-3 Summary of subtidal habitats

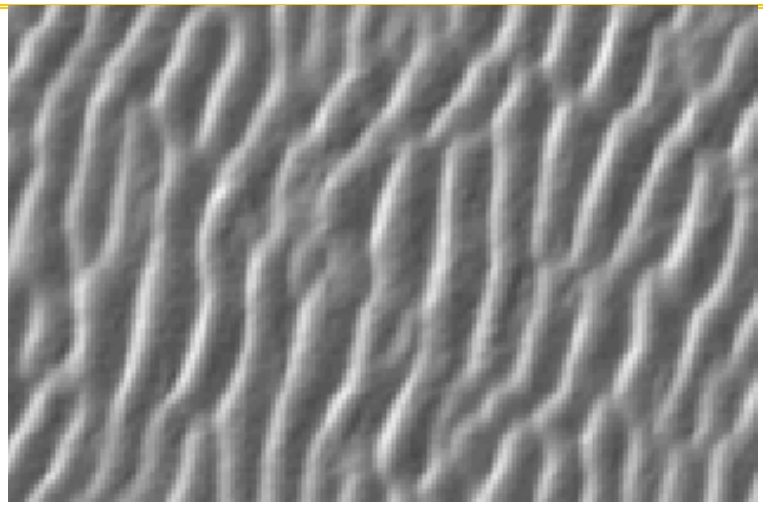
Biotope/biotope complex	Distribution	Site ID	Habitat image
A3.125 Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock	**KP:** 34.268 and KP 34.438	T01	
A4.13 Mixed faunal turf communities on circalittoral rock	**KP:** 2.835 to 4.798 (Scattered communities) 2.980 (Grab sample site S02) 4.798 to 5.658 (Scattered communities) 19.735 to 23.353 (Scattered communities) 23.353 and 27.238 (Scattered communities) 2.866 to 8.430 (Stony reef habitat) 7.864 and 8.914 (Stony reef habitat)	S02	

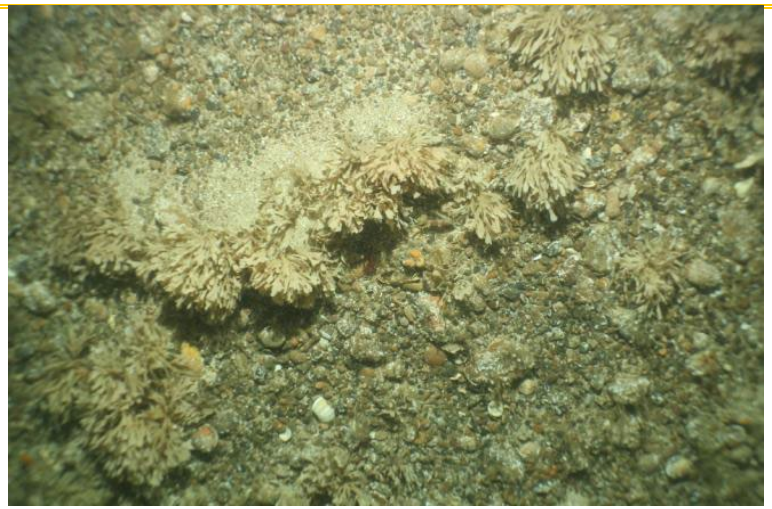
Biotope/biotope complex	Distribution	Site ID	Habitat image
A4.13 Mixed faunal turf communities on circalittoral rock / A5.141 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	**KP:** 23.054 to 26.825	S09	
A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand / A5.25 Circalittoral fine sand	**KP:** 29.482 to 30.074 30.050 (Grab sample site S13)	S13	

Biotope/biotope complex	Distribution	Site ID	Habitat image
A5.14 Circalittoral coarse sediment	**KP:** 33.895 and 34.268	T02	
A5.142 *Mediomastus fragilis*, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel	**KP:** 13.812 and 19.735 (Alternating with A5.15) 14.205 (Grab sample site S06) 19.735 to 23.353 20.604 (Grab sample site S08) 27.238 to 29.482 27.743 (Grab sample site S12)	S06, S08, S12	

Biotope/biotope complex	Distribution	Site ID	Habitat image
A5.145 *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel / A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand	**KP:** 7.209 and 7.806 7.400 (Grab sample site S04)	S04	
A5.15 Deep circalittoral coarse sediment	**KP:** 2.814 and KP 2.835 5.658 and 13.812 13.812 and 19.735 (Alternating with A2.142) 16.686 (Grab sample site S07) 23.353 to 27.238 (Small intrusions) 30.074 to 30.517 (Predominant, with patches of A5.45) 30.517 – 31.814 (Patchy)	S05, S07	

Biotope/biotope complex	Distribution	Site ID	Habitat image
A5.231 Infralittoral mobile clean sand with sparse fauna	**KP:** 0.638 – 1.031 31.814 and 33.895	S01	
A5.231 Infralittoral mobile clean sand with sparse fauna / A5.25 Circalittoral fine sand	**KP:** 31.814 and 33.895 32.449 (Grab sample site S15)	S15	

Biotope/biotope complex	Distribution	Site ID	Habitat image
A5.25 Circalittoral fine sand	**KP:** 1.031 – 2.592	-	
A5.27 Deep circalittoral sand	**KP:** 2.592 to 2.814 4.798 to 5.658 (Predominant, scattered outcrops of A4.13)	S03	

Biotope/biotope complex	Distribution	Site ID	Habitat image
A5.444 *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment / A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	**KP:** 23.353 to KP 27.238 (Predominant, patches of A5.15) 25.996 (Grab sample site S10) 26.988 (Grab sample site S11)	S10, S11	
A5.45 Deep circalittoral mixed sediments	**KP:** 2.835 to KP 4.798 19.735 to 23.353 (Dominant with A5.142) 30.074 to 30.517 (Outcrops) 30.517 to 31.814 (Dominant with bands of A5.15) 31.363 (Grab sample site S14) 31.265 to 31.078	S14	

4.3.3 Protected habitats and species of conservation importance

Intertidal

There are no nature conservation marine protected areas (NCMPAs) located within the vicinity of the installation corridor.

The intertidal section of installation corridor at the Rackwick Bay cable landfall site passes within an area designated as potential Annex I bedrock reef by the Joint Nature Conservation Committee (JNCC). This area of potential reef stretches across much of Orkneys waters and the north-east coast of Caithness. Bedrock reef occurs in areas where the underlying bedrock rises above the seabed and creates a hard surface for species such as corals, sponges and sea squirts, as well as providing shelter for other crustacean and fish species (JNCC, 2014).

No other features of conservation interest were observed during the intertidal surveys in Hoy or Caithness.

Subtidal

Two subtypes European Commission (EC) Habitats Directive Annex I listed reef habitats and three Priority Marine Features (PMF) were identified within the installation corridor:

Annex I Habitats

- 1170 – Reefs
  - Stony Reef
  - Bedrock Reef

Priority Marine Features (PMF)

- Kelp beds
- Tide-swept coarse sands with burrowing bivalves
- Sand eel *Ammodytes sp.*

In the subtidal environment, two subtypes of Rocky Reefs, detailed in the EC Habitats Directive as Annex I under 1170 Reefs, were encountered within the installation corridor; Bedrock Reefs and Stony Reefs (of medium and low grade), defined by Irving (Irving, 2009).

Stony Reef

The rocky areas within the installation corridor were assessed in accordance with the criteria outlined in JNCC Report No.432 (Irving, 2009). Three sections along the installation corridor were identified to hold stony reefs (Low to Medium resemblance); KP 2.866 to KP 8.430, KP 23.054 to KP 26.825 with a small area between KP 30.073 and KP 30.257. One area, between KP 31.265 and KP 31.708 was classified as *potential* Stony Reefs.

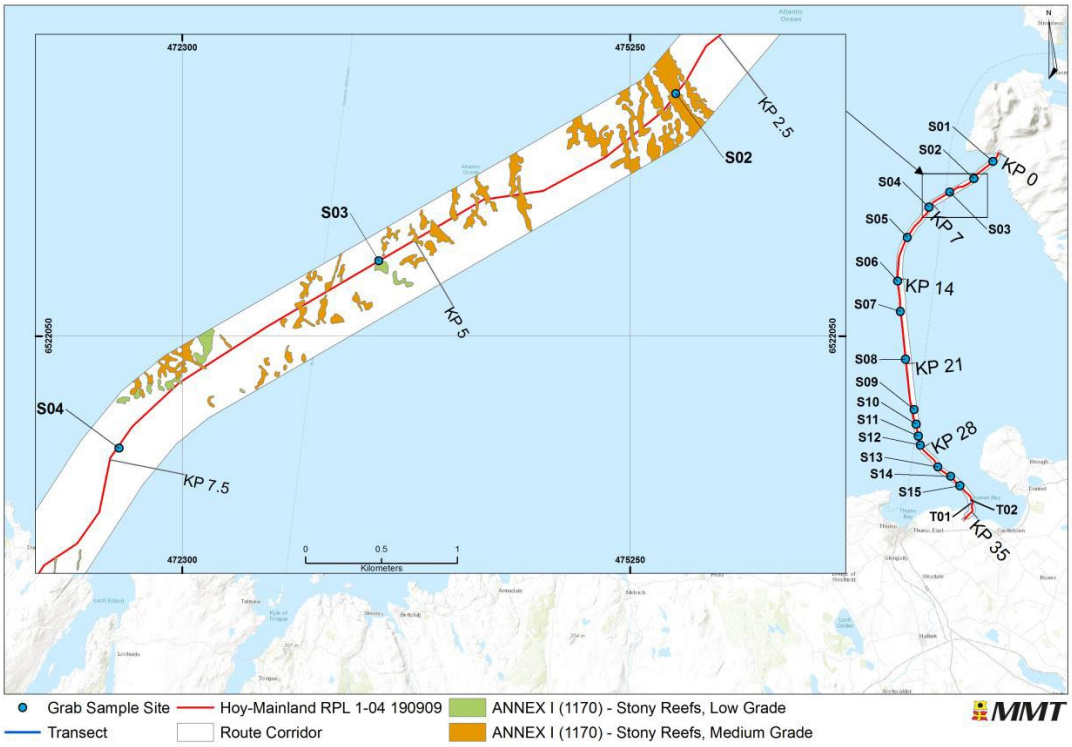
The northern most area, KP 2.866 to KP 8.430 (Figure 4-17, Figure 4-18), comprised elevated outcropping diamicton with dense aggregations of boulders. The majority of these reefs were assessed to be of Medium resemblance to Stony Reefs and thus classified as Annex I. The assessments were based on the composition of fauna and substrate fractions at grab sample site S02, KP 2.980. The collective assessment was extrapolated based on the interpreted textural similarity to the surrounding areas. The habitat identified as present on these features was **A4.13** - Mixed faunal turf communities on circalittoral rock. The distribution, of Low and Medium graded stony reefs, between KP 2.866 and KP 8.430 is presented in Figure 4-17. Geophysical data exemplifying Low and Medium stony reefs is shown in Figure 4-18 and Figure 4-19.

Grab sample site S02 (Figure 4-17) was located at KP 2.980 and comprised dense boulders and cobbles with intermediate sand and shell debris. Associated fauna included *Echinus sp.*, *Flustra foliacea*,

Securiflustra securifrons, *Tubularia sp.*, serpulid worms, *Crossaster papposus*, encrusting poriferans, hydrozoans, *Caryophyllia smithii,* and squat lobsters. One brown crab, *Cancer pagurus*

Two areas, classified as **A5.45** and **A4.13**, were interpreted, at the outermost boundary of the eastern part of survey corridor between KP 7.864 and KP 8.914 (Figure 4-17). The habitats classified as **A4.13**, were associated with outcropping diamicton and further classified as Annex I (1170) – Low grade Stony Reefs.

Figure 4-17 Distribution of Annex I Stony Reefs between KP 2.866 and KP 8.430 (MMT, 2019a)



The section, between KP 23.054 to KP 26.825, comprised outcropping diamicton with dense aggregations of boulders but appeared in the geophysical data not to be as elevated as the northernmost outcroppings (Figure 4-20, Figure 4-18). Based on this, the individual outcroppings have been delineated as Low and Medium resemblance to Stony Reefs.

The rationale has been based on the findings at grab sample site S09, located at KP 24.780, which showed both dense boulder aggregations and mixed sediments. Outcroppings of lower elevation than S09 have been delineated as Low resemblance to Stony Reefs while those exhibiting a higher elevation have been delineated as Medium resemblance.

The habitat matrix identified present on these features was **A4.13** - Mixed faunal turf communities on circalittoral rock/ **A5.141** - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles. The southernmost area, KP 30.073 and KP 30.257, comprised a few patches of outcropping diamicton exhibiting similar conditions as interpreted from the geophysical data.

Figure 4-18 Geophysical evidence for Stony Reefs (Medium grade) (MMT, 2019a)

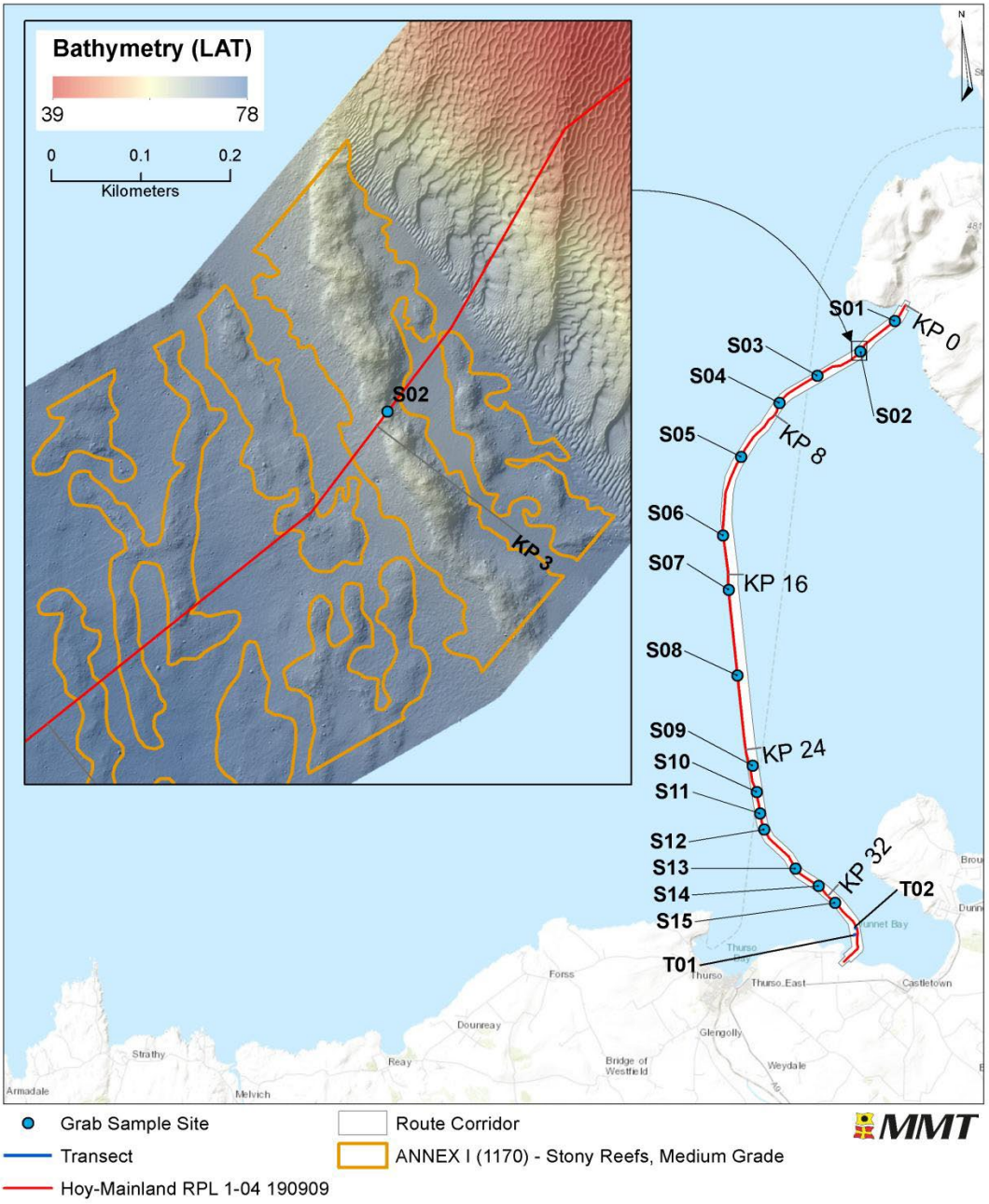
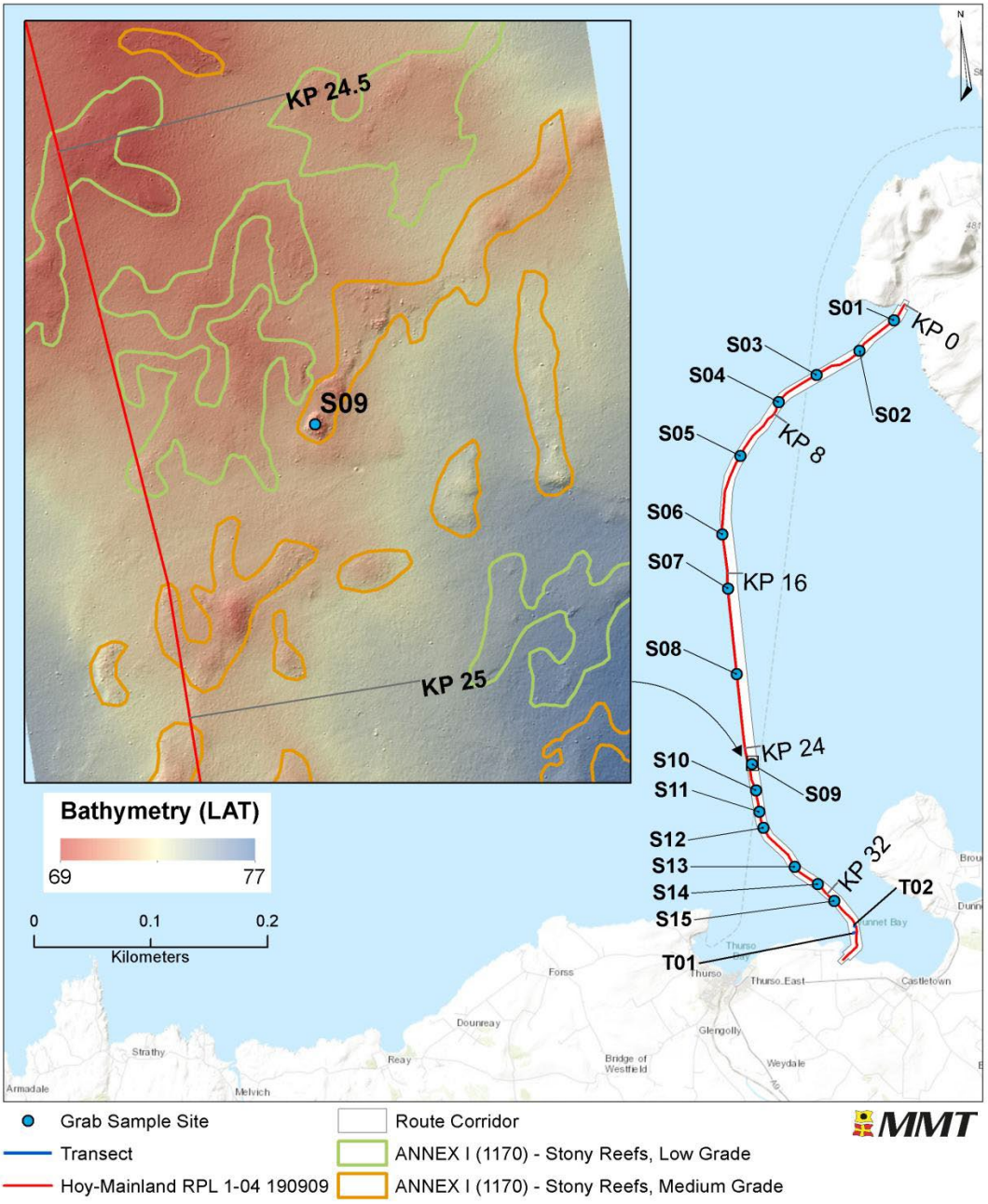


Figure 4-19 Geophysical evidence for Stony Reefs (Low and Medium grade) (MMT, 2019a)



The area delineated as potential Stony Reefs, KP 31.265 to KP 31.708 (Figure 4-20 and Figure 4-21), was assessed based on the coarseness and density of material on the seabed, as visible in the geophysical data. It is possible that areas within these boundaries would meet the extent and elevation criteria for Stony Reefs (Irving, 2009).

The area interpreted as Annex I - Bedrock reefs is considered to be a reef (Figure 4-16 and Figure 4-21), as there is no grading system of "reefiness" of bedrock reefs (Irving, 2009).

The bedrock reef was characterised by different species of encrusting fauna and algae, including *Laminaria* sp. Sand was observed covering patches of the bedrock. The bedrock reef was classified as **A3.125** – Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock.

The bedrock area could further be classified as habitat “Kelp beds”, which is detailed in the SNH list of PMF’s (Tyler-Walters, 2016). Kelp beds, with a dense growth of *Laminaria hyperborea* and foliose red seaweeds, are widely recorded around all coasts of Scotland, and exist on bedrock and boulders in a range of wave exposure regimes and tidal conditions (Tyler-Walters, 2016).

Figure 4-20 Distribution of Annex I areas between KP 23.054 and KP 34.439 (MMT, 2019a)

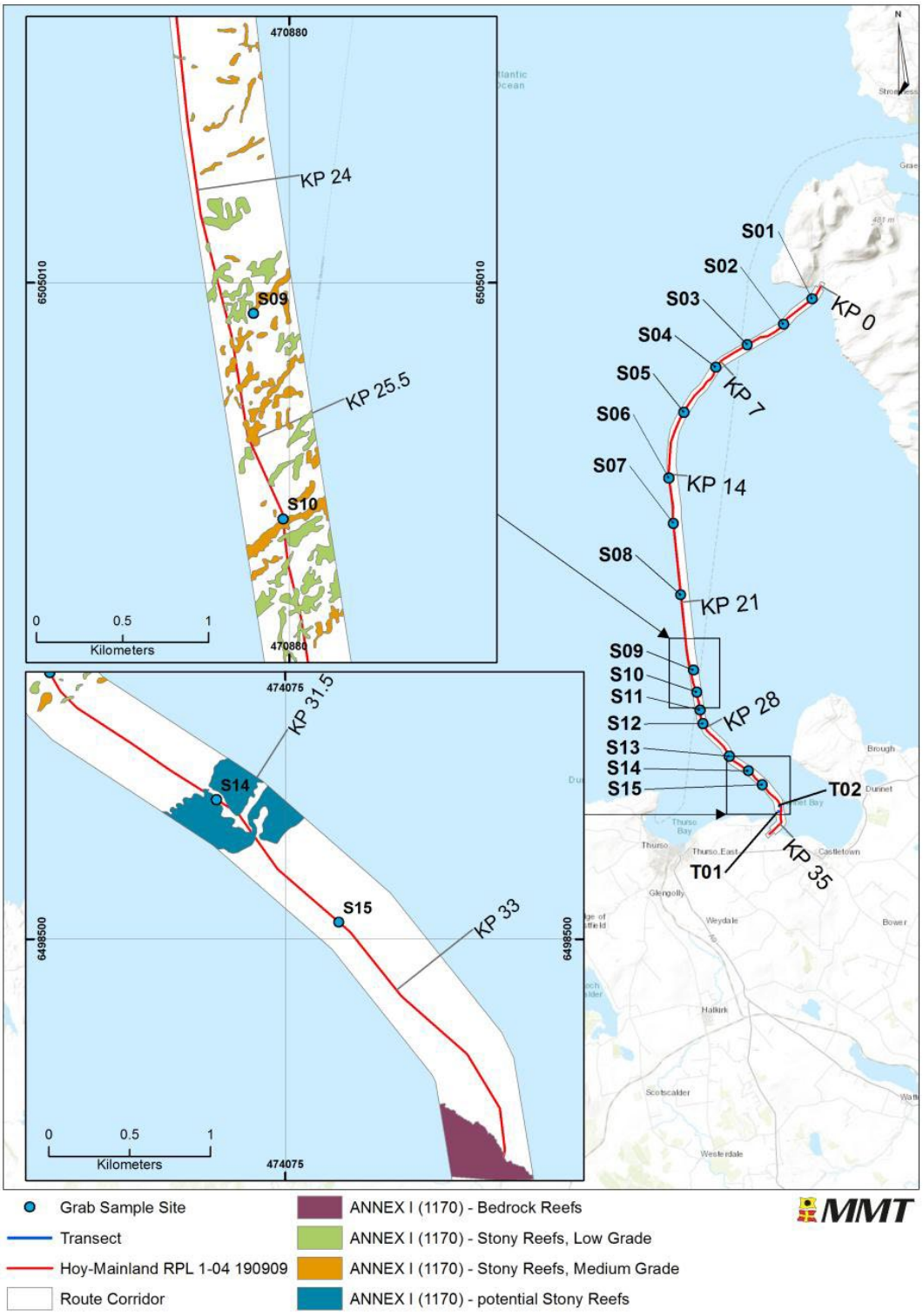
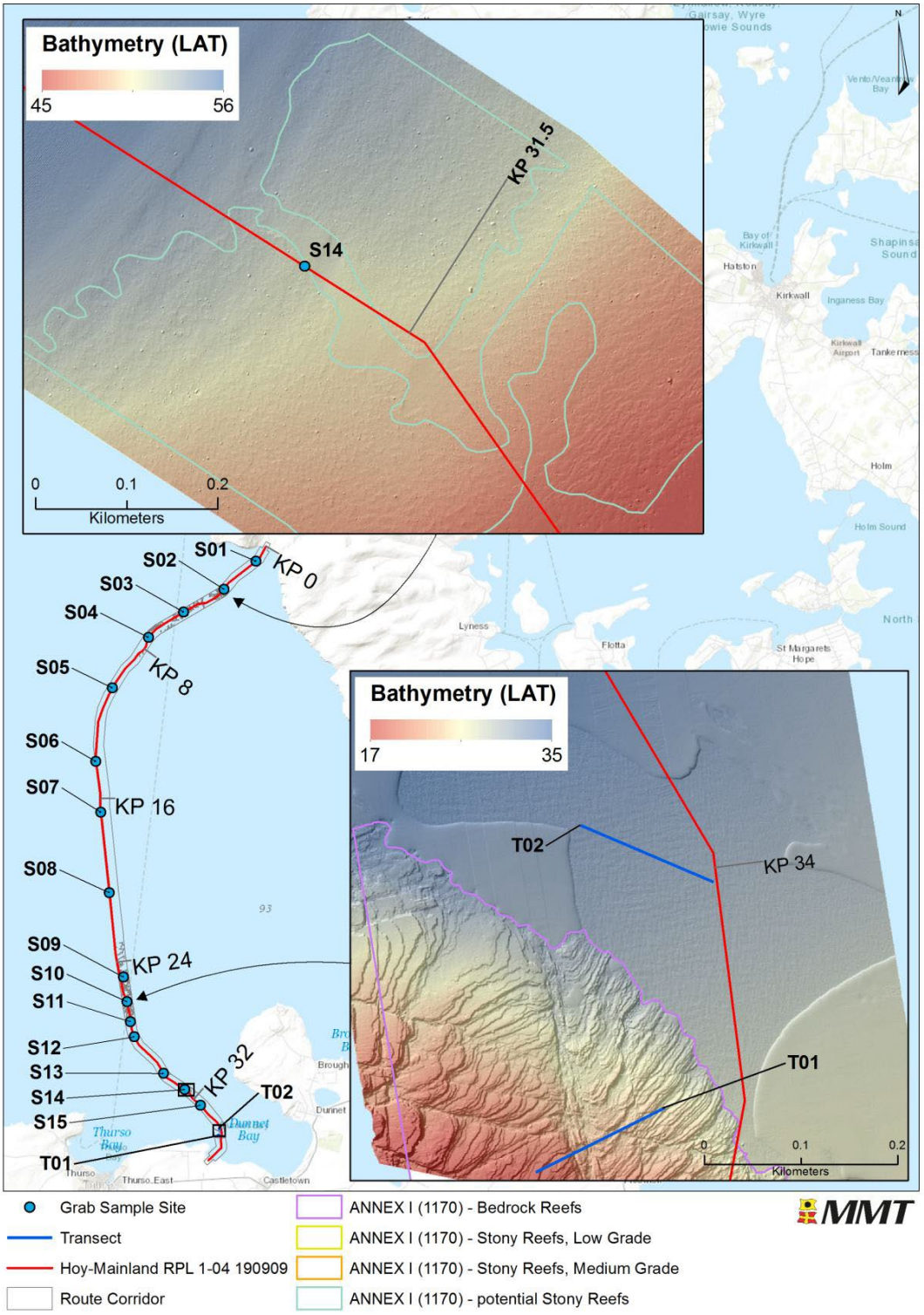


Figure 4-21 Geophysical evidence for potential Stony Reefs and Bedrock Reefs KP 23.054 and KP 34.439 (MMT, 2019a)



Bedrock Reef

An area of bedrock was classified as **A3.125** - Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock between KP 34.268 and KP 34.438. The bedrock was assessed to meet the criteria of a Bedrock Reefs thus qualifying as an Annex I (1170) – Reefs as described within the Habitats Directive (EUR 28, 2013). Transect T01 (Figure 4-16) was located west of the RPL, at KP 34.263, and comprised sand scoured bedrock with occasional patches of sand and shell gravel in the crevices. The bedrock was occasionally covered in foliose and encrusting red algae, and *Laminaria digitata*. Notable fauna included *C. smithii*, *Echinus sp.*, *A. rubens*, *Luidia ciliaris*, hydrozoans, Ascidiacea, and *Membranipora membranacea*. The transition between encrusted bedrock and the occurrences of kelp are visible in the imagery collected and show that denser aggregations of kelp occur upwards while robust species and coralline algae dominated the deeper parts of the bedrock. A delineation of this zonation could be based on the depth across the bedrock, but the area could also present this zonation as a result of temporal variation and exposure.

Priority Marine Features (PMF)

The Priority Marine Feature (PMF) list contains 81 habitats and species considered to be of conservation importance in Scotland's seas. It includes many benthic features which are characteristic of the Scottish marine environment, ranging from flame shell beds in coastal waters to cold-water coral reefs of the deeper seas, (Marine Scotland Website 2019).

Two subtidal habitats listed by SNH as PMF's were found within the installation corridor, "Tide-swept coarse sands with burrowing bivalves" (sample site S04), and "Kelp beds", found at the bedrock area in the southern most end of the route (transect T01).

PMF - Kelp beds (T01)

The bedrock area could further be classified as habitat "Kelp beds", which is detailed in the SNH list of PMF's (Tyler-Walters, 2016). Kelp beds, with a dense growth of *Laminaria hyperborea* and foliose red seaweeds, are widely recorded around all coasts of Scotland, and exist on bedrock and boulders in a range of wave exposure regimes and tidal conditions (Tyler-Walters, 2016).

PMF - Tide-swept coarse sands with burrowing bivalves (S04)

Coarse gravelly sand on exposed coasts extending down to around 20m supports an abundance of burrowing bivalve molluscs, particularly *Tellina* spp. and surf clams, and polychaete worms, tanaids and sand hoppers. It has a very limited distribution with most records from Shetland and a few from Orkney, the west coast of Scotland and Outer Hebrides. Scottish records are probably of national importance at the UK scale (Marine Scotland Website 2019).

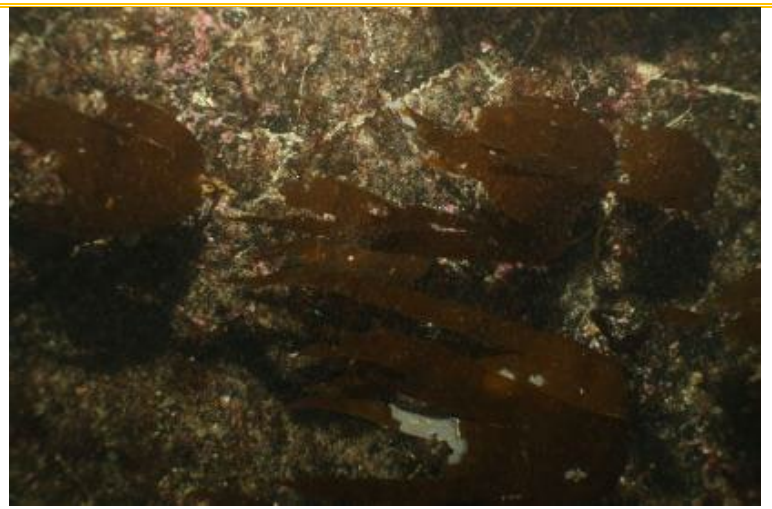
PMF - Sand eel Ammodytes sp.

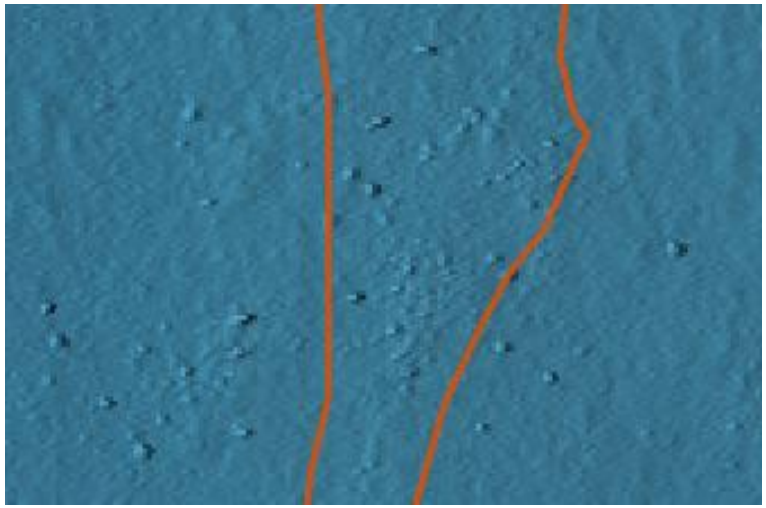
Sand eel *Ammodytes sp.*, most likely lesser sand eel *A. tobianus* was identified at sites S01, S05 and S08. Sand eel is listed as a PMF and lesser sand eel listed as DD (Data Deficient) by the IUCN Red List of Threatened Species (IUCN, 2019; Tyler-Walters, 2016). The installation corridor is located within a previously known spawning and nursing area for the species (Ellis, Milligan, Readdy, & Brown, 2012).

Three individuals of horse mussel *Modiolus modiolus* and five juveniles were identified at grab sample site S10. Juvenile *M. modiolus* were also identified at grab sample sites S11, S12 and S14. Large aggregations of the species make up the habitat "Horse mussel beds" listed as a PMF (Tyler- Walters, 2016), however no such aggregations were identified during the survey.

While the survey area is located within a previously known spawning area for herring *Clupea harengus* as well as a nursing area for blue whiting *Micromesistius poutassou* and anglerfish *Lophius piscatorius* (Ellis, Milligan, Readdy, & Brown, 2012). The aforementioned species are all listed as PMFs, however, none were encountered during the surveyThe protected habitat and species identified within the installation corridor are listed in Table 4-4.

Table 4-4 Protected subtidal habitats and species identified within the installation corridor

Annex I	PMF	Site ID	Habitat Image
1170 – Reefs Bedrock Reefs	PMF - Kelp beds	T01	
-	PMF - Tide-swept coarse sands with burrowing bivalves	S04	

Annex I	PMF	Site ID	Habitat Image
1170 - Reefs Stony Reefs, Low Grade	-	-	
1170 - Reefs *potential* Stony Reefs	-	-	

Annex I	PMF	Site ID	Habitat Image
1170 - Reefs Stony Reefs, Medium Grade	-	S02, S09	
-	PMF - Sand eel *Ammodytes sp.*	S01, S05, S08	

Image source - (MMT, 2019a)

4.4 Potential Impacts to benthic and intertidal ecology

4.4.1 Sensitivity of key protected features to potential impacts in Project area

Two subtypes European Commission (EC) Habitats Directive Annex I listed reef habitats and three Priority Marine Features (PMF) were identified within the subtidal area of the installation corridor:

Annex I Habitats

- 1170 – Reefs
  - Stony Reef
  - Bedrock Reef

Priority Marine Features

- Kelp beds
- Tide-swept coarse sands with burrowing bivalves
- Sand eel *Ammodytes sp.*

While the installation corridor overlaps with the boundary of Hoy SPA and North Caithness cliffs SPA, the key conservation features of both of these SPAs were not related to benthic ecology. No other features of conservation interest were observed within the installation corridor.

4.4.2 Potential impacts during cable installation

The potential impacts associated with different aspects of the cable installation (listed in Table 4-5 and Table 4-6) have been assessed to evaluate any significant effects. The zones of influence of installation activities on identified marine habitats are presented in Table 4-5 (intertidal) and Table 4-6 (subtidal).

Table 4-5 Potential impacts and Zone of Influence / Footprint - intertidal

Activity	Impact	Receptor	Zone of Influence / Footprint
Cable Installation (Cable burial by excavator, cast iron pipe applied to cable)	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion (change to seabed features)	Intertidal habitats (Rackwick): A2.111, A2.21, A2.82, A1.213, A1.4111, A1.2142, A1.123	KP 0.000 - 0.046; Length (L): 46m Width (W): 4m Footprint (L*W) = 184m^2
Cable Installation (Cable burial by excavator, cast iron pipe applied to cable)		Intertidal habitats (Murkle Bay): A2.22, A2.21, A2.82/A1.45, A231	KP 35.641 - 35.745; Length (L): 104m Width (W): 4m Footprint (L*W) = 416m^2
Cable installation (Anchoring during mattress placement)	Abrasion/disturbance of the surface of the substratum or seabed	Intertidal habitats (Murkle Bay): A2.22, A2.21	KP 35.641 - 35.745 Length (L): 104m Anchor footprint (incl. chains): 12.286m²
Cable Installation	INNS (Invasive Non-Native Species)	All intertidal	Intertidal Footprint (KP 0.000 - 0.046, KP 35.641 - 35.745) = 724m^2

Table 4-6 Potential impacts and Zone of Influence / Footprint – subtidal

Activity	Pressure	Receiving environment	Zone of Influence / Footprint
Cable Installation (Cable laid on surface)	Abrasion/disturbance of the surface of the substratum or seabed	A5.231	KP 0.308 – 0.597; Length (L): 289m Width (W): 0.155m Footprint (L*W) = 44.795m^2
		A5.45 (Length: 55 m) ANNEX I (1170) - Stony Reefs, Medium Grade (Length (L): 45 m, Width (W): 0.155 m, Footprint (L*W) = 6.975 m^2)	KP 4.280 –4.380; Length (L): 100m Width (W): 0.155m Footprint (L*W) = 15.50m^2
Cable Installation (Cable laid on surface with uraduct protection)	Abrasion/disturbance of the surface of the substratum or seabed	A5.45 (Length: 110 m) ANNEX I (1170) - Stony Reefs, Medium Grade (Length: 150 m; 52.5 m^2)	KP 2.935 – 3.195; Length (L): 260m Width (W): 0.350m Footprint (L*W) = 91.00m^2
		A5.142 A5.133	KP 29.587 - 29.687; Length (L): 100m Width (W): 0.350m Footprint (L*W) = 35.00m^2
		A5.133 / A5.25	KP 29.587 - 29.687; Length (L): 100m Width (W): 0.350m Footprint (L*W) = 35.00m^2
Cable Installation (Cable Laid on surface with 186 m of cast iron pipe or uraduct protection)	Abrasion/disturbance of the surface of the substratum or seabed	A5.231	KP 0.122 – 0.308; Length (L): 186m Width (W): 0.350m Footprint (L*W) = 65.00m^2
Cable Installation (Cable laid on surface with uraduct protection)		ANNEX I (1170) - Bedrock Reefs (KP 34.000 – 34.310; Length 310m; 81.53m^2)	KP 34.034 - 35.641; Length (L): 1607m Width (W): 0.350m Footprint (L*W) = 562.45m^2
Cable Installation (cable lay – mechanical	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	A5.231 - Infralittoral mobile clean sand with sparse fauna, A5.25 - Circalittoral fine sand,	KP 0.597- 2.935; Length (L): 2.33km Width (W): 7m Footprint (L*W) = 16366m^2

Activity	Pressure	Receiving environment	Zone of Influence / Footprint
cutting/hybrid cutter)	(change to seabed features)	A5.27 - Deep circalittoral sand, A5.15 - Deep circalittoral coarse sediment, A5.45 - Deep circalittoral mixed sediments, ANNEX I (1170) - Stony Reefs, Medium Grade (Length: ~ 20m; 140m^2)	
		A5.45 - Deep circalittoral mixed sediments, ANNEX I (1170) - Stony Reefs, Medium Grade (Length: ~ 110m; 770m^2)	KP 3.195- 4.280 Length (L): 1.085km Width (W): 7m Footprint (L*W) = 7595m^2
		A5.45 - Deep circalittoral mixed sediments, ANNEX I (1170) - Stony Reefs, Medium Grade (Length: ~ 235m; Footprint = 1645m^2) A5.15 - Deep circalittoral coarse sediment, A5.27 - Deep circalittoral sand, ANNEX I (1170) - Stony Reefs, Low Grade (Length: ~ 40 m; 280 m^2)	KP 4.380 - 6.955; Length (L): 2.615km Width (W): 7m Footprint (L*W) = 18305m^2
		A5.15 - Deep circalittoral coarse sediment, A5.142 - Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel	KP 17.355 - 19.355; Length (L): 2.000km Width (W): 7m Footprint (L*W) = 14000m^2
		A5.142 - Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel, A5.15 - Deep circalittoral coarse sediment ANNEX I (1170) - Stony Reefs, Low Grade (Length: ~ 470 m; Footprint = 3290 m^2),	KP 19.355 - 27.755; Length (L): 8.400km Width (W): 7m Footprint (L*W) = 58800m^2

Activity	Pressure	Receiving environment	Zone of Influence / Footprint
		A5.444 - Flustra foliacea and Hydrallmania falcata on tide-swept circalittoral mixed sediment/ A5.451 - Polychaete-rich deep Venus community in offshore mixed sediments ANNEX I (1170) - Stony Reefs, Medium Grade (Length: ~ 250 m; Footprint = 1750 m^2)	
		A5.142 - Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel	KP 27.755 - 29.587; Length (L): 1.832km Width (W): 7m Footprint (L*W) = 12824m^2
		A5.133 - Moerella spp. with venerid bivalves in infralittoral gravelly sand/ A5.25 - Circalittoral fine sand	KP 29.687 - 30.012; Length (L): 0.325km Width (W): 7m Footprint (L*W) = 2275m^2
		A5.15 - Deep circalittoral coarse sediment, ANNEX I (1170) - Stony Reefs, Low Grade (Length: ~ 20 m; Footprint = 140 m^2), A5.45 - Deep circalittoral mixed sediments ANNEX I (1170) - potential Stony Reefs (Length: ~ 105 m; Footprint = 735 m^2)	KP 30.112 - 31.902; Length (L): 1.790km Width (W): 7m Footprint (L*W) = 12530m^2
		A5.231 - Infralittoral mobile clean sand with sparse fauna/ A5.25 - Circalittoral fine sand, A5.14 - Circalittoral coarse sediment, ANNEX I (1170) - Bedrock Reefs (Length: ~ 45 m; Footprint (L*W) = 315 m^2)	KP 31.902 - 34.034; Length (L): 2.132km Width (W): 7m Footprint (L*W) = 14924m^2
Cable Installation (Jetting)	Siltation rate changes, including smothering (depth of vertical sediment overburden)	A5.231 - Infralittoral mobile clean sand with sparse fauna, A5.25 - Circalittoral fine sand,	KP 0.597- 2.935; Length (L): 2.33km Width (W): 7m Footprint (L*W) = 16366m^2

Activity	Pressure	Receiving environment	Zone of Influence / Footprint
		A5.27 - Deep circalittoral sand, A5.15 - Deep circalittoral coarse sediment, A5.45 - Deep circalittoral mixed sediments	
		A5.45 - Deep circalittoral mixed sediments	KP 3.195- 4.280; Length (L): 1.085km Width (W): 7m Footprint (L*W) = 7595m^2
		A5.45 - Deep circalittoral mixed sediments, A5.15 - Deep circalittoral coarse sediment, A5.27 - Deep circalittoral sand	KP 4.380 - 6.955; Length (L): 2.575km Width (W): 7m Footprint (L*W) = 18025m^2
		A5.15 - Deep circalittoral coarse sediment, A5.142 - Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel	KP 17.355 - 19.355; Length (L): 2.000km Width (W): 7m Footprint (L*W) = 14000m^2
		A5.142 - Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel, A5.15 - Deep circalittoral coarse sediment A5.444 - Flustra foliacea and Hydrallmania falcata on tide-swept circalittoral mixed sediment/ A5.451 - Polychaete-rich deep Venus community in offshore mixed sediments	KP 19.355 - 27.755; Length (L): 8.400km Width (W): 7m Footprint (L*W) = 58800m^2
		A5.142 - Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel	KP 27.755 - 29.587; Length (L): 1.832km Width (W): 7m Footprint (L*W) = 12824m^2

Activity	Pressure	Receiving environment	Zone of Influence / Footprint
		A5.133 - Moerella spp. with venerid bivalves in infralittoral gravelly sand/ A5.25 - Circalittoral fine sand	KP 29.687 - 30.012; Length (L): 0.325km Width (W): 7m Footprint (L*W) = 2275m^2
		A5.15 - Deep circalittoral coarse sediment, A5.45 - Deep circalittoral mixed sediments	KP 30.112 - 31.902; Length (L): 1.790km Width (W): 7m Footprint (L*W) = 12530m^2
		A5.231 - Infralittoral mobile clean sand with sparse fauna/ A5.25 - Circalittoral fine sand, A5.14 - Circalittoral coarse sediment	KP 31.902 - 34.034; Length (L): 2.132km Width (W): 7m Footprint (L*W) = 14924m^2
Cable Installation (Cable Laid on surface with uraduct protection, concrete mattresses (Up to 8), Northern Lights FO Cable Crossing Unit footprint (width: 3 m; Length: 6 m) = 18 m^2	Physical change (to another seabed type)	A5.142 –Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel (Length: ~ 20 m) A5.133 – Moerella spp. with venerid bivalves in infralittoral gravelly sand/A5.25 – Circalittoral fine sand (Length: ~ 80 m)	KP 29.587 - 29.687; Length (L): 100m Width (W): 3m 8 mattresses*(unit footprint = 18m^2) Total footprint = 144m^2
Cable Installation (Cable Laid on surface with uraduct protection, concrete mattresses (Up to 8), Farice FO Cable Crossing Unit footprint (width: 3 m; Length: 6 m) = 18 m^2		A5.133 – Moerella spp. with venerid bivalves in infralittoral gravelly sand/A5.25 – Circalittoral fine sand	KP 30.012 - 30.112; Length (L): 100m Width (W): 3m 8 mattresses*(unit footprint = 18m^2) Total footprint = 144m^2

Activity	Pressure	Receiving environment	Zone of Influence / Footprint
30 + 4 (OOS) concrete mattresses Unit footprint (width: 3 m; Length: 6 m) = 18 m^2		A5.231	KP 0.308 - 0.597 Length (L): 289m Width (W): 3m 34 mattresses*(unit footprint = 18m^2) Total footprint = 612m^2
4 (OOS) concrete mattresses Unit footprint (width: 3 m; Length: 6 m) = 18 m^2		A5.231, A5.25, A5.27, A5.15, A5.45 ANNEX I (1170) - Stony Reefs, Medium Grade (L: 15 m)	KP 0.597- 2.935 Length (L): 2.338km Width (W): 3m 4 mattresses*(unit footprint = 18 m^2) Total footprint = 72 m^2
30 concrete mattresses Unit footprint (width: 3 m; Length: 6 m) = 18 m^2		ANNEX I (1170) - Bedrock Reefs (KP 34.000 – 34.310; Length 310 m; 81.53 m^2)	KP 35.745 – 35.795 Length (L): 1607m Width (W): 3m 30 mattresses*(unit footprint = 18 m^2) Total footprint = 540m^2
Anchor deployment Footprint (incl. chains): 12.286m^2	Abrasion/disturbance of the surface of the substratum or seabed	A5.231	KP 0.308 - 0.597 Length (L): 289m Estimated anchor deployments: 3 3 deployments*anchor footprint (12.286m^2) Total footprint: 36.858m^2
Anchor deployment Footprint (incl. chains): 12.286m^2		ANNEX I (1170) - Bedrock Reefs (KP 34.000 – 34.310; Length 310 m; 81.53 m^2)	KP 35.745 – 35.795 Length (L): 1607m Estimated anchor deployments: 16 16 deployments*anchor footprint (12.286m^2) Total footprint: 196.576m^2
Cable Installation (Rock Bags; Unit footprint = 5 m^2 Total number of bags = 1145 + 20% = 1375	Physical change (to another seabed type)	A5.231, A5.25, A5.27, A5.15, A5.45, A5.145 / A5.133, A5.142, A5.451, A5.231 / A5.25, A5.14, A5.444 / A5.451	Entire offshore area (KP 0.046 – 35.745) Total number of rock bags + 20 % = 1375 Total footprint: (5m^2 *1375 rock bags) = 6875m^2
Cable Installation (Grout Bags;	Physical change (to another seabed type)	A5.231, A5.25, A5.27, A5.15, A5.45, A5.145 / A5.133, A5.142, A5.451,	Entire offshore area (KP 0.046 – 35.745)

Activity	Pressure	Receiving environment	Zone of Influence / Footprint
Length: 0.9 m, Width: 0.9 m, Height: 1 m) Unit footprint = 0.81 m^2 Total number of bags = 20		A5.231 / A5.25, A5.14, A5.444 / A5.451	Total number of grout bags = 20 Footprint: (unit footprint *20 bags = 16.2m^2
Cable Installation	INNS (Invasive Non-Native Species)	All intertidal and subtidal habitats	Entire cable footprint (KP 0.000 – 35.795) Total Footprint (including all activities and structures) = 180,032.03m^2

4.4.3 Potential impacts during cable operation

The impacts associated with operation of the replacement cable are not expected to exceed the impacts of the existing installed cable.

4.5 Significance assessment

To determine the sensitivity of intertidal and subtidal habitats within the installation corridor an assessment has been carried out using information provided on the Marine Life Information Network (MarLIN Website 2019).

4.5.1 Intertidal

4.5.1.1 Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion (change to seabed features)

Excavation work will be undertaken within the intertidal from Rackwick TJB to Mean Low Water Springs (MLWS) mark and from Murkle Bay to MLWS mark.

The installation corridor intercepts the EUNIS habitat 'Barren littoral shingle' (A2.111), ' Strandline ' (A2.21), 'Ephemeral green or red seaweed communities (freshwater or sand-influenced)' (A2.82), 'Fucus vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock' (A1.213), 'Coralline crust-dominated shallow eulittoral rockpools' (A1.411), '*Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders' (A1.2142), 'Coralline crust-dominated shallow eulittoral rockpools' (A1.123). The open cut trench across the landfall will be 1m wide with an excavator footprint of 4m wide representing an overall footprint of 260m^2 at Rackwick landfall.

At Murkle Bay landfall the installation corridor intercepts the EUNIS habitat ' Barren or amphipod-dominated mobile sand shores ' (A2.22), 'Strandline' (A2.21), 'Ephemeral green or red seaweed communities (freshwater or sand-influenced)' (A2.82/A1.45), 'Polychaetes in littoral fine sand' (A2.231). The open cut trench across the landfall will be 1 m wide with an excavator footprint of 4m wide representing an overall footprint of 360m^2.

The specific sensitivities of intertidal habitats to the potential impacts associated with the cable replacement; penetration or disturbance of the substratum subsurface, abrasion/disturbance of the surface of the substratum or seabed and smothering and siltation rate changes (heavy) is presented in Table 4-8 for Rackwick and Table 4-9 for Murkle Bay.

The habitat information from MarLIN (Table 4-7 and Table 4-8) indicate that the effects of intertidal disturbance will range from not sensitive to Medium for Penetration or disturbance of the substratum subsurface at Rackwick Bay and Murkle Bay. However, as the disturbance is short-term and spatially localised, the overall significance of the installation of the replacement cable on the intertidal habitats within the installation corridor at both Rackwick Bay and Murkle Bay has been assessed as **Slight** and is **Not Significant**.

4.5.1.2 Physical change (to another seabed type)

Concrete mattresses are likely to be placed within the intertidal zone at Murkle Bay, Scotland, equivalent to a surface area of 540m^2. The 30 concrete mattresses will be installed within the two EUNIS habitats 'Barren or amphipod-dominated mobile sand shores ' (A2.22) and ' Strandline ' (A2.21), which are both highly sensitive to a physical change to another seabed (Table 4-8; MarLIN Website 2019).

Because the sensitivity of habitats (Table 4-7 and Table 4-8) impacted by physical change have been assessed as high and the introduction of the external cable protection constitutes a permanent change to the habitat, the significance of the effect has been assessed as **Moderate**. However, due to the effects being short-term and the area affected small in size relative to the wider extent of the surrounding habitats, the effects are considered to be **Tolerable**. In addition, the external cable protection may over time lead to an increase in the local species diversity

4.5.1.3 Introduction or spread of Invasive Non-Native Species (INNS)

INNS have the potential to alter habitats through ecological engineering. During the cable installation processes (including excavation work and trenching), representative of a footprint of 620m^2. This footprint consist of two parts, the first part constitute the 260m^2 within the intertidal area at Rackwick, Orkney which intercepts the EUNIS habitats; 'Barren littoral shingle' (A2.111), 'Strandline' (A2.21), 'Ephemeral green or red seaweed communities (freshwater or sand-influenced)' (A2.82), 'Fucus vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock' (A1.213), 'Coralline crust-dominated shallow eulittoral rockpools' (A1.4111), '*Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders' (A1.2142) and '*Himanthalia elongata* and red seaweeds on exposed lower eulittoral rock' (A1.123). The second part is the 360m^2 within the intertidal zone at Murkle Bay, Scotland. At Murkle Bay which intercepts the EUNIS habitats; 'Barren or amphipod-dominated mobile sand shores' (A2.22), 'Standline' (A2.21), 'Polychaetes in littoral fine sand' (A2.231) and 'Ephemeral green or red seaweed communities (freshwater or sand-influenced)' (A2.82/A1.45).

Taken together the intertidal habitats sensitivity to the introduction or spread of invasive non-indigenous species, ranges from not sensitive to high sensitivity for A2.231 Polychaetes in littoral fine sand (Table 4-7 and Table 4-8; MarLIN Website 2019).

The introduction of invasive non-native species will be managed under the International Convention for the Control and Management of Ship's Ballast Water and Sediments (embedded mitigation). The latest guidance from the GB non-native species secretariat (2015) will be followed and a Biosecurity Plan produced pre-installation (embedded mitigation). This would include factors such as origins of the vessels and ensuring that relevant equipment is cleaned before use. Taking the mitigations into consideration, the magnitude of the effect has been assessed as negligible.

Although the sensitivity of subtidal habitats to the effects of INNS differ between habitats, as evident in Table 4-7 and Table 4-8, the overall significance of the effect has been assessed as **Not Significant**.

Table 4-7 Sensitivity of intertidal habitats within the installation corridor at Rackwick Bay, Hoy to the Potential impacts of Penetration, physical change and invasive species

Biotope/biotope complex	Penetration or disturbance of the substratum subsurface	Physical change (to another seabed type)	Introduction or spread of invasive non-indigenous species
A2.111 Barren littoral shingle	Not sensitive	High	Not relevant
A2.21 Strandline	*Low*	*High*	*Not sensitive*
A2.82 Ephemeral green or red seaweed communities (freshwater or sand-influenced)	*Low*	*High*	*Not sensitive*
A1.213 *Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock	Not relevant	High	Not sensitive
A1.411 Coralline crust-dominated shallow eulittoral rockpools	Not relevant	High	High
A1.2142 *Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders	Medium	High	High
A1.123 *Himanthalia elongata* and red seaweeds on exposed lower eulittoral rock	Not relevant	High	High
Italics and grey colour = Assessment has been based on sublevel habitat assessments.			

Table 4-8 Sensitivity of intertidal habitats within the installation corridor at Murkle Bay, Caithness to the potential impacts of Penetration, physical change and invasive species

Biotope/biotope complex	Penetration or disturbance of the substratum subsurface	Physical change (to another seabed type)	Introduction or spread of invasive non-indigenous species
A2.22 Barren or amphipod-dominated mobile sand shores	Not sensitive	High	Not sensitive
A2.21 Strandline	*Low*	*High*	*Not sensitive*

Biotope/biotope complex	Penetration or disturbance of the substratum subsurface	Physical change (to another seabed type)	Introduction or spread of invasive non-indigenous species
A2.231 Polychaetes in littoral fine sand	Low	High	High
A2.82 / A1.45 Ephemeral green or red seaweed communities (freshwater or sand-influenced)	*Low /* *Medium*	*High /* *High*	*Not sensitive /* *Not sensitive*
Italics and grey colour = Assessment has been based on sublevel habitat assessments.			

4.5.2 Subtidal

4.5.2.1 Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion (change to seabed features)

Cable trenching, using mechanical cutting or hybrid cutting, will be undertaken at ten sections along the installation corridor (KP 0.585 - 2.915, KP 3.175 - 4.200, KP 4.300 - 6.875, KP 6.875 - 17.275, KP 17.275 - 19.275, KP 19.275 - 27.675, KP 27.675 - 29.500, KP 19.275 - 27.675, KP 30.055 - 31.795, KP 31.795 - 33.800) from Rackwick MLWN mark to Murkle Bay MLWN mark. Such installation activities will impact the subtidal habitats by penetrating and/or disturbing the substrate below the surface of the seabed, as well as including abrasion (changes to seabed features) for a total footprint of 169,843.8m^2.

The installation corridor intercepts the EUNIS habitat 'Infralittoral mobile clean sand with sparse fauna' (A5.231), 'Circalittoral fine sand' (A5.25), 'Deep circalittoral sand' (A5.27), 'Deep circalittoral coarse sediment' (A5.15), 'Deep circalittoral mixed sediments' (A5.45), 'Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel' (A5.142), 'Flustra foliacea and Hydrallmania falcata on tide-swept circalittoral mixed sediment' (A5.444), 'Polychaete-rich deep Venus community in offshore mixed sediments' (A5.451) and 'Moerella spp. with venerid bivalves in infralittoral gravelly sand' (A5.133), as well as ANNEX I (1170) - Stony Reefs (Medium Grade and Low Grade).

The specific sensitivities for subtidal habitats to the potential impacts associated with the cable replacement; penetration or disturbance of the substratum subsurface, abrasion/disturbance of the surface of the substratum or seabed, Physical change (to another seabed type) and Smothering and siltation rate changes is presented in Table 4-9.

The habitat information from MarLIN (Table 4-9) indicate that the effects of subtidal disturbance will range from not sensitive to Medium for Penetration or disturbance of the substratum subsurface at Rackwick Bay and Murkle Bay. However, as the disturbance is short-term and spatially localised, the overall significance of the installation of the replacement cable on the subtidal habitats within the installation corridor has been assessed as **Slight** and is **Not Significant**.

4.5.2.2 Abrasion/disturbance of the surface of the substratum or seabed

Cable laid on the seabed surface with or without additional surface protection (i.e. uraduct or iron pipe protection) will cause abrasion or disturbance to the surface of the seabed. The cable will be laid on the surface without cable protection at two sections along the installation corridor (KP 0.365 - 0.585 and KP 4.200 - 4.300, equivalent to footprint of 49.6m^2).

The cable will be surface laid with cast iron pipe (width 0.263m) or uraduct protection (width 0.350m) at two sections along the installation corridor, representing a footprint of 812m^2 (calculated using a conservative approach, using the dimensions of the uraduct, which has the large footprint).

Additionally, anchoring of the vessel in areas of concrete mattress installation may cause abrasion or disturbance of the seabed. The anchor itself is comprised of a clump of weights which have a footprint of 12.25m². The anchor chain (footprint of which is 0.036m²) may also lay on the seabed in areas of lesser depth. As such, the worst-case footprint for the anchor and chain is 12.286m². Within the areas of concrete mattress installation, it is predicted that the anchor will be deployed 3 times within Rackwick Bay and 16 times within Murkle Bay (1 anchor deployment every 100m). As such, the total footprint of anchor deployment across the route is 233.54m² (36.858m² within Rackwick Bay and 196.576m² within Murkle Bay).

The EUNIS habitats likely to be affected by abrasion/disturbance of the surface of the substratum or seabed includes 'Infralittoral mobile clean sand with sparse fauna' (A5.231), 'Deep circalittoral mixed sediments' (A5.45), 'Circalittoral fine sand' (A5.25), *'Mediomastus fragilis*, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel' (A5.142) and 'Moerella spp. with venerid bivalves in infralittoral gravelly sand' (A5.133) as well as ANNEX I (1170) - Stony Reefs, Medium Grade and ANNEX I (1170) - Bedrock Reefs.

The surface laid cable footprint is equal to 57.35m^2. The footprint representative of the area where the cable laid on the seabed surface with uraduct protection and or iron pipe protection is 750m^2. These footprints, combined with the 233.54m² footprint of anchor deployment, combines to give a total surface area impacted by abrasion/disturbance of the surface of the substratum or seabed of 1040.89m^2.

The habitat information from MarLIN (Table 4-9) indicate that all of the EUNIS subtidal habitats have a 'Low' sensitivity the effects to abrasion or disturbance to the surface of the seabed, only the two Annex I habitats are considered to have a 'Medium' sensitivity to the effects of abrasion. However, as the disturbance is short-term and spatially localised, the overall significance of the installation of the replacement cable has been assessed as **Slight** and is therefore **Not Significant**.

4.5.2.3 Siltation rate changes, including smothering (depth of vertical sediment overburden)

The area surrounding the cable trench is likely to be affected by the resuspension and subsequent deposition of sediments as a result of installation activities. The post lay burial of the cable by jetting is likely to cause the resuspension of sediments. The total footprint of the area affected by jetting has been calculated to be 169,844m^2.

Although modern equipment and installation techniques have reduced the re-suspension of sediment during cable trenching activities, remaining suspended sediment dispersed into the water column has the potential to affect sessile filter feeders and, once settled out, could potentially smother organisms within the deposition area. Suspended sediments can obstruct the filtration mechanisms of some benthic and pelagic species. For example, some types of worm and brittlestars can be affected through the clogging of gills or damage to feeding structures. Suspended sediments can also attach to fish eggs causing abnormalities or death. It can also affect the growth of the macrobenthos and may have a lethal effect on some species.

To determine the sensitivity of habitats within the installation corridor an assessment has been carried out using information provided on the Marine Life Information Network (MarLIN) Website. Table 4-9 shows that the subtidal habitats within the installation corridor that are exposed to jetting have 'Low' to 'Medium' sensitivity to the impact of smothering and heavy siltation rate changes.

Elevated concentrations of suspended sediments are common place in shallow higher energy environments e.g. shallow circalittoral sand biotopes. Areas such as these are known to exceed suspended sediment concentrations of storm events.

Although the sensitivity of subtidal habitats to the effects of siltation and smothering differ between habitats, as evident in Table 4-10, due to the short duration of jetting and the effects being highly localised, the overall significance of the effect has been assessed as **Slight** and is **Not Significant.**

4.5.2.4 Physical change (to another seabed type)

Concrete mattresses will be installed at 84 locations along the installation corridor where the crosses third party cables (Northern Lights FO Cable Crossing and Farice FO Cable Crossing) and where the cable crosses old cables which are out of service. 4Te Rock bags and 1Te Grout bags will be placed for cable protection and stability. An estimated 1375 rock bags and up to 20 grout bags, as a contingency, will be placed along the installation corridor.

The 1375 rock bags that will be placed on the seabed have been calculated to represent a surface area of 6875m^2, the 20 grout bags and the 84 concrete mattresses each represent a footprint of 16.2m^2 and 1512m^2, respectively.

The footprint of uraduct and iron pipe cable protection has been calculated to be 2320m^2.

Although cable protection will only be used where necessary, where it is used the seabed habitat within the footprint of the protection will be lost and replaced with, in places, a harder substrate, changing the seabed type.

MarLIN Website (2019) identifies that the habitats in Table 4-9 have a high sensitivity to the impact, because a permanent change in substrate type would lead to the biotope being re-classified.

However, concrete mattresses and rock bags will provide hard substrate for epifauna to colonise. In areas where there is stony or bedrock reef the surrounding substrate is stable cobbles, boulders and bedrock where the dominant epifaunal species are rapid colonisers, capable of early reproduction and rapid growth. Therefore, it is expected that epifauna will be able to colonise the new substrate.

The external protection in sandy habitats will inevitably support the settlement of non-local hard bottom fauna that may not be representative of the surrounding benthos, although this process is likely to take longer given the limited presence of reef. Evidence suggests that effects on the local fauna in soft sediment areas will in most cases be very localised but long-term.

The above conclusions are supported by evidence from post-construction monitoring of offshore windfarms. The examples provided below are from the introduction of a hard substrate into a predominantly sandy environment. This however can be used to infer that colonisation of external protection in areas, where there is already rock habitat, will likely be quicker i.e. as colonisation of external protection on sand habitats is dependent on the passive transport of adult organisms or the availability of larvae from the surrounding region.

Case Studies on the Offshore Windfarm Egmond aan Zee (OWEZ), Prinses Amalia Wind Farm and Horns Rev Wind Farm found that the density of species on scour protection material were high and the number of species observed increased with time. In addition, in many cases the number of rare species had also increased (Waardenburg *et al*. 2017). Studies (Lindeboom *et al*. 2011) at OWEZ identified 11-17 hard substratum benthos species on the rock material, noting the surrounding habitat was sandy. At the Horns Rev windfarm, the scour protection has been colonised by sea anemones and the soft coral *Alcyonium digitatum* (Langhamer 2012). Monitoring of the Nord Stream pipeline in Swedish waters showed that over a period of four years a general increase in epifauna was seen on the introduced hard substrate (pipeline and rock berms; Nord Stream 2014).

Further studies (although limited) into the effects of artificial structures on adjacent soft sediments have provided contrasting results. Changes in localised community structure as a result of changes in sediment texture have previously been identified by Ambrose and Anderson (1990). Results showed reduced densities of some taxa near artificial structures which may have either resulted from increased predation as reef-associated fish move over sand to feed or changes in localised sediment

composition creating a less suitable habitat for certain species. In contrast to this, Davis *et al.* (1982) identified no measurable decrease in adjacent infauna densities at a distance of 4m from artificial structures over the two-year period since their introduction (Pidduck *et al.* 2017).

The total loss of habitat as a result of external cable protection has been calculated as 10,723.2m^2.

Because the sensitivity of habitats (Table 4-9) impacted by physical change have been assessed as high and the introduction of the external cable protection constitutes a permanent change to the habitat, the significance of the effect has been assessed as **Moderate**. However, due to the effects being short-term and the area affected small in size relative to the wider extent of the surrounding habitats, the effects are considered to be **Tolerable**. In addition, the external cable protection will over time lead to an increase in the local species diversity.

4.5.2.5 Introduction or spread of Invasive Non-Native Species (INNS)

INNS grow at rates that outcompete native species, in part because they are without any natural predators to keep it in check. The spread of INNS can be devastating to ecosystems, destroying the balance of flora and fauna, often smothering entire areas and in effect creating monocultures.

Vector pathways for introduction of invasive non-native species includes ballast water, fouling and structures located off the coast.

INNS can become established in both artificial and natural habitats. INNS are strongly associated with artificial structures and have been found to dominate ecological communities on artificial habitats. This is largely due to low natural biodiversity and a high density of vectors and pathways within these areas e.g. ports and marinas. INNS may be less likely to become established in high-quality natural habitats, most likely because native communities have evolved to optimally utilise all available resources leaving few ecological gaps for INNS to exploit. However, in modified, stressed or degraded natural habitats then INNS may successfully colonise, emphasising the importance of maintaining good environmental status (Biosecurity Plan 2018).

Harbour and marina-associated structures, infrastructure constructions and aquaculture operations, may be higher risk sites, not only due to their often relatively higher risk for introduction, but also to their importance in key infrastructure or economic activity. Reduced functionality, restrictions on normal activities or closures may have relatively disproportionate effects in these areas.

Information from the Marine Life Information Network (MarLIN) has been extracted and will be used to determine the sensitivity of subtidal habitats to the impacts of INNS. Table 4-9 shows that the habitats within the installation corridor range from 'Not sensitive', to 'Medium', to 'High' sensitivity to the INNS.

The introduction of invasive non-native species will be managed under the International Convention for the Control and Management of Ship's Ballast Water and Sediments (embedded mitigation). The latest guidance from the GB non-native species secretariat (2015) will be followed and a Biosecurity Plan produced pre-installation (embedded mitigation). This would include factors such as origins of the vessels and ensuring that relevant equipment is cleaned before use. Taking the mitigations into consideration, the magnitude of the effect has been assessed as negligible.

Although the sensitivity of subtidal habitats to the effects of INNS differ between habitats, as evident in Table 4-9. The overall significance of the effect has been assessed as **Not Significant**.

Table 4-9 Sensitivity of subtidal habitats within the installation corridor between Murkle Bay, Caithness and Rackwick Bay, Hoy to the potential impacts; penetration, abrasion, physical change, smothering and invasive species

Biotope/biotope complex	Penetration or disturbance of the substratum subsurface	Abrasion/disturbance of the surface of the substratum or seabed	Physical change (to another seabed type)	Smothering and siltation rate changes (heavy)	Introduction or spread of invasive non-indigenous species
A3.125 Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock	Not relevant (NR)	Medium	High	Low	High
A4.13 Mixed faunal turf communities on circalittoral rock	*Not relevant*	*Medium*	*High*	*Medium*	*Medium*
A4.13 Mixed faunal turf communities on circalittoral rock / A5.141 Pomatoceros triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	*Not relevant* / Low	*Medium* / Low	*High* / High	*Medium* / Low	*Medium* / Not sensitive
A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand / *A5.25 Circalittoral fine sand*	Low / *Low*	Low / *Low*	High / *High*	Medium / *Medium*	High / *High*
A5.14 Circalittoral coarse sediment	*Low*	*Low*	*High*	*Medium*	*High*

Biotope/biotope complex	Penetration or disturbance of the substratum subsurface	Abrasion/disturbance of the surface of the substratum or seabed	Physical change (to another seabed type)	Smothering and siltation rate changes (heavy)	Introduction or spread of invasive non-indigenous species
A5.142 Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel	Low	Low	High	Medium	High
A5.145 Branchiostoma lanceolatum in circalittoral coarse sand with shell gravel / A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand	Medium / Low	Low / Low	High / High	Low / Medium	No evidence / High
A5.15 Deep circalittoral coarse sediment	*Low*	*Low*	*High*	*Medium*	High
A5.231 Infralittoral mobile clean sand with sparse fauna	Low	Low	High	Low	Not sensitive
A5.231 Infralittoral mobile clean sand with sparse fauna / *A5.25 Circalittoral fine sand*	Low / *Low*	Low / *Low*	High / *High*	Low / *Medium*	Not sensitive / *High*
A5.25 Circalittoral fine sand	*Low*	*Low*	*High*	*Medium*	*High*
A5.27 Deep circalittoral sand	*Medium*	*Medium*	*High*	*Medium*	Not relevant
A5.444 Flustra foliacea and Hydrallmania falcata on tide-	Medium / Low	Medium / Low	High / High	Low / Medium	No evidence / High

Biotope/biotope complex	Penetration or disturbance of the substratum subsurface	Abrasion/disturbance of the surface of the substratum or seabed	Physical change (to another seabed type)	Smothering and siltation rate changes (heavy)	Introduction or spread of invasive non-indigenous species
swept circalittoral mixed sediment / A5.451 Polychaete-rich deep Venus community in offshore mixed sediments					
A5.45 Deep circalittoral mixed sediments	*Low*	*Low*	*High*	*Medium*	*High*

Italics and grey colour = Assessment has been based on sublevel habitat assessments.

4.6 Management and mitigation measures

Based on the description of the intertidal and subtidal environments and potential impacts from installation activities provided in Sections 4.4 and 4.5, Table 4-10 summarises the impacts associated with the installation of the replacement cable for key receptors taking management and mitigation measures into account.

Table 4-10 Summary of impacts on subtidal and intertidal ecology

Environmental receptor	Potential Impacts	Management and mitigation and overall impact significance
Intertidal Ecology	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion (change to seabed features) Physical change (to another seabed type)	**No significant impacts on intertidal ecology from cable replacement**, due to: ▪ Cable installation activities will be short term. ▪ Cable installation footprint is spatially small relative to the extent of the surrounding intertidal area ▪ All cable landfall works undertaken in line with standard best practice and general environmental management.
Subtidal Ecology	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion (change to seabed features)	**No significant impacts on subtidal ecology from cable replacement**, due to:

Environmental receptor	Potential Impacts	Management and mitigation and overall impact significance
	Physical change (to another seabed type)	▪ Micro-routing where possible around higher grade Annex I Reef Habitat ▪ Deployment of anchors/anchor chains on the seabed will be kept to a minimum in order to reduce disturbance to seabed. ▪ Ballast water discharges from Project vessels will be managed under the International Convention for the Control and Management of Ships' Ballast Water and Sediments standard. ▪ The latest guidance from the GB non-native species secretariat (2015) will be followed and a Biosecurity Plan produced pre-installation. ▪ Cable installation activities will be short term. ▪ Cable installation footprint is spatially small relative to the extent of the surrounding subtidal environment ▪ Rock bags, grout bags and concrete mattresses deployment will be minimised in areas identified as potential Annex I reef habitat and the footprint of the deposits will be the minimum required to ensure cable safety and stability. ▪ All cable landfall works undertaken in line with standard best practice and general environmental management.

5. FISH AND SHELLFISH

5.1 Introduction

This section provides further details of the fish and shellfish species that may be present within the vicinity of the replacement installation corridor. Potential impacts on species determined to be at risk of impact from the proposed installation activities are then assessed, along with the mitigation and management measures that will be utilised to remove or reduce these impacts. This section should be read in conjunction with the separate EPS Risk and Protected Sites and Species Assessment which assesses the impacts to protected sites and species based upon worse case scenarios for the Project including activity extent, time of year and duration.

5.2 Data sources

Prior to commencement of any works on the Project, an EPS Risk and Protected Sites and Species Assessment was conducted to assess the impact the Project may have on protected species and habitats in the vicinity of the installation corridor. This assessment detailed the baseline for basking sharks in the area and assessed impacts of the Project on the species. This information has been used to inform the baseline overview of this Section, with the assessment findings being summarised as well.

MMT were commissioned to undertake environmental survey and report on the findings to provide an overview of benthic environment along the marine installation corridor. Information acquired from this survey has been used to inform the baseline section of this report and in assessing the potential impacts the installation activities may have on the identified species. The Project documents used to inform this baseline description include the following:

- Environmental Survey Report, (MMT, 2019a)
- Pentland Firth East EPS Risk and Protected Sites and Species Assessment, (Xodus Group, 2019b) (Appendix C)

The Project documents have been supplemented where necessary to establish baseline conditions by undertaking a desktop review of published information and through consultation with relevant bodies. These data sources used to inform the baseline description and assessment include but are not limited to the following:

- Fisheries Sensitivity Maps in British Waters, Coull, Johnstone and Rogers, 1998
- Spawning and nursery grounds of selected fish species in UK waters, Ellis *et al*. 2012
- Updating Fisheries Sensitivity Maps in British Waters, Aires *et al*. 2014

5.3 Fish and shellfish description

5.3.1 Spawning and nursery grounds

Figures 5-1 and 5-2 detail the fish species that are known to utilise the Pentland Firth as either a nursery or spawning ground. While this data is sourced from a commercial fisheries standpoint, the data matches similar environmental reports that detail the presence of spawning and nursery grounds around Scotland (Coull, Johnstone and Rogers, 1998; Ellis *et al.*, 2012; Aires, González-Irusta and Watret, 2014).

Figure 5-1 Spawning and Nursery ground extents of species within the installation corridor (1 of 2)

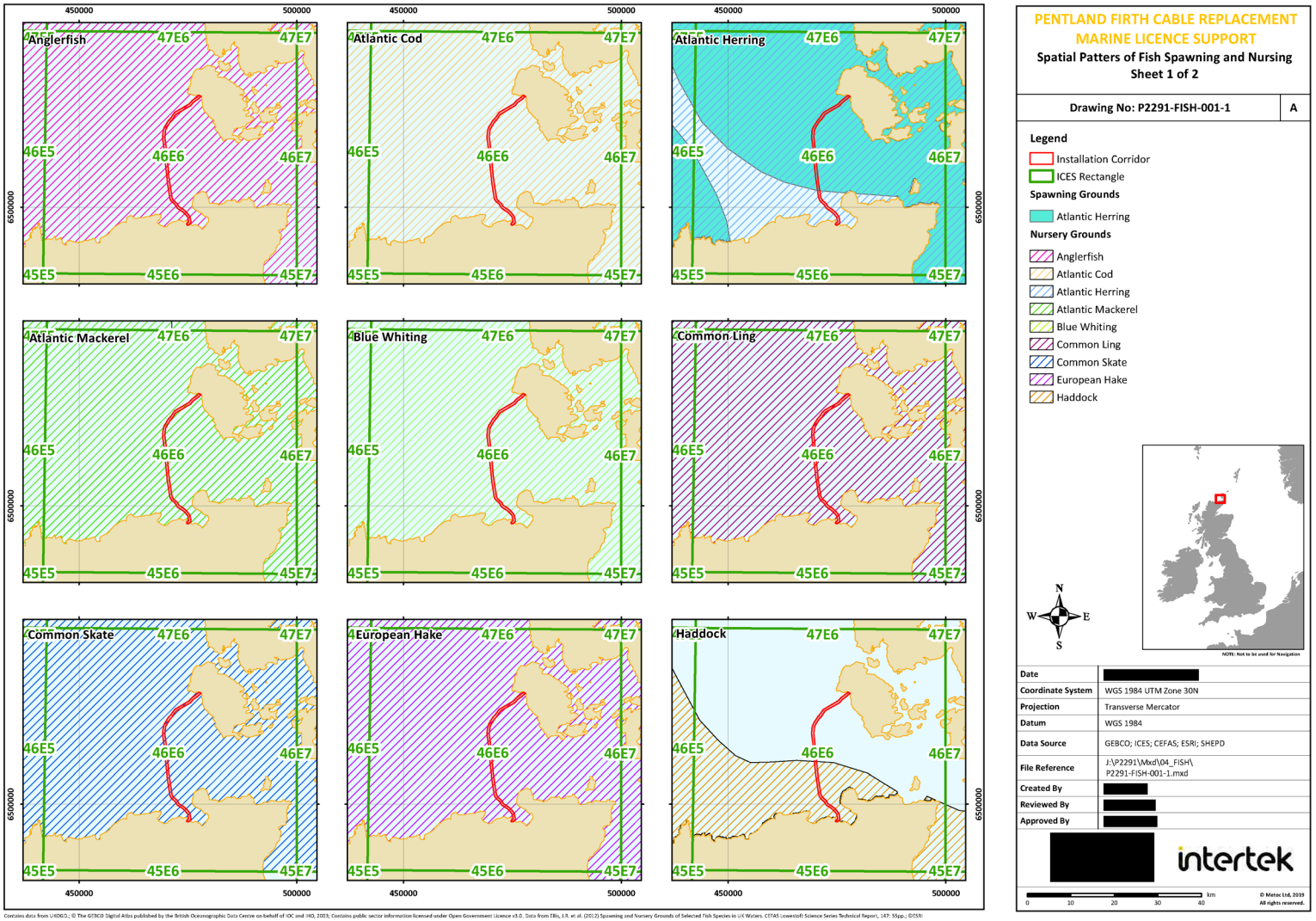
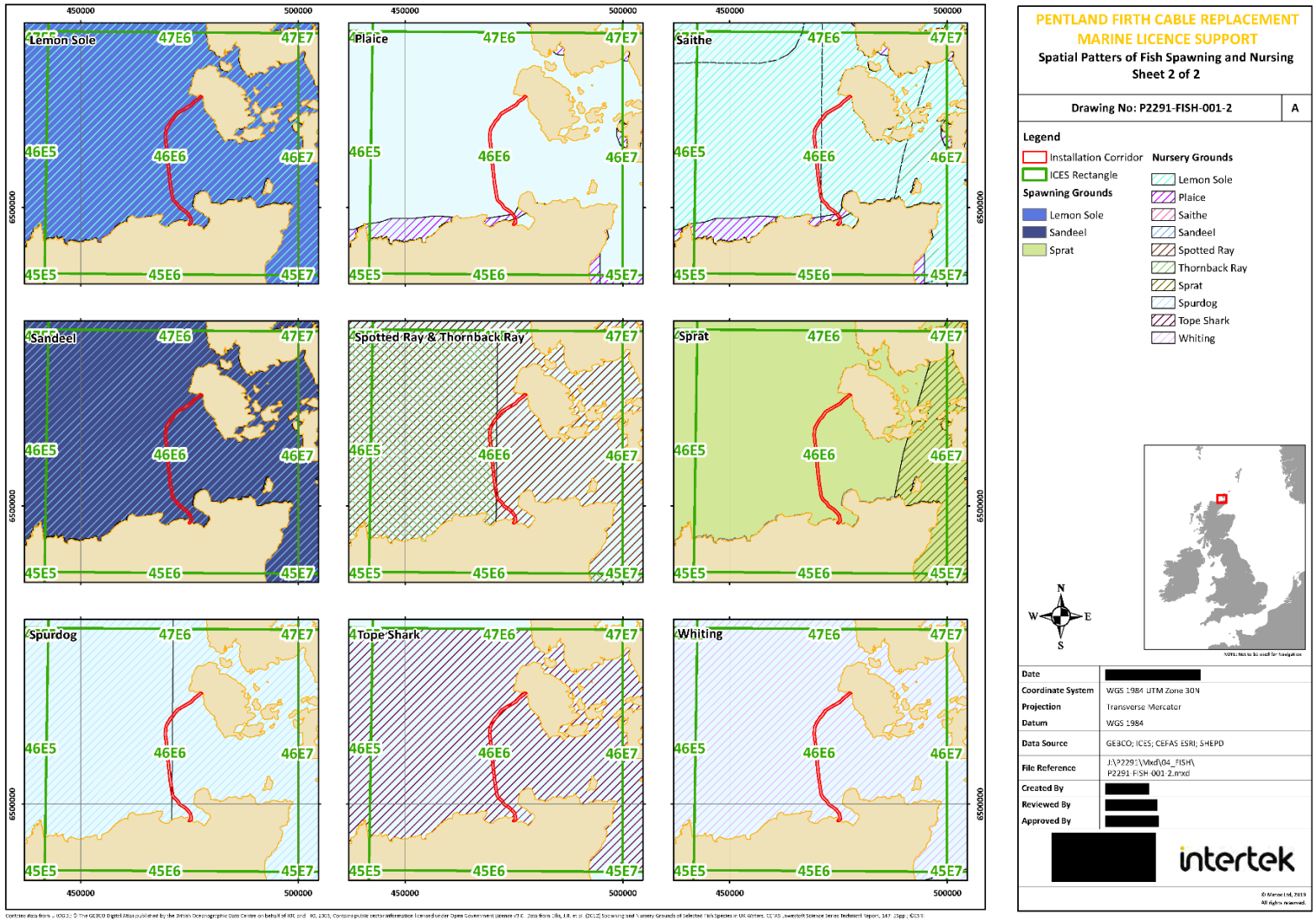


Figure 5-2 Spawning and nursery ground extents of species within the installation corridor (2 of 2)



PENTLAND FIRTH CABLE REPLACEMENT
MARINE LICENCE SUPPORT
Spatial Patters of Fish Spawning and Nursing
Sheet 2 of 2

Drawing No: P2291-FISH-001-2	A

Legend

- Installation Corridor
- ICES Rectangle

Spawning Grounds

- Lemon Sole
- Sandeel
- Sprat

Nursery Grounds

- Lemon Sole
- Plaice
- Saithe
- Sandeel
- Spotted Ray
- Thornback Ray
- Sprat
- Spurdog
- Tope Shark
- Whiting

N, W, E, S

Date	[redacted]
Coordinate System	WGS 1984 UTM Zone 30N
Projection	Transverse Mercator
Datum	WGS 1984
Data Source	GEBCO; ICES; CEFAS ESRI; SHEPD
File Reference	J:\P2291\Mxd\04_FISH\ P2291-FISH-001-2.mxd
Created By	[redacted]
Reviewed By	[redacted]
Approved By	[redacted]

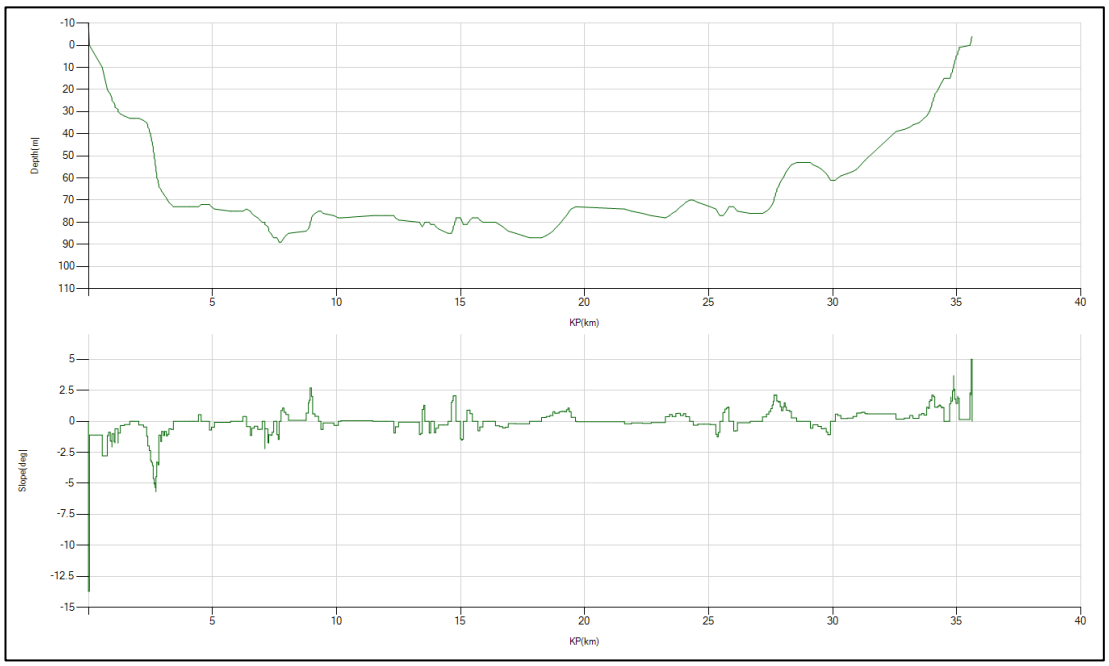
[redacted]

intertek

Environmental surveys conducted by MMT (MMT, 2019a) indicated that present along the route are areas of clean coarse sands/gravel and shells. Such habitat is a suitable spawning ground for Atlantic herring (*Clupea harengus*), sandeel, lemon sole (*Microstomus kitt*) and European sprat (*Sprattus sprattus*) with eggs released by individuals adhering to the seabed in these conditions (see Figure 5-1, 5-2) (Coull, Johnstone and Rogers, 1998; Ellis *et al.*, 2012). Previous surveys have identified the area as a spawning/nursery ground for these species, with Atlantic herring and sandeel being listed as PMFs (Mobile Species) in Scottish waters due to their importance as a prey species for several other predators (Tyler-Walters *et al.*, 2016). The area is also known nursery ground for numerous other species including anglerfish (*Lophius piscatorius*), Atlantic cod (*Gadus morhua*), Atlantic mackerel (*Scomber scombrus*), blue whiting (*Micromesistius poutassou*), common ling (*Molva molva*), common skate (*Dipturus batis*), European hake (*Merluccius merluccius*), haddock (*Melanogrammus aeglefinus*), European plaice (*Pleuronectes platessa*), saithe (*Pollachius virens*), thornback ray (*Raja clavata*), spurdog (Squalus sp.), tope shark (*Galeorhinus galeus*), and whiting (*Merlangius merlangus*) (Coull, Johnstone and Rogers, 1998; Ellis *et al.*, 2012; Aires, González-Irusta and Watret, 2014)

While suitable spawning habitat for Atlantic herring is found across the entire installation corridor, there may be a depth limitation to its' extent. Atlantic herring spawning typically occurs within depths of 10 – 40m, while approximately 85% of the installation corridor is below depths of 40m (between approximately KP 2.5 and KP 32.5) (see Figure 5-3), precluding herring spawning from occurring.

Figure 5-3 Depth profile of the installation corridor



In addition to the above fish species, it is also possible that the installation corridor is an important nursery ground for juvenile brown crab (*Cancer pagurus*). A study (Moore, 2009) assessing the conservation importance of benthic species and habitats in the Pentland Firth (in relation to renewable energy developments in the region) noted the frequency at which juveniles of the species were observed at sample sites across the Pentland Firth. One such sample site was located within the vicinity of the installation corridor. They were found to be feeding on the barnacle population that thrives in the tide-swept conditions. Due to the species' typical preference for lower energy environments (Marshall *et al.*, 2006), it has been suggested that the introduction of tidal turbine infrastructure in the Pentland Firth, and a subsequent reduction in tidal flow, could lead to an increase in brown crab population (du Feu *et al.*, 2019). Survey results from the MMT report (MMT, 2019a) did not find a similarly high presence of juvenile crab however, with no juveniles and only a single adult brown crab being identified along the entire installation corridor.

5.3.2 Horse mussels

Horse mussels (*Modiolus modiolus*) are a bivalve species that typically grow more than 10cm in length and can be found around the entire British coastline (Tyler-Walters, H, 2007). Individually *M. modiolus* are not a designated species, but when they form large aggregations they can be classified as the habitat 'Horse mussel beds', a PMF habitat that is designated due to their biogenic reef characteristics (Tyler-Walters, H, 2007). These beds have been found to be rich in biodiversity and provide habitat and shelter for numerous species such as whelks, crabs, brittlestars and act as important settling grounds for other bivalve molluscs and scallops (Marine Scotland, 2018a). Such beds also provide several ecosystem services such as carbon sequestration and storage (Mackenzie *et al.*, 2018). Due its status as a biogenic reef, horse mussel beds are listed as a UK Biodiversity Action Plan (UKBAP) Priority Habitat (JNCC, 2015a). While the species used to have an extensive distribution around the UK, the population has declined in recent years, partly due to the damaging effects of trawling and scallop dredging. As a result, horse mussel beds are now classified on the OSPAR List of Threatened and/or Declining Species and Habitats. Currently the most extensive horse mussel beds are found in the north and west of Scotland, including the waters around Orkney (JNCC, 2015a). Survey results of the MMT report found several individual horse mussels along the installation corridor. Three adult horse mussels (*M. modiolus*) and five juveniles were identified at grab sample site S10 (KP 25.996), with further juveniles also being identified at S11 (KP 26.988), S12 (27.743) and S14 (KP 31.363). No horse mussel beds were identified however, with the individuals identified not being aggregated together.

5.3.3 Basking sharks

The second largest species of fish in the world, growing up to 12m in length, basking sharks are filter feeders that feed on plankton and zooplankton (The Wildlife Trusts, 2019). Due to the low population numbers, the Northeast Atlantic population of basking sharks are listed as 'endangered' under the IUCN Red List of Threatened Species (Fowler, 2009). Basking sharks are protected in Scotland under the Nature Conservation (Scotland) Act 2004, with it being an offence to intentionally or recklessly disturb or capture individuals (Scottish Parliament, 2004). They are found throughout the UK, with sightings typically peaking in the summer months.

As described in Section 2.1.5.3, studies of basking shark abundance and behaviour in Orkney waters showed no clear pattern or particular concentration to their sightings, aside from sightings generally being lower in the Winter months between November and April (Evans, Baines and Coppock, 2010). The population density of the species in the region is low, with approximately 385 individuals being distributed across North Scotland and Orkney (Evans, Baines and Coppock, 2010).

The EPS Risk Assessment (Xodus Group, 2019b) includes further detail on the legislative protections offered to basking sharks (Section 1.3.2).

5.4 Potential impacts and zone of influence

Table 5-1 Potential impacts and zone of influence

Activity	Impact	Receiving environment/ species	Zone of influence
Cable installation Surface lay with rock/grout bags, post-lay jetting and trenching)	Physical change (to another substratum type)	Spawning and nursery habitat, *Modiolus modiolus* beds	The immediate vicinity of cable protection which in the case of individual rock bag placement will be 5m² per bag.
	Death or injury by collision	Basking shark	Immediate path of the installation vessel

5.5 Mitigation

Section 5.3 of the EPS Risk Assessment details several mitigation measures for the protection of basking sharks within the area. An additional measure regarding cable protection measures (EPSRA13) has also been included. Proposed measures are summarised in Table 5-2 below.

Table 5-2 Overview of proposed mitigation measures for basking sharks

Mitigation no.	Mitigation
EPSRA 4	**Basking shark mitigation zone** - During installation works, the MMO will monitor for the presence of basking sharks, in addition to marine mammals and otters, and will delay start of the installation if any are seen within 500 m of the survey vessel.
EPSRA 11	**Slow moving survey vessel** - The installation vessel will be moving at a maximum speed of 4 knots (during installation activities) to allow any basking sharks time to move away from the vessel should they be disturbed by the vessel presence or noise. Should a basking shark be found to be in the direct way of the survey route, the installation vessel will slow down further or, if possible, alter course to avoid collision.
EPSRA 12	**Tool box talks** - Installation vessel crew will be made aware of all protected species within the marine environment through the following guidance; the Marine Conservation Society (MCS) Basking Shark Code of Conduct and good practice measures for boat control near basking sharks and the Scottish Marine Wildlife Watching Code and Guide to Best Practice for Watching Marine Wildlife.

5.6 Impact assessment

5.6.1 Physical change (to another substratum type)

5.6.1.1 Sand eel (*Ammodytes* sp.)

Sand eels (Ammodytes sp.) were identified at 3 out of 15 grab sample sites along the route, an individual at S01 (KP 0.877), an individual at S05 (KP 10.480) and three individuals at S08 (KP 20.604). Later photo identification of these individuals indicated that they were most likely lesser sand eel (*A. tobianus*), a species which is listed as data deficient under the IUCN Red List of Threatened Species (Collette, Fernandes and Heessen, 2014). Their presence along the route is consistent with the Pentland Firth being a historical low-intensity spawning and nursery ground for the species (Ellis *et al.*, 2012). Due to the low number of individuals identified along the route and minimal spatial extent of cable protection measures along the route, it is expected that the effects of the cable installation activities on the species distribution and potential spawning habitat will not be significant.

5.6.1.2 Atlantic herring and other species

While the Pentland Firth has been identified as a low intensity spawning ground for Atlantic herring, sprat and lemon sole and a nursery ground for numerous other species (Section 5.3.1 above), no evidence of these species was identified during the environmental survey. Approximately 85% of the route is located at depths that are typically outside of the depth ranges for Atlantic herring spawning, further reducing the likelihood of the installation corridor being an important location for the species. Any disturbance caused by the installation activities will be temporally and spatially limited with cable protection measures being limited to rock/grout bag placement and protection at cable crossings and the use of URADUCT when crossing Annex I Stony reef habitat. This will reduce the likelihood of long-term adverse effects on the habitat and species found here. As such, it is expected that the potential for these species and their distribution within the Project area and the wider Pentland Firth to be adversely affected is negligible.

5.6.1.3 Brown crab (*Cancer pagurus*)

The results of the environmental survey (MMT, 2019a) found one single adult brown crab along the entirety of the installation corridor; no juveniles were identified. While this does not completely discount the possibility of locations along the route being utilised by juveniles as a nursery area, as the species was previously identified as utilising the wider Pentland Firth area, the installation corridor will occupy a small area in relation to their wider available habitat. The lack of identified juveniles within the corridor, and minimal area the cable and associated protection measures will occupy in the context of the wider Pentland Firth means that any impact to individuals or their habitat will be spatially and temporally negligible. As such, no significant impact on the species or its distribution within the Pentland Firth will occur as a result of the Project.

5.6.1.4 Horse mussels

The individuals identified during the environmental survey did not however form horse mussel beds, with no live individuals being identified from the imagery taken at each site. Large deposits of *M. modiolus* shells are present at points along the route however, indicating the potential historical presence of the species in the area. Due to the lack of aggregations of the *M. modiolus* being present along the route and low number of individuals being identified, physical change to the seabed as a result of the Project will not have a significant effect on the species or its' distribution in the Pentland Firth.

5.6.2 Death or injury by collision

5.6.2.1 Basking shark

Section 3.3.1.1 of the EPS Risk Assessment (Xodus Group, 2019b) assessed the potential impact of vessel collisions on basking sharks. It concluded that the risk of collision was low due to the slow-moving nature of the vessels and low likelihood of the vessels overlapping with basking sharks within the installation corridor. This is in addition to the temporal and spatial constraints of the installation activities limiting the time at which collisions could potentially occur and low population distribution of the species within the Project area. As such, impacts to the species by the installation activities are considered to be not significant. There is no change to the results of the assessment conducted in the EPS Risk Assessment (Xodus Group, 2019b).

6. MARINE MAMMALS

6.1 Introduction

This Section of the report provides further details of the marine mammals that may be present within the vicinity of the replacement cable Project. Potential impacts to marine mammals determined to be at risk of impacts from the proposed installation activities are then assessed, along with the mitigation and management measures that will be utilised to remove or reduce these impacts. This Section should be read in conjunction with the separate EPS Risk and Protected Sites and Species Assessment which assesses the risk to marine mammals based upon worse case scenarios for the Project including activity extent, time of year and duration.

6.2 Data sources

Prior to commencement of any works on the Project, an EPS Risk and Protected Sites and Species Assessment was conducted to assess the baseline for marine mammals in the vicinity of the installation corridor and assessed impacts of the Project on the relevant species. This information has been used to inform the baseline overview of this section, with the assessment findings of the EPS Risk Assessment being summarised.

- EPS Risk and Protected Sites and Species Assessment (Xodus Group, 2019b) (Appendix C)

Baseline conditions have been established by undertaking a desktop review of published information and through consultation with relevant bodies. The data sources used to inform the baseline description and assessment include but are not limited to the following:

- Joint Nature Conservation Committee (JNCC) (https://jncc.gov.uk)
- Scottish Natural Heritage (SNH) (https://www.nature.scot)
- Marine Scotland maps National Marine Planning interactive (NMPi) (https://marinescotland.atkinsgeospatial.com/nmpi)
- Abundance and Behaviour of Cetaceans & Basking Sharks in the Pentland Firth and Orkney Waters (Evans *et al*. 2010)

6.3 Marine mammal description

6.3.1 Cetaceans

All cetacean species found in the UK are listed under Annex IV of the Habitats Directive as EPS and are protected in Scottish Territorial waters under Section 39 of the Conservation (Natural Habitats, &c.) Regulations 1994, with it being an offence to capture, kill or disturb any EPS (HM Government, 1994). Additionally, as harbour porpoise and bottlenose dolphins are listed under Annex II of the Habitats Directive, conservation of these species requires designation of SAC's under Schedule 2 of the Habitats Regulations.

As detailed in Section 2.1.4, there are six commonly observed cetacean species within the Pentland Firth and four species that are infrequent visitors. These species are detailed in Table 6-1 below.

Table 6-1 Cetacean's recorded in the Pentland Firth (Reid, Evans and Northridge, 2003; Evans, Baines and Coppock, 2010; Hammond et al., 2017)

Species	Description of Occurrence	Density estimates within the Project area (individuals/km²)*	Estimated population abundance in the Project area; and the North Sea*[1]
Commonly recorded species			
Harbour porpoise (*Phocoena phocoena*)	Accounting for 50.4% of all recorded sightings in the Pentland Firth, harbour porpoise are widely distributed throughout Orkney and north Caithness, with sightings along the Caithness coast concentrated in Thurso Bay, Dunnet Bay and Gills Bay, and sightings in Orkney concentrated in the inner waters of Orkney and the Stronsay Firth. Peak sightings typically occur in the summer months between July and September. Typically found in small groups of one to three individuals, they may concentrate in larger groups to exploit good food resources.	0.152	16,822; 336,223
Minke whale (*Balaenoptera acutorostrata*)	Minke whales have a wide distribution throughout the north of Scotland, with common sighting locations in the vicinity of the installation corridor including West Hoy, Gills Bay, Dunnet Bay, Stroma and Thurso Bay. Sightings of the species have been recorded between January and October, with peak sightings occurring in summer between June and August. They are commonly sighted individually or in small groups of up to ten, but can concentrate in larger groups when foraging, with this behaviour being recorded particularly around Gills Bay.	0.01	1,319; 9,237
White-beaked dolphin (*Lagenorhynchus albirostris*)	Sightings of white-beaked dolphin are very widely distributed across northern Scotland, both on- and offshore, with small concentrations of sightings occurring in Thurso Bay and Duncansby Bay. Sightings of the species peak between June and October in the nearshore but are sighted year-round. In recent years there has been a potential range shift in the population, with a reduction in sightings being noted in northern Britain between the 1980's-90's and 2002, potentially due to changing prey distribution. Typically, the species is found in groups of less than 10 individuals, although groupings of 50 individuals or higher are not uncommon.	0.021	2,722; 16,562
Risso's dolphin (*Grampus griseus*)	Risso's dolphin are frequently sighted in the north of Scotland, with a wide distribution of sightings all over the Caithness coastline and Orkney waters. Sightings occur year-round with peaks occurring between June and August. Group sizes typically consist of less than 8 individuals, although a group of 16 individuals was observed. The species uses the region for feeding and potentially breeding, with juveniles being sighted within groups in the region.	N/A	1,569; N/A
Killer whale (*Orcinus orca*)	Widely distributed throughout the north of Scotland, within the vicinity of the cable corridor killer whales are most frequently sighted between Dunnet Head and Duncansby Head, and in adjacent waters towards Orkney. Sightings of the species have been recorded year-round, with peaks between May and July in inshore waters where killer whales have been observed predating on harbour seals, harbour porpoise, otters and common eider. Individuals typically live in stable matriarchal groups (called 'pods') of between 1 and 10 members. Photo-ID and genetic evidence suggest that the overall population within Pentland Firth and Orkney waters number as few as 30 individuals.	N/A	30; 2,437
Bottlenose dolphin	While the main populations of bottlenose dolphin in UK coastal waters are centred around Cardigan Bay in Wales and the Moray Firth in north-east Scotland, they are sighted across the UK with sightings in the north of Scotland concentrated	0.004	637; 2,222

Species	Description of Occurrence	Density estimates within the Project area (individuals/km²)*	Estimated population abundance in the Project area; and the North Sea*[1]
(*Tursiops truncatus*)	around Dunnet Bay and Thurso Bay. Sightings in the survey area peak between May and September, with group sizes of 80 individuals being recorded in this period.		
Infrequently recorded species			
Short-beaked common dolphin (*Delphinus delphis*)	In the north of Scotland, sightings for short-beaked common dolphin are concentrated between Strathy Point and Lybster Point and in and around Scapa Flow, outside of the survey area. Sightings occur between May and November with peaks in June and July, with most sightings observing groups of between 10 and 50 individuals, with the occasional larger group of up to 200 animals.	N/A	3,016; N/A
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Sightings of Atlantic white-sided dolphin have been recorded within the Pentland Firth and the west of Orkney, with sightings typically peaking between July and September but still being recorded between March and October.	N/A	559; 2,187
Long-finned pilot whale (*Globicephala melas*)	Found offshore and near-shore, near the survey area sightings of long-finned pilot whale typically concentrate around Duncansby Head and Gills Bay, with these sightings being scattered throughout the year but mainly between May and August. Sightings in winter tend to feature larger group sizes however, up to 150 animals in some cases. The species is usually found in smaller group sizes than this however, of between 6 and 40 individuals.	N/A	2,193; N/A
Sperm whale (Physeter macrocephalus)	Sperm whales are infrequent visitors to the Pentland Firth and Orkney waters, with sightings typically consisting of pods of whales of typically 6 to 15 individuals between the months of July and December.	N/A	283; N/A

* N/A denotes data deficiency

[1] Population estimates within the project area are based on a wider original proposed corridor as used in the EPS Risk Assessment accompanying this report; actual numbers will be lower in the revised final installation corridor.

6.3.1.2 Potential impacts to cetaceans

While there exists the risk of cetaceans colliding with installation vessels and equipment, due to the mobile nature of such species and limited time that the installation activities will encompass, the risk will be minimal and will not have an adverse effect on the local cetacean population.

The impact that carries the greatest risk to cetaceans within the Project area is underwater noise generated by Project vessels and installation equipment. Such noise has the ability to impact cetaceans in two ways. These are:

- Injury - physiological damage to an individuals' auditory or other internal organs, and;
- Disturbance – either temporary or continuous. While this factor does not result in injury, disruptions to behavioural patterns such as migration breathing, nursing, breeding, foraging, socialising and/or sheltering may occur.

To determine the potential impact of noise generated by the Project on cetaceans, the sound levels that will be produced are compared to the available estimated thresholds for injury and disturbance in cetaceans. JNCC guidance (JNCC and Natural England and Countryside Council for Wales, 2010) recommends using the injury criteria proposed by Southall *et al*. (2009) based on a combination of linear (un-weighted) peak pressure levels and mammal hearing weighted (M-weighted) sound exposure levels (SEL) (See Section 3.2.1.1 of the EPS Risk and Protected Sites and Species Assessment).

If frequencies of the sound produced fall outside the predicted auditory bandwidth for a species, then disturbance is unlikely. Sufficiently high noise sources can still cause damage to an individuals' auditory or other internal organs, however. For details on the typical auditory bandwidths of cetaceans, see Table 6-2 below.

Table 6-2 Auditory bandwidths estimated for hearing groups of cetaceans (Southall *et al.*, 2009; Marmo *et al.*, 2013; NFMS, 2018)

Hearing Group	Estimated Auditory Bandwidth
Low-frequency cetaceans (deep diving species e.g. minke whale, pilot whale, etc.)	7 Hz to 35 kHz, with peak sensitivity around 100- 200 Hz
Mid-frequency cetaceans (small dolphins e.g. bottlenose dolphin, common dolphin, white-beaked dolphin, etc.)	150 Hz to 160 kHz, with peak sensitivity above 10 kHz (Except for killer whales: 50 Hz to 100 kHz)
High-frequency cetaceans (harbour porpoise)	200 Hz to 180 kHz, with peak sensitivity above 4 kHz

6.3.2 Pinnipeds

Under the Marine (Scotland) Act 2010, all grey and harbour seals are protected within Scottish territorial waters, with it being an offence to kill, injure or take seals, intentionally or recklessly, without a license. The subsequent Protection of Seals (Designated Sea Haul-out Sites) (Scotland) Order 2014 made it an offence to harass a seal (intentionally or recklessly) at a haul-out site, with the Order also designating 194 protected haul-out sites around the Scottish coastline.

The waters of the Pentland Firth, and in particular Orkney are used by both grey and common seals for breeding and feeding purposes, with the region being a stronghold for both species (SNH, 2019g). Of the 194 designated haul-out sites found around Scotland, 56 are located within the Pentland Firth and Orkney Waters. Due to the western sides of the islands predominantly featuring steep cliff faces, haul out sites in the isles tend to be found along their eastern shores, which are typically more sheltered and provide for more suitable haul-out locations (Barne *et al.*, 1997). The pupping season for harbour seals in Orkney typically occurs in mid-June to July (SMRU, 2019), with the grey seal pupping season taking place later in the year, typically from mid-September up until January (Bowen, 2016). Within the cable survey corridor, the mean-at-sea distribution of harbour seals is

approximately 0-10 individuals per 25 km^2, which is lower compared to the typical North Sea average (Atkins Geospatial, 2019). The mean at-sea distribution of grey seals in the vicinity of the survey works is approximately 8-17 individuals per 25 km$_2$, which is near the mean distribution across the North Sea (Atkins Geospatial, 2019). Grey and harbour seal densities within the

6.3.2.1 Potential Impacts to pinnipeds

Similar to cetaceans, while there exists the risk of seals colliding with installation vessels and equipment, due to the mobile nature of grey and harbour seals and limited time that the installation activities will encompass, the risk will be minimal and will not have an adverse effect on the local seal population.

Seals found at haul-out sites have a typical disturbance range of 900m, where vessels or human presence at a distance lower than this may cause the seals to 'flush' from the site into the sea (Brassuer and Reijnders, 1994). There is however, no risk of the cable installation activities causing disturbance to any seal haul-out sites, due to the closest designated haul-out sites to the installation corridor being Selwick, found 11.1km north of Rackwick Bay around the Hoy coastline, and Gills Bay which is found approximately 19km to the east of the installation corridor.

Underwater noise generated by the cable installation activities poses the greatest threat to seals present within the vicinity of the cable corridor. Seals possess a typical hearing range of 50 Hz to 86 Hz (NFMS, 2018), with any underwater noise emissions within these ranges having the potential to cause physical injury to individuals or have a disturbance effect. Assessment of this impact is covered in more detail in the supporting EPS Risk and Protected Sites and Species Assessment (Section 3.2.2)

6.3.3 Otters

Otters (*Lutra lutra*) are an EPS, and as such are fully protected in Scotland (not only in protected sites) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (SNH, 2019f). As described in Section 2.1.4 there is one site in Orkney that is designated for the species; the Loch of Isbister SAC. Due to the distance of this site from the (25km straight line distance, sea distance would be even further) there is no possibility of individuals from this site being present within the installation corridor. However, an Extended Phase 1 habitat survey conducted by ERM between the 10th – 13th June 2019 and 3rd – 5th September 2019 (ERM, 2019), found otter signs (including spraints) at Rackwick Bay. The level of activity found within the survey area (otter prints, spraint, prey remains) indicate that a single individual utilises the Rackwick Bay area. An otter holt was also found near the mouth of the Burn of Clicknafea, although this was outside of the survey area and therefore outside of the installation corridor for the project.

6.3.3.1 Potential impacts to otters

As an individual has been found to utilise Rackwick Bay for as a habitat and for feeding purposes, there is the potential for installation activities to disturb the otter present here and prevent it from feeding within Rackwick Bay and cause it to abandon its' holt.

6.4 Potential impacts and zone of influence

Table 6-3 Potential pressure(s) and Zone of Influence

Activity	Pressure	Receptor	Zone of Influence
Cable installation (cable jetting and trenching)	Underwater noise emissions	Cetacean and pinniped species	Injury – 0m (Directly next to vessel) (Xodus Group, 2019b) Disturbance – Entire installation corridor (Only when noise is emitted over a period of months) (Xodus Group, 2019b)
	Presence of installation vessel	Otters	Rackwick Bay nearshore area

6.5 Mitigation

As described in Section 5.2 of the supporting EPS Risk and Protected Sites and Species Assessment, a Marine Mammal Protection Plan (MMPP) will be prepared as part of the marine CEMP to minimise the risks of disturbing marine mammals and reduce the risk of collisions. These measures are detailed in full in the EPS Risk and Protected Sites and Species Assessment and are summarised in Table 6-4 below. No additional mitigation measures have been proposed.

Table 6-4 Overview of proposed mitigation measures for marine mammals

Mitigation ID	Mitigation measure
EPSRA 1 & 2	**Marine mammal monitoring** – There will be MMO coverage for the entire duration of activities. **Marine Mammal Observer** – During daylight hours the MMO(s) will observe the sea for the presence of marine mammals and basking sharks and will have the power to delay and / or halt work activities should an individual of these species be sighted within 500m of the activities (100m when avoiding critical delays).
EPSRA 5	**Cetacean and seal mitigation zone** - Should any cetaceans or seals be detected within 500 m of the vessel prior to the commencement of installation activities (or after breaks in activity of more than 10 minutes), operations will be delayed until their passage, or the transit of the vessel, results in the cetaceans or seals being more than 500 m away from the vessel.
EPSRA 6	**Pre-soft-start search –** Visual and (if required) acoustic monitoring will occur 30 mins prior to commencement of installation activities to determine if any marine mammals or basking sharks are present within 500m of activities (100m in event of critical delay as per M2 above).
EPSRA 7	**Soft start -** For all equipment that has soft start capability: Power will be built up slowly over at least 20 minutes to give any cetaceans, seals or basking sharks adequate time to leave the area. Build-up of power will occur in uniform stages to provide a constant 'ramp-up' in amplitude.
EPSRA 8	**Passive Acoustic Monitoring (PAM)** – PAM will be utilised by a qualified MMO/PAM operator in times of poor visibility (e.g. fog).
EPSRA 10	**Reporting** – All recordings of cetaceans, seals and basking sharks will be made using JNCC Standard Forms. A monitoring report detailing the features of interest recorded, methods used to detect them, and details of any problems encountered will be submitted to Marine Scotland and SNH at the end of operations.

Additionally, mitigation measures for otters as outlined in Section 5.4 of the EPS Risk and Protected Sites and Assessment are summarised in Table 6-5 below.

Table 6-5 Overview of proposed mitigation measures for otters

Mitigation ID	Mitigation measure
EPSRA 14	**Otter survey** - A pre-installation survey at the cable landfalls will be conducted at least two months prior to works commencing. This survey will be followed up with a walkover survey immediately prior to works commencing. An ECoW will be responsible for the otter survey and for advising appropriate mitigation measures, which will be detailed in the relevant onshore CEMPS and SSEN Otter SPP, as required.
EPSRA 15	**Otter monitoring** - There will be MMO coverage for the duration of the marine activities, with adequately trained and experienced MMO(s) working standard 12-hour shifts.

6.6 Impact assessment

Assessment of the impacts of underwater noise on pinnipeds and cetaceans was detailed in Section 3.2.2 and 3.4 of the supporting EPS Risk and Protected Sites and Species Assessment respectively (Xodus Group, 2019b). Regarding cetacean species, it was determined that there should not be any adverse impacts to the Favourable Conservation Status (FCS) to local cetacean species, with recommended mitigation measures further minimising any potential disturbance effects. Regarding pinnipeds, it was determined that due to the short-term and localised nature of the installation activities and recommended mitigation strategies outlined in the report, long-term adverse impacts on grey and harbour seal populations in within the vicinity of the cable corridor are highly unlikely. As such, the actual case impacts of the Project to marine mammals in the vicinity of the installation corridor are expected to be not significant.

Assessment of the impact cable installation activities may have on otters was detailed in Section 3.2.2.1 and 3.5 of the EPS Risk Assessment (Xodus Group, 2019b). Due to the minimal time in which cable installation activities will occur within the nearshore environment of Rackwick Bay (approximately 3 days) any disturbance effects will be temporary in nature. As disturbance could still occur however, an EPS licence has been acquired for the project, with further mitigation measures (detailed in Table 6-5 above) further minimising the potential for disturbance.

7. PROTECTED SITES AND SPECIES

7.1 Introduction

This section provides further details of the protected sites and species that may be present or have the potential to be present within the vicinity of the installation corridor. Potential impacts on sites determined to be at risk of impact from the proposed installation activities are then assessed, along with the mitigation and management measures that will be utilised to remove or reduce these impacts. This Section should be read in conjunction with the separate EPS Risk and Protected Sites and Species Assessment which assesses the impacts to protected sites and species based upon worse case scenarios for the Project including activity extent, time of year and duration.

7.2 Data sources and method

Prior to commencement of any works on the Project, an EPS Risk and Protected Sites and Species Assessment was conducted to assess the impact the Project may have on protected species and habitats in the vicinity of the installation corridor. This assessment detailed the baseline for any protected sites in the area and assessed the impacts of the Project on these sites. This information has been used to inform the baseline overview of this section, and assessment findings corroborated with this report to ensure consistency.

The Project documents used to inform this baseline description include the following:

- EPS Risk and Protected Sites and Species Assessment (Xodus Group, 2019b) (Appendix C)

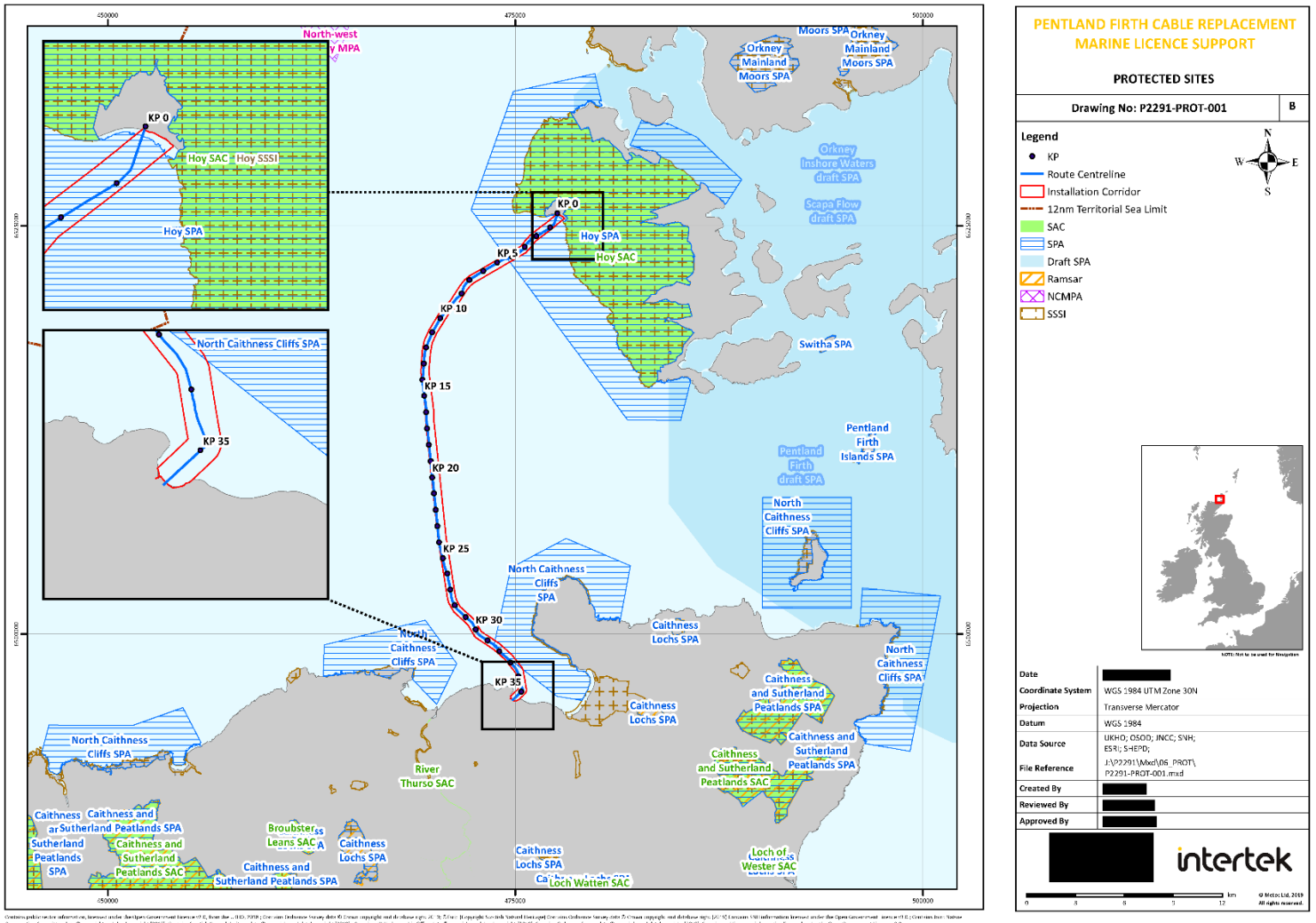
The Project documents have been supplemented where necessary to establish baseline conditions by undertaking a desktop review of published information and through consultation with relevant bodies. These data sources used to inform the baseline description and assessment include but are not limited to the following:

- Joint Nature Conservation Committee (JNCC) (https://jncc.gov.uk)
- Scottish Natural Heritage (SNH) (https://www.nature.scot)
- The Royal Society for the Protection of Birds (RSPB) (https://www.rspb.org.uk/)
- Marine Scotland maps NMPi (https://marinescotland.atkinsgeospatial.com/nmpi)

7.3 Protected sites and species

There are 6 protected sites located within the installation corridor: Hoy SPA, Hoy SAC, Hoy SSSI, Hoy RSPB Nature Reserve, Hoy and West Mainland National Scenic Area and North Caithness Cliff's SPA. Additionally, there is an area identified as a Potential Annex I Stony Reef near the Rackwick Bay landfall site. In the vicinity of the installation corridor there are a further 4 protected sites: Caithness Lochs SPA and Ramsar, Orkney Inshore Waters pSPA, Dunnet Head SSSI and three designated seal haul-out sites at Selwick, Gills Bay and Stroma. Figure 7-1 displays these sites below.

Figure 7-1 Protected sites found in the Pentland Firth and Orkney waters



7.3.2 Special Areas of Conservation (SAC)

The key directive issued by the EU to legislate for the protection of habitats and species of conservation importance is Directive 92/43/ (known as the Habitats Directive). This directive (along with the 'Birds Directive' established the Natura 2000 network of protected sites. This included the protected sites known as SACs for habitats and species. The Habitats Directive aims to promote habitat and wildlife conservation by requiring Member States to undertake measures to maintain or restore habitats and species listed on the Annexes of the directive.

7.3.2.1 Hoy SAC (Within)

The Hoy SAC covers the northern and western terrestrial environment of Hoy. There are five Annex 1 habitats that the site is primarily designated for (JNCC, 2016b). These habitats are:

- Vegetated sea cliffs of the Atlantic and Baltic Coasts
- Natural dystrophic lakes and ponds
- Northern Atlantic wet heaths with *Erica tetralix*
- Alpine and Boreal heaths
- Blanket bogs

Additionally, the site contains other Annex I habitats that are present as a qualifying feature but are not primary reasons for the sites' designation. These are:

- European dry heaths
- Petrifying springs with tufa formation (Cratoneurion)
- Alkaline fens
- Calcareous rocky slopes with chasmophytic vegetation

7.3.3 Special Protection Area (SPA)

The key directive issued by the EU to legislate for the protection birds is Directive 2009/147/EC (as amended) on the Conservation of Wild Birds (known as the Birds Directive). This directive (along with the 'Habitats Directive' established the Natura 2000 network of protected sites. This included the protected sites known as SPAs for birds. The Birds Directive aims to protect EU bird species, and their eggs, nests and habitats, through the preservation, maintenance and restoration of new and existing habitats important to bird species. This is primarily achieved through the designation of SPAs. There are more than 500 wild bird species naturally occurring in the EU which are protected under various annexes.

7.3.3.1 Hoy SPA (Within)

Covering the northern and western two-thirds of the island, the Hoy SPA contains a variety of habitat features including the old red sandstone cliffs and sea stacks, moorland, heathland and the UK's most northerly native woodland (JNCC, 2005b). This diverse range of habitats is utilised by many breeding bird populations. Qualifying species for the site is Arctic skua (*Stercorarius parasiticus*), fulmar (*Fulmarus glacialis*), great black-backed gull (*Larus marinus*), guillemot (*Uria aalge*), kittiwake (*Rissa tridactyla*), peregrine (*Falco peregrinus*), puffin (*Fratercula arctica*), red-throated diver (*Gavia stellata*), and great skua (*Stercorarius skua*). The great skua population is of international importance, accounting for 14% of the world's breeding population (JNCC, 2005b). In addition, the site supports a seabird assemblage of international importance, being home to 120 000 individuals (JNCC, 2005b).

7.3.3.2 North Caithness Cliff's SPA (Within)

Covering the majority of the Caithness coastline from Red Point to Duncansby Head, along with the Island of Stroma, the old red sandstone cliffs of this site provide nesting sites for numerous species of birds (JNCC, 2005c). These birds then utilise areas within and outwith the SPA for foraging. The site is designated primarily on the basis of six breeding bird species. These are fulmar, guillemot, kittiwake and peregrine, puffin and razorbill (*Alca torda)*. The site also features a seabird assemblage of international importance, supporting 110000 individuals during the breeding season. The site also contains several component Sites of Special Scientific Importance (SSSI'S), including Duncansby Head, Dunnet Head, Holborn Head, Red Point Coast and Stroma).

7.3.3.3 Caithness Lochs SPA and Ramsar (Approx. 6.97km east)

Loch Heilen, found approximately 6.97km east of the cable survey corridor, is a shallow mesotrophic sand loch and is part of the Caithness Lochs SPA and Ramsar site (JNCC, 2005a). The site is utilised over-winter by populations of Greenland White-fronted goose (*Anser albifrons flavirostris*) (1.3% of the Great Britain (GB) wintering population), whooper swan (*Cygnus cygnus*) (4.5% of the GB wintering population) and greylag goose (*Anser anser*) (6.9% of the wintering Iceland/UK/Ireland population).

7.3.3.4 Orkney Inshore Waters pSPA (Approx. 7.4km north)

In 2016 a number of new pSPA's were announced for public consultation. Of the proposed sites, two were located in Orkney; North Orkney pSPA and Scapa Flow pSPA (SNH, 2017a). Along with these two sites, a Pentland Firth pSPA was also announced. Following the period of public consultation and review by SNH and JNCC, in 2019 a supplementary consultation report was published which recommended for the withdrawal of the Pentland Firth pSPA, along with introducing the potential joining of the two Orkney pSPA's into a single site: the Orkney Inshore Waters pSPA (Marine Scotland, 2019a). This option is currently the preferred policy recommendation, and would provide for the protection of numerous Annex 1 or migratory breeding and non-breeding seabirds, including great northern diver (*Gavia immer*), red-throated diver, black-throated diver (*Gavia arctica*), Slavonian grebe (*Podiceps auratus*), common eider (*Somateria mollissima*), long-tailed duck (*Clangula hyemalis*), common goldeneye (*Bucephala clangula*), velvet scoter (*Melanitta fusca*), red-breasted merganser (*Mergus serrator*), and European shag (*Phalacrocorax aristotelis*). Consultation regarding the choice between one or two separate pSPA's closed on the 29th of July 2019, with some responses to this being published online. Of the consultation responses released for public viewing on the matter, there is currently a split in opinion between environmental groups such as the RSPB and the Wildfowl and Wetlands Trust who are in agreement that the 2 SPA's be combined into one, and several fishermen's associations who have indicated that they would prefer to keep the sites separated (Marine Scotland, 2019b). These responses will be considered by Scottish Ministers who will decide upon which sites to designate in the near future.

7.3.4 Sites of Special Scientific Interest (SSSI)

SSSIS are statutory designations made by SNH under the Nature Conservation (Scotland) Act 2004 (SNH, 2019h). Under Section 3 of the Act, SNH have the responsibility to designate areas of land as SSSI's that are of special interest for their flora, fauna, geology or morphology.

7.3.4.1 Hoy SSSI (Within)

Covering 94.997km² across Hoy from the interior of the island to the northern and western coasts, Hoy SSSI is designated for the protection of several geological and biological features (SNH, 2012, 2019c). Designated geological features are:

- Coastal geomorphology of Scotland (Upper Old Red Sandstone)
- Old Red Sandstone Igneous

- Quaternary geology (including the most northerly corries in Scotland) and Devonian geology (Hoy sandstone exposures on the north-west coast)

Designated biological features are:

- Blanket bog, dystrophic loch, upland oak woodland and assemblage
- Arctic skua, fulmar, great black-backed gull, great skua, guillemot, peregrine, red-throated diver and a breeding bird assemblage.

7.3.4.2 Dunnet Head SSSI (Approx. 1.71km east)

Dunnet Head SSSI, measuring 0.9305km², covers the coastal sandstone cliffs of the most northerly headland of the UK mainland (SNH, 2010a, 2018). The site has been designated for the nationally important maritime cliff top vegetation found here, along with the resident guillemot breeding colony (accounting for 1% of the UK population) and other breeding seabirds such as razorbill and fulmar.

7.3.5 Other protected sites

7.3.5.1 Hoy and West Mainland National Scenic Area (Within)

Designated in 1980, the Hoy and West Mainland National Scenic Area (NSA) covers the northern half of Hoy. The area on Hoy was designated for several Special Qualities, including its coastal scenery and the traditional buildings and crofting patterns of Rackwick (SNH, 2010b). The areas original description from Scotland's Scenic Heritage 1978 describe the hills of North Hoy as '..dominating the Orkney scene with a power that is scarcely in tune with their modest height' and that '..their bold shape, fine grouping, soaring cliffs and headlands, including the famous stack of the Old Man of Hoy, are almost as important to the Caithness scene as they are in that of Orkney'.

7.3.5.2 Potential Reef (Within)

The intertidal section of the cable landfall site passes within an area designated as potential Annex I bedrock reef by the JNCC. This area of potential reef stretches across much of Orkneys waters and the north-east coast of Caithness. Bedrock reef occurs in areas where the underlying bedrock rises above the seabed and creates a hard surface for species such as corals, sponges and sea squirts, as well as providing shelter for other crustacean and fish species (JNCC, 2014).

7.3.5.3 Designated Seal Haul-Out Sites (10.6km north)

As described in Section 2.2.12, The Protection of Seals (Designation of Haul-out Sites) (Scotland) Order 2014 designated 194 seal haul-out sites around the coast of Scotland, providing seals increased legal protection at the time when they are most vulnerable out of the water. There are no designated haul-out sites located in the direct vicinity of the replacement installation corridor. The closest haul sites to the cable corridor include the Selwick site for harbour seals (found approximately 10.6km around the coast to the north of Hoy), Gills Bay for grey seals (found approximately 19.1km to the east) and Stroma for grey seals (found approximately 20.5km to the east) (Atkins Geospatial, 2019). The distance at which seals are disturbed at haul-out sites by human presence has been estimated to be 900m (Brassuer and Reijnders, 1994). As the closest site is 10.6km from the installation corridor, installation activities will not disturb any seal haul-out sites, with these sites not being considered further in this assessment.

7.3.6 Non-protected sites of interest

7.3.6.1 Hoy RSPB Nature Reserve (Within)

The Hoy RSPB Nature Reserve is the largest of its kind in Orkney, measuring 39.26km² (RSPB, 2019a). Important habitat for breeding birds such as the blanket bog and dry heath within the site is maintained by the organisation. Key species found within the reserve include great skua, hen harrier (*Circus cyaneus*), puffin, red-throated diver and European stonechat (*Saxicola rubicola*).

7.4 Potential impacts and zones of influence

Review of the baseline data has identified the following impact that may cause an adverse effect to receiving environment and species in the vicinity of the cable corridor, along with the worst-case Zone of Influence (ZOI) of the impact (Table 7-1).

Table 7-1 Potential impacts and zone of influence

Activity	Impact	Receiving environment/ species	Zone of influence
Cable installation Surface lay with rock/grout bags, post-lay jetting and trenching)	Physical presence of installation vessels	Breeding and non-breeding seabirds	4km divers and sea ducks. 2km all other seabird species. Based on the extent and potential consequences of seabird displacement from offshore wind farm developments published by the UK Joint SNCB (JNCC, 2017). Disturbance will be limited in extent and duration and there is sufficient space in the surrounding environment for birds to temporarily relocate. Therefore, only sites within 2-4km of the proposed installation and maintenance activities have been screened for displacement (dependant on species present).

7.5 Mitigation

As described in Section 5.5 of the EPS Risk Assessment, several mitigation measures have been recommended to minimise the risks of disturbing seabirds. No new mitigation measures have been proposed. These measures are detailed in full in the EPS Risk Assessment and are summarised in Table 7-2 below.

Table 7-2 Overview of proposed mitigation measures for seabirds

Mitigation ID	Mitigation measure
EPSRA 16	**Rafting seabirds -** The survey vessels will be moving at a maximum speed of 4 knots to allow any rafting seabirds time to move away from the vessel should they be disturbed by the vessel presence.
EPSRA 17	**Wintering birds** - When within a SPA which has been designated for wintering birds that may roost or feed in close proximity to the installation corridor or the landfall, further consultation will be undertaken with SNH on the requirement for any seasonal restriction to be implemented for cable installation in order to avoid disturbance to qualifying species.
EPSRA 18	**Breeding birds** - When within a SPA which has been designated for breeding birds that may nest or feed in close proximity to the installation corridor or the landfall, further consultation will be undertaken with SNH on the requirement for any seasonal restriction to be implemented for cable installation in order to avoid disturbance to qualifying species.
EPSRA 19	**Light disturbance** - When within a SPA and where there is potential for 24 hour working, lighting on-board the cable survey vessel(s) will be kept to the minimum level required to ensure safe operations and lights will be directed or shielded to prevent upward illumination and minimise disturbance.

7.6 Impact assessment

7.6.1 Physical presence of installation vessels

Within the vicinity of the installation corridor there are two protected sites that contain protected seabird features that may potentially be impacted by the presence of the installation vessels. These sites, and their protected species, are:

- Hoy SPA (Including component Hoy SSSI, within installation corridor) – Arctic skua, fulmar, great black-backed gull, great skua, guillemot, kittiwake, peregrine, puffin, red-throated diver, seabird assemblage
- North Caithness Cliffs SPA (Including component Dunnet Head SSSI, within installation corridor) – Fulmar, guillemot, kittiwake, peregrine, puffin, razorbill, seabird assemblage of international importance

Disturbance can lead to a number of physiological and behavioural responses which can affect demographic characters of the population. Responses to disturbance can result in: loss of energy; impaired breeding; unrest through increased vigilance; disruption to incubation; and increased nest failures due to predation and nest abandonment (Valente and Fischer, 2011).

The extent to which a seabird responds to disturbance is dependent upon a number of factors including: period of breeding cycle during which disturbance occurs; duration, type and intensity of the disturbance (e.g. onshore works are likely to be more disruptive to seabirds than the offshore works due to the generation of loud noises and use of machinery); presence of opportunistic predators; and the degree of habituation with the disturbance (Showler *et al.*, 2010). Some seabirds are more resilient to disturbance than others.

There is also the potential for temporary visual and noise disturbance to interrupt breeding and feeding activities of birds located at sea along the coastline. Disturbance is predicted to be limited to that initiated by the movement of vessels or by noise impacting birds causing them to flush into flight or dive. The level of noise associated with offshore cable installation activity is low with the presence of vessels the main cause of disturbance.

7.6.1.1 Hoy SPA

Conservation objectives (SNH, 2019a)
To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained.

To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site
- Distribution of the species within the site
- Distribution and extent of the habitats supporting the species
- Structure, function and supporting processes of habitats supporting the species
- No significant disturbance of the species

Assessment against conservation objectives
The installation corridor passes within the Hoy SPA for approximately 4.15km, within an area of approximately 1.97km² (0.01% of the overall area of the SPA). The Hoy SPA covers the northern and western two-thirds of the island, as well as a large extent of the western coastline and marine area, accounting for approximately 47.6% of the SPA's total area (JNCC, 2016c). Of the features protected within this site, six have been assessed to be of favourable/recovering condition (Arctic skua, great

black-backed gull, great skua, peregrine, red-throated diver and the seabird assemblage) with four features being of unfavourable condition (fulmar, guillemot, kittiwake and puffin) (SNH, 2019e).

Red-throated diver and great skua are known to nest inland on the moorland habitat found in the interior of the island (JNCC, 2005b). The other species protected within this site utilise the old red sandstone cliffs for nesting and breeding. Due to installation corridors' (and therefore installation vessels) distance from these breeding sites, the Project will not have any adverse effect on the distribution and extent of these habitats or their structure, function and supporting processes.

While the cable does pass through an area of sea that could potentially be utilised for foraging purposes by the bird populations within the SPA, due to the minimal extent the cable will occupy and short timeframe of the installation vessels presence (see Appendix A, project description for schedule), any disturbance to birds in the area will be temporary and therefore not cause significant disturbance to any species or significantly affect their distribution within the site. Installation works are scheduled to commence nearshore at Rackwick Bay. Additionally, due to the Pentland Firth being utilised by high numbers of shipping vessels, and Northlinks' *Hamnavoe* ferry route passing close to the west coast of Hoy and the north Caithness coast, nesting birds at these locations will already be habituated to the presence of vessels in the area.

As such, the populations of all protected species will remain viable components of the site, with the integrity of the Hoy SPA being maintained.

7.6.1.2 North Caithness Cliffs SPA

Conservation objectives (SNH, 2019b)
To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained.

To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site
- Distribution of the species within the site
- Distribution and extent of the habitats supporting the species
- Structure, function and supporting processes of habitats supporting the species
- No significant disturbance of the species

Assessment against conservation objectives
The installation corridor passes through the North Caithness Cliffs SPA for approximately 2.45km, within an area of approximately 0.51km² (0.003% of the overall area of the SPA). The North Caithness Cliffs SPA covers the majority of the sea cliffs along the north Caithness coast between Red Point and Duncansby Head. Of relevance to this Project are the cliffs at Dunnet Head, which is a component SSSI of the overall North Caithness Cliffs SPA. Erosion of the sandstone cliffs creates ideal nesting ledges for breeding seabirds (SNH, 2010a) such as razorbill, kittiwake, fulmar, peregrine, puffin and guillemot, with the guillemot colony accounting for 1% of the overall UK population. Both the guillemot colony and seabird assemblage found at Dunnet Head are currently of favourable condition (last surveyed in 2016) (SNH, 2019d). Nesting seabirds at the site are found primarily to the north-west of the site, located approximately 3.96km from the cable survey corridor.

Due to the distance from the survey corridor to the cliffs of Dunnet Head preventing any direct interaction with the cliffside nesting habitat, there will be no adverse effect on the distribution and extent of these habitats or their structure, function and supporting processes.

While the cable does pass through an area of sea that could potentially be utilised for foraging purposes by the bird populations within the SPA, due to the minimal extent the cable will occupy and

short timeframe of the installation vessels presence (see Appendix A, project description for schedule), any disturbance to birds in the area will be temporary and therefore not cause significant disturbance to any species or significantly affect their distribution within the site. Findings from the environmental survey report did not indicate the presence of significant numbers of sand eels (a common prey species of many coastal bird species) along the installation corridor, indicating that the corridor will not pass through any important feeding areas for the local populations. Installation works are scheduled to commence at Rackwick Bay. Additionally, due to the Pentland Firth being utilised by high numbers of shipping vessels, and Northlinks' *Hamnavoe* ferry route passing close to the west coast of Hoy and the north Caithness coast, nesting birds at these locations will already be habituated to the presence of vessels in the area.

7.6.2 EPS Risk and Protected Sites and Species Assessment

The findings of this assessment match the findings of the protected sites assessment presented in the EPS Risk and Protected Sites and Species Assessment (Xodus Group, 2019b), with that assessment concluding that 'Due to the temporary and localised nature of the Project activities no significant or adverse impact is anticipated'.

8. MARINE ARCHAEOLOGY

8.1 Introduction

This Section describes the key characteristics of the marine historic environment along the installation corridor between Rackwick Bay, Hoy and Murkle Bay in Caithness (Section 8.4) and presents results from an assessment of potential impacts of the Project on these characteristics (Section 8.5).

This Section also describes the methodologies and the criteria used to determine the importance or sensitivity of the identified historic environment assets (Section 8.3). Where potential direct or indirect impacts are identified (Section 8.5), recommendations have been made for mitigating and managing those impacts (Section 8.6).

Marine cultural heritage encompasses not only shipwrecks, but also other evidence of human exploitation of maritime resources, such as shipyards, piers, fish traps, anchor sites and submerged landscapes where human beings and early hominids 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 (Marine (Scotland) Act 2010, Section 73, Paragraph 5).

The Section uses the following terms for different aspects of the cable corridor:

- Cable survey corridor – 500m wide corridor, within which the marine geophysical and geotechnical surveys were conducted, and the core area of the Desk Based Assessment (DBA);
- RPL – the Route Plan Line (RPL), a route within the cable survey corridor, used by MMT (MMT, 2019b). The final cable route is yet to be determined.

8.2 Sources of Information

8.2.1 Desk-based assesment

The principal reference sources examined for this assessment 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/);
- Statutory lists, registers and designated areas, including List of Scheduled Ancient Monuments, Designated Wrecks and Historic Marine Protected Areas;
- UK Hydrographic Office (UKHO) wreck register and relevant nautical charts;
- Aviation Research Group Orkney and Shetland http://www.crashsiteorkney.com; (ARGOS, 2019)
- Flemming, N.C., (2003). Strategic Environmental Assessment of Continental Shelf Area SEA4 in regard to prehistoric archaeological remains. Prepared for the Dept of Trade & Industry; (Flemming, 2003)
- Larn, R., & 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;
- Heath/Ferguson private wreck database, which contains material not published by Ferguson and has been added to by Heath and Ferguson as new discoveries of wreck sites have been made;
- Further information on wrecks was followed up in the National Archives Admiralty (ADM) files, based at Kew in Surrey, which holds ship log books and casualty reports from wrecks (http://www.nationalarchives.gov.uk/);

- Other readily available archaeological and historical reports, databases, websites and publications were consulted for information about the area of the survey corridor and, where used, are cited in the report. They are listed in the reference Section.

8.2.2 Field surveys

MMT were contracted by Global Marine Group to undertake geophysical, geotechnical and environmental surveys for the installation corridor. The objective of the surveys was to provide overview information of the geophysical conditions along the entire survey route, based on interpretations of obtained data, determining conditions with regards to bathymetry, geology, and other seabed features detected during the surveys (MMT, 2019b). The data from these surveys have been reviewed by a marine archaeologist and used in this Section where appropriate.

8.3 Assessment methodology

The following codes of practice, professional guidance and standards documents informed the work conducted for this report:

- The Chartered Institute for Archaeologists (CifA) Codes, Standards and Guidance (various) https://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. & 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);
- Historic Environment Scotland Designation Policy and Selection Guidance 2019;
- The Joint Nautical Archaeology Policy Committee and Crown Estate. (2006). Maritime Cultural Heritage & Seabed Development: JNAPC Code of Practice for Seabed Development. York: CBA;
- Plets, R., Dix, J., & 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; (The Crown Estate, 2014)
- Wessex Archaeology. (2006). On the Importance of Shipwrecks: Final Report Volume 1. Salisbury: Wessex Archaeology; (Wessex Archaeology, 2006)
- Wessex Archaeology. (2011a). Assessing Boats and Ships 1860-1913 Archaeological Desk-Based Assessment. Salisbury: Wessex Archaeology; (Wessex Archaeology, 2011a)
- Wessex Archaeology. (2011b). Assessing Boats and Ships 1914-1938 Archaeological Desk-Based Assessment. Salisbury: Wessex Archaeology; (Wessex Archaeology, 2011b) and
- Wessex Archaeology. (2011c). Assessing Boats and Ships 1939-1950 Archaeological Desk-Based Assessment. Salisbury: Wessex Archaeology. (Wessex Archaeology, 2011c)

8.3.1 Desk based assessment

The DBA was conducted to identify possible submerged cultural heritage within the 500m wide cable survey corridor (the installation corridor). It was completed in accordance with the CIfA Standard and Guidance for historic environment desk-based assessment (Chartered Institute for Archaeologists,

2014) and reviewed key data sources of known submerged sites within the installation corridor. Any items identified outside, but close to this corridor are also detailed in this report. This is because the listed positions of many of these sites are completely unverified or categorised as Position Approximate by the UKHO. Therefore, although the listed positions may be located outside the installation corridor, descriptions of their circumstance of loss indicate they could be located within it and thus be impacted.

8.3.2 Field surveys

MMT were contracted by Global Marine Group to undertake geophysical, geotechnical and environmental surveys for the cable corridor. The objective of the surveys was to provide overview information of the geophysical conditions along the entire survey route, based on interpretations of obtained data, determining conditions with regards to bathymetry, geology, and other seabed features detected during the surveys (MMT 2019).

ORCA conducted a review and analysis of the SSS and MBES images of the whole corridor, and all SSS contacts and magnetic (MAG) anomalies identified by MMT, provided as lists (ORCA 2019). See Table 8-2 for how geophysical contacts and anomalies were evaluated. The results from this have been integrated into this report.

ORCA conducted an assessment of the 18 offshore VC logs, the grab sample logs and the results from 19 Trial Pits (TPs) dug at Murkle Bay and Rackwick. This geotechnical investigation programme was conducted by MMT and the relevant data supplied to ORCA.

The methods, resolution limitations and results of the subsea surveys by MMT were presented in the reports that accompanied the data files for review (MMT 2019). All surveys were of sufficient standard and specification for archaeological review by an experienced marine archaeologist to identify and assess any anthropogenic anomalies. All survey data was acquired in the WGS 1984 UTM Zone 30N coordinate system.

8.3.3 Receptor evaluation

The importance attributed to each area, site or feature identified is determined following the criteria outlined in Table 8-1, which incorporate general guidelines used by statutory authorities and agencies such as the Scottish Government and Historic Environment Scotland. These are outlined in the Historic Environment Policy Statement for Scotland (HEPS) 2019 with the accompanying Designation Policy and Selection Guidance 2019; Scottish Planning Policy (SPP) 2014; Planning Advice Note (PAN 2/2011) Planning and Archaeology; the Marine (Scotland) Act 2010; English Heritage Designation Selection Guide: Ships and Boats, Prehistory to Present (2012); and Wessex Archaeology's three-part Assessing Boats and Ships 1860-1950 (2011). It should be noted that a site that has not been statutorily designated can still be of high importance. Features for which further information is unavailable are recorded as of uncertain importance. The weight given to historic environment considerations will depend on a number of factors, including intrinsic, contextual and associative characteristics (Designation Policy and Selection Guidance 2019, Annex 5, paragraphs 15-17).

Table 8-1 Definitions of importance of archaeological and historical sites

Level of importance (sensitivity)	Criteria
Very High	Archaeological and historical sites, submerged prehistoric landscapes and deposits, wrecks, wreck cargos, or areas of relative international importance, including world heritage sites. Shipwrecks dating to the prehistoric, Norse and Medieval periods, which are very rare; wreck cargos that contain very rare artefacts or artefacts representative of a particular area or time period; vessels and aircraft, lost in international conflicts, which involved losses of life. Shipwrecks involved in international trade, which were lost before 1913, a period during which the shipping industry was a major element in Britain's world influence, but only if the cargo is likely to survive and is of very high historical value, or if the remains provide evidence of ground-breaking changes in construction technology or vessel design and if the vessel type is extremely rare.
High	Archaeological and historical sites, submerged prehistoric landscapes and deposits, wrecks, wreck cargos, or areas of relative national importance, including designated wrecks (designated under UK or Scottish legislation) or HMPAs. Shipwrecks dating to the prehistoric, Norse and Medieval periods, which are rare; wreck cargos that contain rare artefacts or artefacts representative of a particular area or time period; non-designated vessels and aircraft, lost in conflicts, which involved losses of life; aircraft lost while on military service, 20th–century vessels lost during peacetime with known losses of life likely to remain onboard. Shipwrecks involved in national trade, which were lost before 1913, a period during which the shipping industry was a major element in Britain's world influence, but only if the cargo is likely to survive and is of high historical value, or if the remains provide evidence of changes in construction technology or vessel design and if the vessel type is rare.
Medium	Archaeological and historical sites, wrecks, wreck cargos and areas of relative regional importance, or high local significance due to local associations. Shipwrecks, shipwreck cargos, anchorages and fishing areas from before 1913 that would have been involved in regional industry and trade if they are representative of the changes in naval engineering or support the identification and preservation of the diversity of vessels from this period, but only if the cargo is likely to survive and is of moderate historical value, or if the vessel type is not common.
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. Vessel types and cargos of limited intrinsic, contextual or associative characteristics, or that are still common.
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. Find-spots, which may represent an isolated find, or could represent the location of a hitherto unknown site. Unidentified geophysical contacts/anomalies are also of uncertain importance and are evaluated further in Table 8-2.

Many of the contacts/anomalies recorded in the analysis of the geophysical datasets cannot be assigned a level of importance based on the criteria outlined in Table 8-1 as without visual 'ground-truthing' very little is known about them. The potential for these contacts/anomalies to be anthropogenic is therefore outlined in Table 8-2. Note that though classed as 'high', 'medium' and 'low', levels of geophysical potential do not imply a historical value to the contacts/anomalies – a contact/anomaly may be of high geophysical potential (i.e. it looks anthropogenic) but may not be of historical importance.

Table 8-2 Definitions of level of potential of geophysical contacts / anomalies

Level of geophysical potential	Description
High	Contact/Anomaly 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 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 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.

8.3.4 Impact Evaluation

8.3.4.1 Magnitude of impact

In order to allow for flexibility in the licence application and during cable installation, it is assumed that anywhere within the 500m wide survey corridor could be impacted, but that as part of the embedded project design the cable will avoid wrecks and will avoid any other identified historic environment assets where reasonably possible.

The magnitude of any potential adverse effects on marine cultural heritage receptors caused by the Project are determined using the criteria outlined in Table 8-3. It should be noted that these categories are guideline criteria, since assessments of magnitude are also matters of professional judgement. Any positive impacts will be addressed individually, using similar levels of magnitude.

Table 8-3 Definitions of magnitude of adverse impact

Magnitude of Impact	Description of Direct Impact	Description of Indirect Impact
Major	Works would result in the complete loss of the site or the loss of an area, features or evidence fundamental to the historic character and integrity of the site, severance of which would result in the complete loss of physical integrity.	The removal of, or a fundamental and irreversible change to, the relationship between a marine heritage asset or environment and a historically relevant seabed context. Major change that removes or prevents appreciation of characteristics key to a heritage asset, or permanent change to or removal of surroundings of a less sensitive asset or seabed context. A noticeable change to a key relationship between a marine heritage asset or environment and a highly sensitive, valued or historically relevant seabed context over a wide area or an intensive change to a less sensitive or valued asset or seabed context over a limited area.
Moderate	Works would result in the loss of an important part of the site or some important features and evidence, but not areas or features fundamental to its historic character and integrity. Severance would affect the integrity of the site, but key physical relationships would not be lost.	Noticeable change to a non-key relationship between a marine heritage asset or environment and a historically relevant seabed context. Relationship, asset, or context tolerant of moderate levels of change. Small changes to the relationship between a heritage asset and a historically relevant seabed context over a wide area or noticeable change over a limited area.
Minor	Works or the severance of the site would not affect the main features of the site. The historic integrity of the site would not be significantly affected.	Minor changes to the relationship between a heritage asset or environment and a historically relevant seabed context over a wide area or minor changes over a limited area. Relationship, asset, or context considered tolerant of change.

Magnitude of Impact	Description of Direct Impact	Description of Indirect Impact
Negligible	A very slight change, which is barely distinguishable, and approximates to the 'no change' situation	A very slight change, which is barely distinguishable, and approximates to the 'no change' situation.

8.3.4.2 Significance of Effect

Magnitude of impact is combined with the historic importance or sensitivity of the receptor to produce an overall effect significance. As per the assessment of magnitude of impact, Table 8-4 below is a guide and the final assessment of significance of effect will also require professional judgement.

In this methodology, moderate and major effects are considered significant effects that may require control, management and mitigation. However, it should be noted that impacts that lead to non-significant effects may still benefit from management or mitigation.

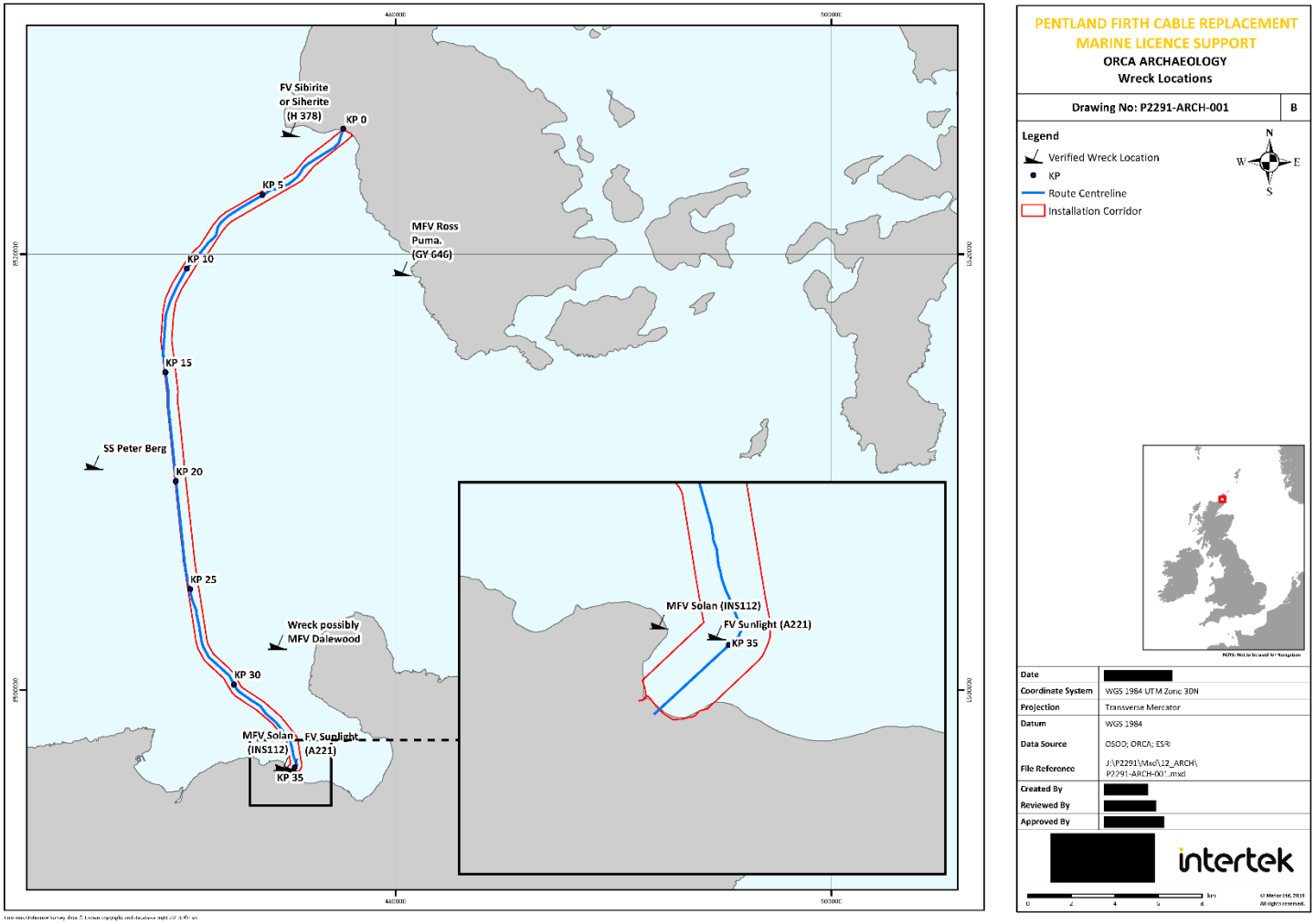
Table 8-4 Significance of effect matrix

Magnitude	Historic Importance/Sensitivity				
	Negligible	Low	Medium	High	Very high
Negligible	Negligible	Negligible	Negligible	Minor	Minor
Minor	Negligible	Negligible	Minor	Minor or moderate	Moderate
Moderate	Negligible	Minor	Moderate	Moderate	Major
Major	Minor	Minor or moderate	Moderate	Major	Major

8.4 Site characterisation

Figure 8-1 below highlights the location of notable archaeological findings within the vicinity of the installation corridor.

Figure 8-1 Archaeology location map in the Pentland Firth



8.4.1 Potential for submerged landscapes and prehistoric sites

Hominids and humans have occupied the UK continental shelf (UKCS) at various times for more than 700,000 years, but finds showing this are incredibly rare. Submerged landscapes are where human beings and early hominids 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. Although in general terms, the potential for submerged prehistoric archaeology and landscapes across wide areas of the UKCS is high (DECC, 2009), the potential for site preservation in areas of the shelf deeper than 80 m is low (Flemming, 2003).

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

Recent research and modelling indicates that the relative sea level was perhaps 20 m lower 10,000 years ago, before rising comparatively quickly up to 7,000 years ago, slowing after that until by roughly 5,000 years ago, the coastlines of Orkney and Caithness are, with some later localised transgressions and regional variation, roughly as we see them now (Bates *et al.*, 2013; Dawson and Smith, 1997; Mcilvenny, 2009; Timpany *et al.*, 2017; Wickham-Jones and Bates, 2016). The evidence shows that relative sea level has risen significantly since prehistory.

A deposit of silty sand and marine shell that was laid down around 8200 BP resulting from the Storegga tsunami extreme event has been recorded in sediment sequences from northern Shetland to as far south as north east England (Smith *et al.*, 2004). It has been recorded in sediments in the lower Wick valley (Dawson and Smith 1997), below the intertidal peat in Dunnet Bay itself (Mcilvenny, 2009; McIlvenny, Muller and Dawson, 2013) and at Strath Halladale, west of Dounreay (McIlvenny, Muller and Dawson, 2013)(Dawson 1999).

Investigations at Dunnet Bay have shown the presence of a series of intercalated sand and peat layers, including intertidal peats containing remnant tree stumps or submerged forest (McIlvenny, Muller and Dawson, 2013). The lowest peat layer has been radiocarbon dated as forming in the Late Mesolithic period between 5770-5630 cal BC and 4440-4270 cal BC (McIllvenny 2009). Peat layers from the Early Bronze Age (2040-1880 cal BC) and the Early Iron Age (740-390 cal BC) have also been observed (Mcilvenny, 2009; McIlvenny, Muller and Dawson, 2013). The peat sequences from Dunnet Bay highlight the potential for peats to be present at landfall and in the intertidal zone of the cable corridor.

Equally informative submerged wood and intertidal peat deposits have been recorded in small bays across the Orkney archipelago, largely dated between 4800-3000 cal BC (e.g. Buckland *et al*. 1998; Timpany *et al*. 2017) covering a critical period in prehistory, the Mesolithic-Neolithic transition, when the hunter-gatherer lifestyle was replaced with one of sedentism and agriculture.

Despite the proven potential for evidence outlined above, the onshore and nearshore geotechnical information from the TPs in Murkle Bay and Rack Wick, revealed no peat deposits of interest (ORCA, 2019). No organic sediments were recorded in any of the VC samples offshore, or in the shallow grab samples from the benthic layer (ORCA, 2019).

8.4.2 Shipwrecks and aircraft wrecks

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. The coastal archaeological evidence suggests exploitation of the marine environment within the Project area for fishing and transport purposes from prehistoric times.

Therefore, there is a high probability for unknown, unrecorded vessels to have sunk in the Project area over the centuries. If these have not been destroyed by the marine environment, the remains of such vessels and their associated artefacts may not always be visible in geophysical data, due to being constructed from materials that do not provide strong geophysical or magnetic returns or buried beneath the surface of the seabed. However, based on results from the geophysical surveys conducted, the nature of the seabed as shown by the surveys, and the likely narrow width of potential disturbance within the cable corridor, the risk of impacting unknown remains has been reduced overall to low.

No marine cultural heritage statutory designations have been identified in or within 1.5km on either side of the cable survey corridor.

There are a total of 65 wrecks that may be in or close to the cable corridor (see ORCA 2019). Most do not have known locations.

Two of these wrecks are losses from WW1 (HMT *Orsino*) and WW2 (SS *Navarra*), which as such should be considered as war graves if found and are of high importance. Indications from the War Day Books (Kriegstagebücher or KTB) that sank the vessels are that they are likely to be west of the cable corridor not in it (ORCA, 2019).

There are eight wrecks from the 18th and 19th centuries potentially lost within the cable survey corridor that, if they survive, are considered to be of high or medium importance, because of their date, their cargo, being involved in international or regional trade, or as evidence of new and changing technologies, especially in the transition from sail to steam.

There are a further eight wrecks from the late 18th, 19th and early 20th centuries that are considered to be of low-medium importance, and another 26 of low importance despite their pre-1914 date because they are well-recorded common vessel types, with cargos of low importance.

Two modern wrecks must be considered of high importance (the *Celerity* and the *Desire*), because crew were lost and never recovered. The former was lost in 1981, the latter in 1963, and there are likely to be relatives still living.

There are three modern wrecks of low importance and seven of negligible importance that were identified by the DBA. Four of these have locations that are outwith the cable survey corridor (see Figure 8-1) and one, the FV *Sunlight*, is within the survey corridor, but is of negligible importance. The likely remains of the boiler from this have been identified in the bathymetric data.

The likelihood of unknown unrecorded wrecks being impacted is low due to the geophysical survey work conducted by MMT and the nature of the seabed along much of the route, which is not conducive to good preservation conditions, except in parts of Murkle Bay and Dunnet Bay.

There are 16 known aircraft potentially lost in the vicinity of the cable survey corridor, all during WW2 (ORCA, 2019). The exact location of their loss is unknown and the locations given in Canmore are arbitrary approximate locations.

These aircraft are automatically protected under the Protection of Military Remains Act 1986 (PoMRA) since they were lost on active service. Therefore, these would be considered of high importance if found. No likely wreckage from these aircraft have been identified by the review of the geophysical data, indicating that the risk of the Project chancing across one of these is negligible-low.

8.4.3 Unexploded ordinance (UXO)

During both World Wars a large amount of ordnance, both offensive and defensive, was used in the seas around Orkney and the Pentland Firth. Some of these munitions still exist and are regularly found by divers or fishermen. These finds are taken very seriously by the Ministry of Defence (MOD) who

immediately deploy a bomb disposal team to assess and deal with the items located. They are usually detonated where they are found, as it is considered too dangerous to move them.

Figure 8-2 The Whitten Head Mine Field

One of the largest German minefields was laid to the north of mainland Scotland by surface raider SMS Möwe in January 1916. This was known to the British as the Whitten Head Field and had over 250 mines (Figure 8-2). By the end of April 1916, the Royal Navy had accounted for 70 of these mines and considered the field cleared. However, there is the low possibility that live mines from the Whitten Head minefield could have drifted into the cable corridor either as a result of minesweeping operations or mines having broken free of their mooring. Mines associated with the Whitten Head Field have been found ashore on Orkney and in the Pentland Firth.

The only reported U-Boat mine-laying activity near the cable survey corridor is off the Old Man of Hoy, with four mines laid by U-80 21st January 1917. The report in the KTB states the four mines were laid on high water slack 0.9 miles from land. The Bi Monthly minesweeping reports show that the area was subsequently swept for mines 9th April 1917 and a further 4 mines in groups of two were found, indicating that there had been some further mine-laying. Two were a mile north west of the Old Man of Hoy and the other two were 1.5 miles west of Old Man of Hoy (PROADM 116-1516 Bi monthly minesweeping reports). No further mines were reported after this.

It should be noted that this historic environment baseline assessment of the potential for UXO in the study area does not replace any UXO identification and mitigation study commissioned for the Project.

8.4.4 Geophysical anomalies

8.4.4.1 SSS contacts

MMT's offshore SSS survey produced 695 contacts (MMT, 2019b). 677 of these were identified as natural features, such as boulders. The other 18 were classified as potential anthropogenic debris, four of which correlated with MAG anomalies inside the survey corridor. All contacts were reviewed by and the 18 contacts identified as debris were re-evaluated as natural features (ORCA, 2019), or could not be identified on the images provided. No anthropogenic contacts (high or medium geophysical potential) were identified.

8.4.4.2 Multi-beam echosounder (MBES) anomalies

The review of MMT's MBES survey raster datasets did not reveal any potential anthropogenic features that had not already been identified in, or provide any further information already obtained from, the SSS and MAG geophysical survey data. Review of 4Docean's nearshore DTM surveys in the bays at either end of the cable corridor (MMT, 2019b) identified a likely anthropogenic feature in Murkle Bay, that could also be seen on the overlapping MBES data. It is thought that the contact and debris could be the boiler and associated wreckage from FV *Sunlight*, wrecked in the 1950s (ORCA 2019). This is 172m to the SW of the recorded location at 58 36.442N 03 25.647W. The *Sunlight* is of negligible importance.

The results of MMT's geophysical surveys as they relate to the nature of the seabed are described in their report (MMT, 2019b). The MBES data gave full coverage of the proposed cable route showing good seabed detail, including sand ripples, sand waves and boulders and rocks. The existing power cables could be clearly seen when not covered by sand.

In general, the MBES data indicates that the potential for unknown undiscovered historic environment assets is low along much of the corridor due to the conditions on the seabed. Wrecks will be damaged and destroyed by lying exposed on compact surfaces (including bedrock); by being subject to migrating seabed sediments; by marine flora and fauna if wooden; and by strong currents.

The areas of soft clays and less mobile sands are where there is a low-moderate potential for undiscovered remains to lie buried, in parts of Murkle Bay and Dunnet Bay, which are sheltered by Dunnet Head.

8.4.4.3 Magnetic (MAG) anomalies

A total of 170 MAG anomalies were identified in the survey corridor. Of these, 97 are associated with cables or possible cables. Other than these, no potential anthropogenic anomalies were identified during SULA and ORCA's review of the MAG data (ORCA 2019).

The majority of anomalies not correlating to cables showed no visual indication on either SSS or MBES and appear to be buried under the sand. The anomalies have a low magnetic signature and are widely spread along the whole route. Therefore, they are most likely to be geological in origin.

8.5 Mitigation

In general terms, it is preferable to manage the presence of cultural heritage sites by routing the cable and locating construction footprints 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 there being no identified maritime heritage assets in the form of geophysical contacts or verified sites within the corridor. The mitigation and management measures outlined in Table 8-5 below will result in the avoidance, reduction or offsetting of any potential impacts on cultural heritage by the Project.

Table 8-5 Overview of proposed mitigation measures for marine archaeology

Mitigation ID	Mitigation measure
ARCH 2	**Mitigation during installation** - In order to manage the potential for impacting unknown heritage, the Crown Estate's PAD reporting protocol (2014) produced by Wessex Archaeology will be implemented. The use of vessels with DP positioning systems rather than anchors will further prevent accidental impact.

8.6 Potential impacts

The potential impacts to marine historic environment assets are identified below.

8.6.1 Direct damage to or destruction of known and unknown marine historic envornment assets inculding unexploded ordnance

During seabed preparation, direct impacts to known and unknown cultural material on the seabed could be caused by vessel activities, seabed preparation, boulder clearance and grapnel hooking of debris, resulting in the removal of marine cultural heritage or removal of material that forms the context of the site. See Table 8-5 for suggested Project mitigation measures that will prevent such impacts.

During construction and installation, direct impacts to known and unknown cultural material on the seabed could be caused by activities resulting in the removal of marine cultural heritage or removal of material that forms the context of the site. Cable trenching and drilling activities at landfalls and trenching along the cable route could cause greater potential impacts as they penetrate the seabed surface resulting in the potential destruction of any cultural heritage beneath and in the immediate vicinity of the cable route. Cable installation and burial, vessel activity, trench backfilling and stabilisation methods such as rock placement have the potential to cause direct damage to sites of marine cultural heritage through compression. See Table 8-5 for suggested Project mitigation measures that will prevent such impacts.

During operation and maintenance, it is possible that direct impacts to cultural material on the seabed could be caused by maintenance vessels dropping anchors on the seabed during routine inspections or preventative maintenance for general maintenance. The use of vessels with DP positioning systems rather than anchors, and informing any vessels with anchors of locations to avoid, will prevent such an impact. See Table 8-5 for suggested Project mitigation measures that will prevent such impacts.

During decommissioning of the cable, it is assumed that any impacts will be contained within the width of disturbance created by the installation of the cable. It is anticipated that there will not be any further effects than those predicted during preparation, installation or operation.

8.6.2 Indirect damage to or destruction of known and unknown marine historic envornment assets inculding unexploded ordnance

There is potential that movement of the cable could expose areas of seabed that could affect nearby sites of cultural heritage interest (if present). However, such movement is considered to be very unlikely if the cables are buried or provided with protection where surface laid (e.g. rock placement).

9. HUMAN HEALTH

9.1 Introduction

This section provides further details of the potential negative influences on human health that may be present within the vicinity of the installation corridor. Potential impacts to human health determined to be at risk of impacts from the proposed installation activities are then assessed, along with the mitigation and management measures that will be utilised to remove or reduce these impacts

9.2 Data sources

The baseline conditions have been established through undertaking a desktop review of published information and consultation with the relevant bodies. These data sources used to inform the baseline description include the following:

- 'Corporate report: Radioactive particles in the environment around Dounreay.' (Dounreay, 2019);
- Information leaflet: 'Monitoring of Beaches near Dounreay' (Dounreay, 2016a);
- Particle finds data table: 'Murkle Beach particle finds' (Dounreay, 2016b);
- Dounreay. Review of Beach Monitoring Programme for Fragments of Irradiated Nuclear Fuel (Particles) (SEPA, 2012).
- Dounreay Particles Advisory Group - Fourth Report. (Dounreay Particles Advisory Group, 2008).

9.3 Dounreay nuclear power station and the nearby environment

Dounreay Nuclear Power Station (located approximately 18km west of the Murkle Bay landfall site) was an experimental nuclear site that first achieved criticality (when a reactor is controlling a sustained fission chain reaction) in 1958, and was operational until the end of the 1990's. The site was used for testing and recycling different fuel types, with used fuel being dismantled in water-filled ponds before chemical processing was conducted to recover any material that may be re-used (Dounreay, 2016a). Such chemical processes created small metallic fragments, which in some instances entered the site's effluent system and were released into the marine environment. Routine monitoring of the nearby coastline first detected such particles in the environment in 1983, at which point new protections were implemented by the UK Atomic Energy Authority (UKAEA) to prevent such discharge from occurring again. This system was still being utilised when SEPA became responsible (in 1996) for regulation under the Radioactive Substances Act 1993 (SEPA, 2012).

Particles that entered the marine environment behave similarly to grains of sand, with the particles being transported by the sea potentially onto the nearby beaches along the Caithness Coast, including Murkle Bay. As such, nearby beaches are routinely monitored with radiation detection instruments to find and remove any radioactive particles washed up. The frequency of monitoring is location dependent and was carried out on a monthly basis at Sandside beach and a bi-monthly basis at Dounreay foreshore in the first half of 2019 (Dounreay, 2019). This process is agreed and regulated by the Scottish Environmental Protection Agency (SEPA) and funded by the Nuclear Decommissioning Authority, with findings published publicly online. The latest available data point for particle finds at Murkle Beach was taken on the 26th of November, 2016 and was categorised as minor (Dounreay, 2019).

Particles found in the offshore environment near Dounreay have formed a plume centred on the site of the Old Diffuser, found to be the primary offshore source of radioactive particles (Dounreay Particles Advisory Group, 2008). The plume runs southeast – northwest along the shoreline due to wave action and tidal currents. Almost all particles are found within 2km of the Old Diffuser, the

majority within 1km. Between 2008 and 2012 a ROV was utilised to remove particles from the offshore environment, which should lead to a reduction in the transport of radioactive particles onshore.

9.4 Potential impacts and zones of influence

Table 9-1 Potential impacts and zone of influence

Activity	Impact	Receiving environment	Zone of influence
Cable Installation (Surface lay with rock/grout bags, post-lay jetting and trenching)	Resuspension of radioactive particles	Local human population	Limited to the sediments that could be directly disturbed through installation of the cable.

9.5 Impact assessment

9.5.1 Resuspension of radioactive materials

Since routine monitoring for radioactive particles began in the early 1980's, three particles have been identified and removed. These findings are detailed in Table 9-2 below.

Table 9-2 Murkle Beach particle finds (Dounreay, 2016b)

ID Number	Date	Easting	Northing	Depth (cm)	Cs137 Bq	Co60 Bq	Nb94 Bq	Type	Category
MKBCH/ 07/01	16th Apr 2007	316780	969621	10	1.3E+04	<2.6E+00	<2.7E+00	-	Minor
MKBCH/ 09/01	18th May 2009	316696	969439	18	9.0E+03	<1.0E+01	<9.8E+00	-	Minor
MKBCH/ 16/01	26th Nov 2016	316889	969219	6	2.1E+04	<2.1E+00	1.2E+01	DFR	Minor

Cs137 Bq - Content of Caesium 137 activity in the particle, measured in becquerels

Co60 Bq - Content of Cobalt 60 activity in the particle

Nb94 Bq - Content of Niobium 94 activity in the particle

DFR – Originated from Dounreay Fast Reactor

In comparison, at the Dounreay monitoring site over 300 particles have been discovered from the early 80's to the 29th of September 2019. As a result of so few particles being identified despite the extensive monitoring effort, the risk of disturbing radioactive particles at the Murkle Bay landfall site is imperceptible.

Although active radioactive particles do occur at a further distance from Dounreay, as evidenced by particles found on Murkle Beach, they are rarely found in the seabed. At the distance of the installation corridor (a minimum of around 18km), the risk of encountering a radioactive particle is minimal.

10. SHIPPING AND NAVIGATION

10.1 Introduction

This section provides further details of the shipping and navigation activity that may be present within the vicinity of the installation corridor. Potential impacts to shipping and navigation from the proposed installation activities are then assessed, along with the mitigation and management measures that will be utilised to remove or reduce these impacts. This section should be read in conjunction with the separate NRA (Appended to PAC Report - Appendix D) which identifies and assesses potential hazards within and in the vicinity of the installation corridor and presents measures to manage these.

10.2 Data sources and methodology

Prior to commencement of any works on the Project, an NRA was conducted. This assessment detailed the baseline for shipping and navigation activity in the area and includes assessment of any hazards identified and mitigation measures to manage these. This information has been used to inform the baseline overview of this section, with the assessment of the findings being summarised as well. The Project documents used to inform the baseline description are listed as follows:

- NRA (AECOM, 2019a, 2019b, 2019c)
- FLMAP for Pentland East and Hoy (SHEPD, 2019) (Appendix B)

The Project documents have been supplemented where necessary. The data sources used to inform the baseline description and assessment includes but is not limited to the following:

- Shipping Study of the Pentland Firth and Orkney Waters (PFOW) (Marine Scotland, 2012b).

10.3 Shipping and navigation description

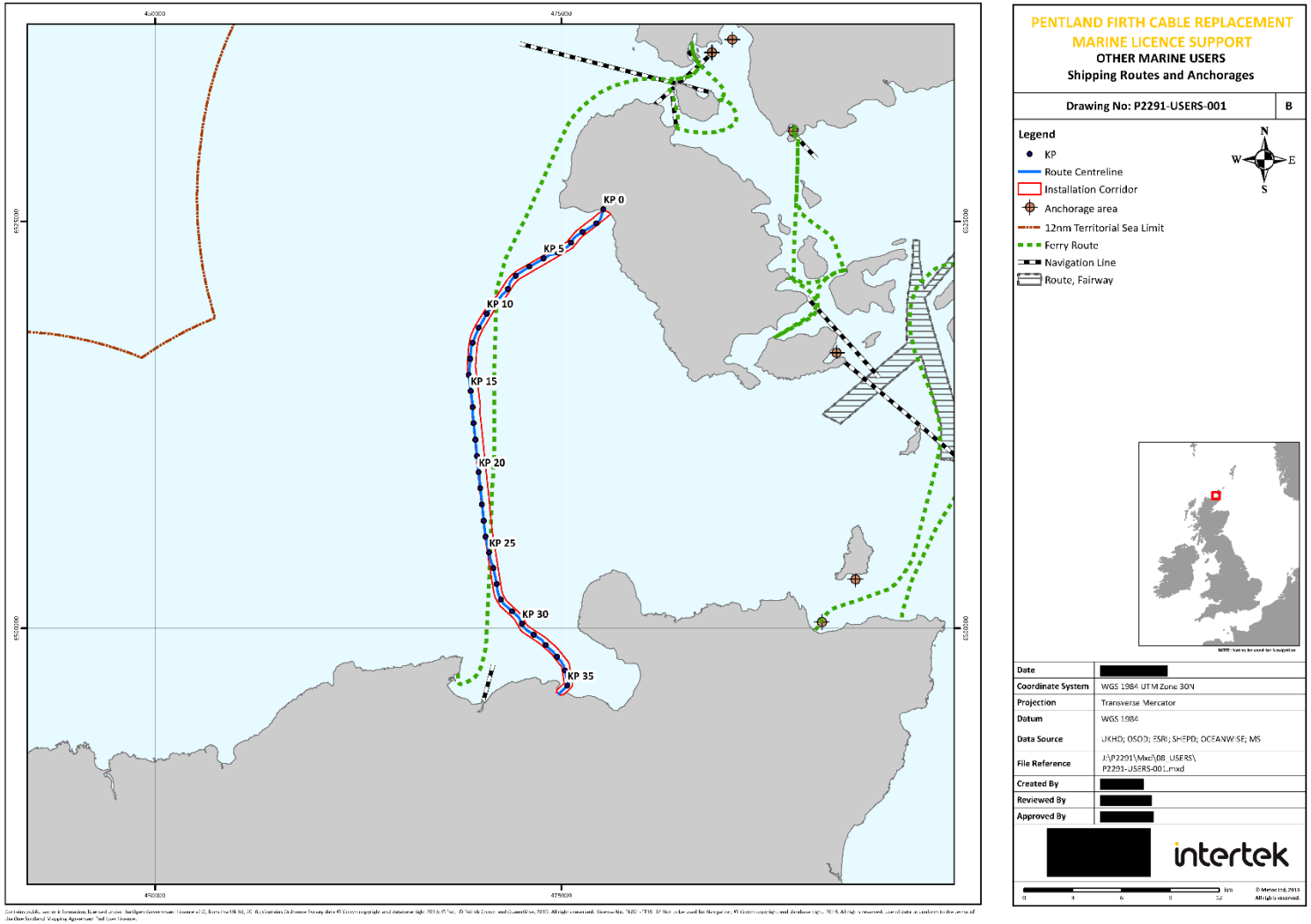
10.3.1 Shipping density

The Pentland Firth is a shipping route of international importance, being the prime route for vessels to transit between the North Sea and west coast of Scotland and the Atlantic Ocean. In a shipping study of the PFOW conducted by Marine Scotland published in 2012 (Marine Scotland, 2012b) both commercial shipping and recreational vessels were analysed. Fishing vessels and military vessels were not included in the study. The shipping study identified passenger vessels (ferries) as the most common type of commercial shipping followed by cargo vessels (Marine Scotland, 2012b). An average of 35 vessels transit through the Pentland Firth each week (MMO, 2017). The only ferry service that operates within the 5nm buffer of the installation corridor is the Northlink Ferries from Scrabster to Stromness and back (Figure 10-1). This ferry runs three times daily during the week in the peak season and twice at weekends and during the off-peak season (Northlink Ferries, 2019).

10.3.2 Other sea users

The data on the recreation vessels that use the Pentland Firth and Orkney waters shows a clear seasonal trend, with the summer months seeing significantly higher numbers than the winter (Marine Scotland, 2012b). Vessels typically visit the main ports and marinas of the region including Westray, Kirkwall, Stromness, Wick and Scrabster. The FLMAP (SHEPD, 2019) identified medium levels of fishing traffic for the Pentland east installation corridor. More detail on the activity level of commercial fisheries can be found in Section 11-3 of this report and in the FLMAP (SHEPD, 2019).

Figure 10-1 Shipping routes and anchorages within the Pentland Firth and Orkney waters



10.3.3 Navigational features

The waters around Orkney (excluding the Pentland Firth and Scapa Flow) are categorised by the IMO as an Area to be Avoided (ATBA). To avoid the risk of pollution and damage to the environment, all vessels over 5,000GT carrying oil or other hazardous liquid cargoes in bulk, should avoid this area (Marine Scotland, 2012b).

Several prohibited anchorage areas exist in Scapa Flow, east of the installation corridor, to protect infrastructure associated with the Flotta Oil Terminal and a military wreck. This may be of importance to survey vessels that need to shelter. There are no anchorage areas within 5nm of the installation corridor. (AECOM, 2019b and 2019c)

The following navigational features have been identified in the vicinity of the installation corridor:

- There are wrecks within 5nm of the installation corridor (Section 8.4.2).
- There two existing telecommunication cables and two electricity distribution cables that run within the 5nm buffer zone and are crossed at the southern end of the cable near the Scottish north coast. One of the telecommunication cables is operated by Farice and runs from the UK to Iceland, the other is operated by Northern Lights and connects Orkney to the mainland of Scotland. The two electricity cables that are currently installed between mainland Scotland and Hoy, include the east cable which this Project aims to replace. The installation corridor runs in between the existing west and east cables, typically at a distance of 0.5nm.
- There are three disused and one operational dredge disposal sites within 5nm of the installation corridor. The most significant of these dredge disposal sites is the larger disused site, which lies over the installation corridor and could affect burial of the cable. The active site is located in Thurso Bay and lies 1nm southwest of the installation corridor (AECOM, 2019b and 2019c).
- No military practise areas have been identified in the vicinity of the installation corridor (AECOM, 2019b and 2019c).

Further details and maps showing the principal navigational features near the installation corridor can be found in the 'Baseline Information' chapter of the NRA (AECOM, 2019Aa 2019b and 2019c).

10.3.4 Weather and sea conditions

All the reviewed documents NRA (AECOM, 2019a, 2019b, 2019c), FLMAP (SHEPD, 2019) and the shipping study (Marine Scotland, 2012b)) highlight the importance of tide and weather conditions as influencing factors on the vessel activity in the region. The shipping study of the PFOW (Marine Scotland 2012b) found that tide and weather conditions have a strong impact on recreational sailing, but also a notable influence on commercial shipping and passenger vessels in particular (Marine Scotland 2012b).

10.4 Potential impacts and zones of influence

Two Navigation Risk Assessment Workshops were carried out by AECOM for the installation corridor of the replacement cable, one in Kirkwall and one in Thurso, which respectively identified 23 and 34 hazards and assigned them a baseline risk score (AECOM, 2019a, 2019b, 2019c). The key potential impacts on shipping and navigation that were identified in the NRA and in the FLMAP are detailed in Table 10-1 below. The potential impacts that are specific to fishing vessels (e.g. fishing gear interaction with static gear) are discussed in Section 11.4 in this report. The navigational risk associated with the Pentland Firth replacement cable will be greater during installation and protection works and the likelihood of impacts increases with amount of time taken for the installation.

Table 10-1 Potential impacts and zone of influence

Activity	Impact	Receiving environment	Zone of influence
Cable installation (presence of vessels)	Collision risk	Passenger and shipping vessels	0.79km² (based on a transient 500m safety zone surrounding the vessel).
	Loss of access		

10.5 Mitigation

Several mitigation measures have been recommended to minimise the navigational risk in the FLMAP and NRA. These measures are detailed in full in these Project documents and are summarised in Table 10-2 below. The table also identifies whether the mitigation measures originate from the FLMAP (SHEPD, 2019) or the NRA (AECOM, 2019a, 2019b, 2019c). No new mitigation measures are identified within the assessment in this ESI Report.

Table 10-2 Overview of proposed mitigation measures for shipping and navigation

Mitigation no	Mitigation measure
FLMAP 1	**Stakeholder engagement -** Continuing effective positive liaison with all interested parties through the pre-construction, construction and operational phases of the cable replacement.
FLMAP 2	**Communication -** Informing sea users of construction areas and planned activities through the Notice to Mariners (NTMs), Weekly Notice of Operations (WNO) and update emails from the developer and their subcontractors.
FLMAP 3	**Construction Phase Plan (CPP) -** Provision of details of the schedule for cable lay activities to local ports, ship operators, fishermen and recreational sailing organisations.
FLMAP 4	**AIS tracking -** Cable lay vessel to be fitted with AIS so that it can be easily detected by other vessels transiting through the area.
FLMAP 5	**Safety zone -** Implementation of safety zones (500m) around the cable lay vessel will reduce the risk of collision between the cable laying vessel and fishing vessels transiting the area.
NRA 1	**Guard vessel** - A guard vessel will be used for areas of exposed cable where a risk to the asset or a danger to navigation has been identified.

10.6 Impact assessment

10.6.1 Collision risk

As the installation corridor crosses both the Northlink *Hamnavoe* ferry route at two points along its' route, along with the Pentland Firth being utilised as a shipping lane for vessels transiting between the Atlantic Ocean and North Sea, there exists the risk of a vessel collision occurring. This can either be a direct collision with the installation vessel(s), or an indirect collision, in the case of a vessel-to-vessel collision occurring due to displacement of vessels avoiding the construction area. To alleviate this risk, a 500m safety exclusion zone will be maintained surrounding the installation vessel. This will be transient with the vessel as it moves across the installation area. As such, the ZOI is therefore approximately 0.79km² surrounding the installation vessel offshore at any time.

Whilst 500m is the maximum permissible size (either side of the cable) for a safety zone, it could be that during the construction phase, the safety of other users is better served through an additional precautionary area communicated by Notice to Mariners in which it is recommended other legitimate sea users do not enter. If entry is unavoidable, then navigation with extreme caution is advised. Through the use of the 500m safety zone, Notices to Mariners and other mitigation measures as

detailed in Table 10-2 above, the risks of collisions (both direct and indirect) occurring as a result of the installation activities are greatly reduced. As such, the potential risk of vessel collisions is minimal.

10.6.2 Loss of access

There exists the potential for the installation vessels presence to require other legitimate sea users to alter their typical navigation course, resulting in a loss of earnings, additional costs or disruption of normal activities. To mitigate this risk, a Notice to Mariners will be issued and key stakeholders made aware of the installation schedule to allow for alternate navigation routes to be devised if required. Additionally, as the 500m safety zone surrounding the vessel will be transient and follow the installation corridor in a linear fashion, the area of sea inaccessible at any particular point time will be negligible in spatial and temporal extent. As such, potential impacts of the loss of access to other sea users are expected to not be significant. Details on the timescales of activities are provided in Section 2 'Project Description'.

11. COMMERICAL FISHING

11.1 Introduction

This Section provides further details of commercial fishing activity that may be present within the vicinity of the installation corridor. Potential impacts to commercial fishing from the proposed installation activities are then assessed, along with the mitigation and management measures that will be utilised to remove or reduce these impacts. This Section should be ready in conjunction with the separate FLMAP which provides a summary assessment of all the potential marine interactions, including commercial fisheries, which could influence or affect the proposed cable works.

11.2 Data sources

Prior to commencement of any works on the Project, a FLMAP was prepared to set out how SHEPD will interact with all legitimate sea users, prior to and during any works relating to replacement of the Pentland East cable. This plan specifically illustrates the associated risks to the commercial fisheries industry (and other legitimate sea users) and addresses the potential effects. This information has been used to inform the baseline overview of this Section, with the assessment findings being summarised as well.

- FLMAP for Pentland East and Hoy (SHEPD, 2019)

Furthermore, an NRA was conducted. This assessment detailed the baseline for shipping and navigation activity in the area and includes assessment of any hazards identified and mitigation measures to manage these. This information has been used to inform the specific navigational risks associated with commercial fishing activity in the area.

- NRA (AECOM, 2019a, 2019b, 2019c)

The Project documents have been supplemented where necessary. The data sources used to inform the baseline description and assessment includes but is not limited to the following:

- Fishing effort and quantity and value of landings by ICES Rectangle (Scottish Government, 2019)

11.3 Commercial fisheries description

The proposed works are located in ICES rectangle 46E6. According to the Marine Scotland statistics, this area is primarily targeted for shellfish and pelagic species, although some demersal species are also targeted within Orkney waters (Scottish Government, 2019). Within ICES rectangle 46E6, creeling (potting) accounts for three-quarters of fishing effort, with the top species being targeted being crab, lobster and haddock. Fishing effort follows a seasonal pattern with activity varying to shelter from adverse weather conditions, react to seasonal changes and exploit target species (SHEPD, 2019).

In 2018, a total catch value of £5.5M was landed from ICES rectangle 46E6. This is more than in the neighbouring ICES rectangles along the Scottish North Coast to the west (46E5) and to the east (46E7) of the area of interest, but lower than in the ICES rectangles further north: 47E5, 47E6 (which covers most of the Orkney Isles) and 47E7 (Scottish Government, 2019).

The Pentland Firth east submarine electricity cable is sited within the 6nm limit, in which the UK has exclusive fishing rights. Half of the fishing fleets targeting this area are 15m and over, with the other half split between the 10-15-meter vessels and the under 10m fleet (Scottish Government, 2019). Potting vessels represent the primary fishery that may interact with the cable locations, due to their nearshore location. Freezer trawlers and demersal stern trawlers are also used in the Pentland and Hoy area. There is low dredging activity in the installation corridor (SHEPD 2019).

11.4 Potential impacts and zones of influence

Key potential impacts on commercial fisheries are detailed in Table 11-1 below. The potential for collision risk was assessed in Section 10.6.1 above, with the risk expected to be minimal due to the temporary nature of vessel displacement and mitigation measures to be implemented.

Table 11-1 Potential impacts and zone of influence

Activity	Impact	Receiving environment	Zone of influence
Cable installation (presence of vessels)	Loss of access	Commercial fishing vessels	0.79km² (based on a transient 500m safety zone surrounding the vessel).
Post installation (longer-term impact)	Loss of fishing ground	Commercial fishing vessels	In the direct vicinity of the cable and associated protection measures.
	Increased snagging risk	Commercial fishing vessels	In the direct vicinity of the cable and associated protection measures.

11.5 Mitigation

Both the FLMAP (SHEPD 2019) and the NRA (AECOM 2019a, 2019b and 2019c) have identified mitigation options to minimise the potential effects on commercial fishing. Some mitigation measures are common between commercial fishing and shipping and navigation, while some are exclusive to aspects of commercial fishing, in Table 11-2 below. The Safety Management Plan found in Section 11 of the FLMAP (SHEPD, 2019) further details safety procedures that will be followed to further reduce the impact of the Project on other sea users.

Table 11-2 Overview of proposed mitigation measures for commercial fishing

Mitigation ID	Mitigation measure
FLMAP 1	**Stakeholder engagement** - Continuing effective positive liaison with commercial fishing stakeholders through the pre-construction, construction and operational phases of the cable replacement.
FLMAP 2	**Communication -** Informing fishermen of construction areas and planned activities through the Notice to Mariners (NTMs), Weekly Notice of Operations (WNO) and update emails from the developer and their subcontractors.
FLMAP 3	**Construction Phase Plan (CPP) -** Provision of details of the schedule for cable lay activities to local ports, ship operators, fishermen and recreational sailing organisations.
FLMAP 4	**AIS tracking -** Cable lay vessel to be fitted with AIS so that it can be easily detected by other vessels transiting through the area.
FLMAP 5	**Safety zone -** Implementation of safety zones (500m) around the cable lay vessel will reduce the risk of collision between the cable laying vessel and fishing vessels transiting the area.
FLMAP 6	**Fishing Industry Representatives (FIR) and Standard operating procedures (SOP) -** In most cases a FIR will be present on board of the survey boats to prevent fishing gear interactions. Should a FIR not be present on a vessel a SOP has been created for the FIR and crew of the survey and construction vessels to follow.
FLMAP 7	**Raising awareness -** The as-laid position and route of the cable will be provided to the UKHO and KIS-ORCA for inclusion on all marine charts in the region so fishing vessels can take care along the cable route.
NRA 1	**Guard Vessel** - A guard vessel will be used for areas of exposed cable where a risk to the asset or a danger to navigation has been identified.
NRA 2	**Timing and schedule -** Organising construction schedules as far as is practicably possible in order to reduce the combined loss of fishing area associated with safety zones during the surveys and construction phase of the submarine cable replacement.

11.6 Impact assessment

11.6.1 Loss of access

There exists the potential for the installation vessels presence to restrict access to fishing grounds or to cause fishing vessels to deviate from their typical navigation route, resulting in a loss of earnings, additional fuel costs or disruption of normal fishing activities. Longer term impacts relate specifically to reduced fishing effort within traditional fishing grounds, particularly for trawl fisheries where there is an increased risk of gear being snagged on the subsea cable and associated protection measures (e.g. concrete mattresses or rock placement). Finally, occasional maintenance during the lifetime of the cable can be expected and this could potentially interfere with normal fishing activities (SHEPD 2019).

Regarding the immediate loss of access to fishing grounds and navigation routes due to the presence of installation vessels, the impacts relate to the 500m safety zone that will be enforced around the installation vessel when in operation. Due to the linear nature of the cable installation route and transient nature of this safety zone however, the duration of time where fishing vessels will be displaced will be minimal. When the installation schedule for the cable is finalised, this will be circulated amongst local fishermen ahead of the activities to provide as much notice as possible, allowing for temporary changes in routing to be made.

11.6.2 Loss of fishing ground and Increased snagging risk

The main fishing activity in the vicinity of the installation corridor is potting, with trawling and dredging effort being minimal along the route. As such there is not expected to be any significant loss of trawling or dredging grounds to local fishermen. Potting vessels will be able to return to their usual fishing grounds after the vessel has passed through the area. With the cable taking up a minimal spatial footprint along the seabed, the impact to these grounds and the target species will be negligible. As such it is expected that there will be no adverse effect of the Project to the traditional fishing grounds in the area. While occasional maintenance of the cable may occur in the future, such activities will be clearly communicated ahead of time with typical safety procedures (such as those used in this Project) being followed, thus ensuring impacts to local fishermen are kept to a minimum.

12. TOURISM AND RECREATION

12.1 Introduction

This Section provides further of details the baseline of tourism and recreational activities present within the vicinity of the installation corridor. Potential impacts to tourism from the proposed installation activities are then assessed, along with the mitigation and management measures that will be utilised to remove or reduce these impacts.

12.2 Data sources

Prior to commencement of any works on the Project, a FLMAP was prepared to set out how SHEPD will interact with all legitimate sea users, prior to and during any works relating to replacement of the Pentland East cable. This plan also provided a summary assessment of all the potential marine interactions, including recreational activities, which could influence or affect the proposed cable works. This information has been used to inform the baseline overview of this Section, with the assessment findings being summarised as well.

- FLMAP for Pentland East and Hoy (SHEPD, 2019)

The Project documents have been supplemented where necessary to establish baseline conditions by undertaking a desktop review of published information and through consultation with relevant bodies. These data sources used to inform the baseline description and assessment include but are not limited to the following:

- 'Scottish Marine Recreation and Tourism Survey (SMRTS)' by LUC (2016);
- 'Marine and Coastal Tourism and Recreation in the Pentland Firth and Orkney Waters: A Case Study' by Aquatera (2015);
- 'Pilot Pentland Firth and Orkney Waters Marine Spatial Plan Consultation Draft: Socio-Economic Baseline Review' by Marine Scotland Science (2015); and

'Socio-economic Baseline Reviews for Offshore Renewables in Scottish Waters' by Marine Scotland (2012).

12.3 Tourism and recreation description

Tourism is a major contributor to local economies in the Orkney Islands and the Pentland Firth, with Orkney waters being a popular destination for coastal and marine tourism. Various recreational activities take place on the Caithness coast and around Hoy, including general recreation, walking, bird and wildlife watching, sailing, canoeing or kayaking, sea angling, climbing, bouldering and coasteering, surfing or paddle boarding, sea swimming and scuba diving. Although most activities can be undertaken throughout the year, the summer months attract a much greater number of visitors due to more favourable weather conditions.

12.3.1 Overview of tourism literature

The 'SMRTS' (LUC, 2016) report summarises the recreation and tourism activities undertaken at sea or around the Scottish coastline and can be used to assess how the area of interest compares to the rest of Scotland. The 'Marine and Coastal Tourism and Recreation in the Pentland Firth and Orkney Waters: A Case Study' (Aquatera, 2015) and 'Pilot Pentland Firth and Orkney Waters Marine Spatial Plan Consultation Draft: Socio-economic Baseline Review' (Marine Scotland, 2015c) provide an overview of the marine recreational activities within the Pentland Firth and Orkney waters. Further

detail of the specific activities that take place in the vicinity of the proposed replacement cable can be found in the 'FLMAP for Pentland East and Hoy' (SHEPD, 2019).

12.3.2 Surfing, paddle boarding and diving

According to the FLMAP, the most popular activities in the vicinity of the proposed replacement cable are surfing, paddle boarding and diving. Surfing is particularly popular near Thurso, were numerous local, national and international competitions are held (Aquatera, 2015). Low levels of surfing activities are seen around Hoy. Diving tourism is vitally important to the local economies of Orkney. The wrecks of the German High Seas Fleet at Scapa Flow attract most divers, but other areas around Orkney and the north coast of Caithness and Sutherland are also popular with divers (Aquatera, 2015). There are five recreational dive sites within 5nm of the installation corridor, including a hotspot of diving activity near Murkle Bay (AECOM, 2019b and SHEPD, 2019).

12.3.3 Sea angling, sailing and cruising

The FLMAP further identified medium levels of sea angling from shore, sailing and cruising and motor cruising. Sea angling from shore occurs around the entire Scottish coastline. Hotspots for sea angling in the vicinity of the proposed cable corridor are located at Thurso Bay and Dunnet Head (Marine Scotland 2015, SHEPD 2019). Low to medium levels of recreational sailing, cruising and motor cruising takes place across the proposed cable corridor. There are several sailing clubs operating in the area around Pentland and Hoy and most sailing activity is confined to the summer months. Further details on sailing clubs in the region can be found in the FLMAP (SHEPD, 2019). AIS data from Royal Yachting Association (RYA) vessels is displayed in Figure 12-1 below, which indicates the general intensity of vessels along the installation corridor is low.

12.3.4 Other recreational activities

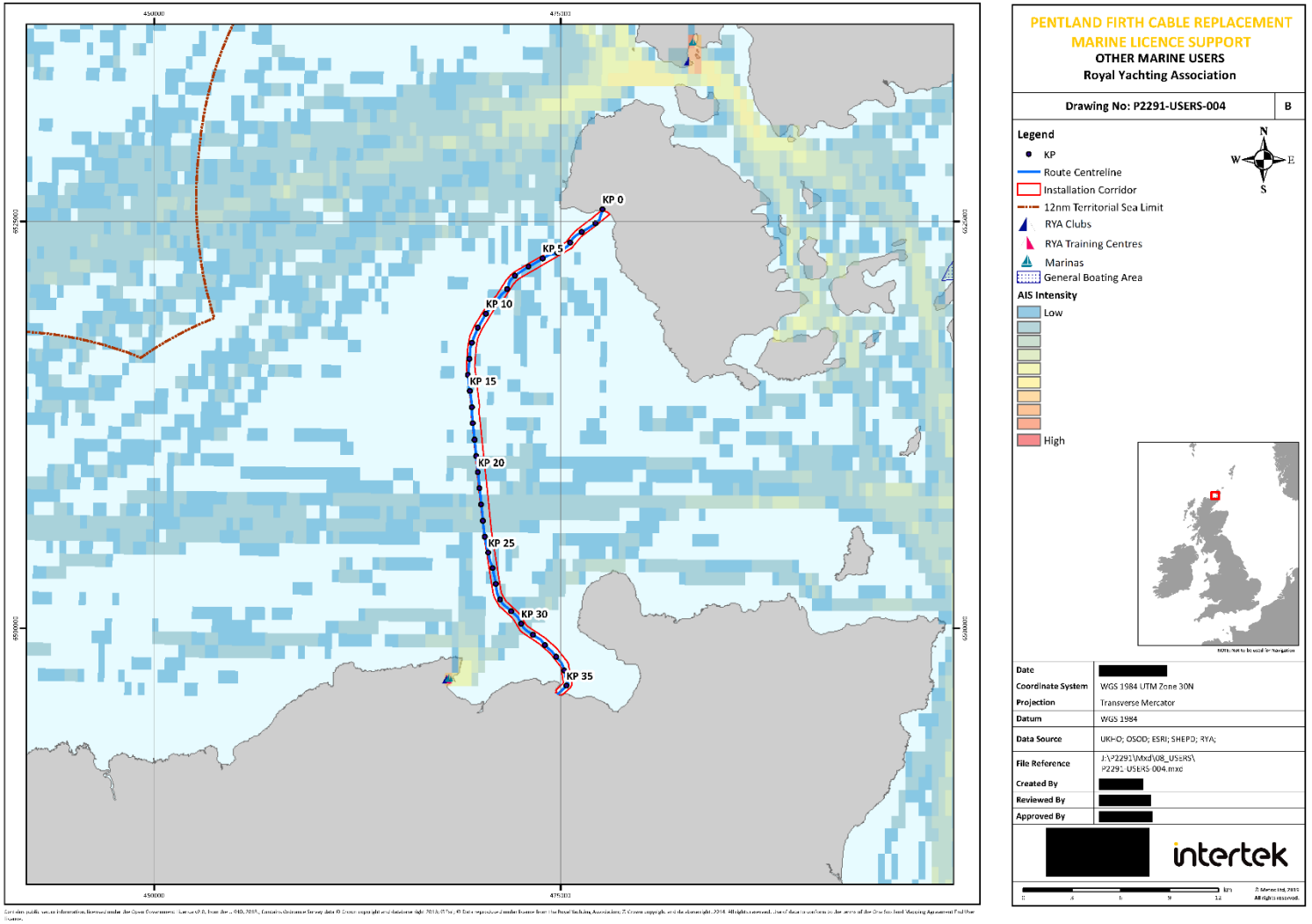
Furthermore, there are low levels of the following activities: canoeing and kayaking, coasteering, jet skis, power boating, rowing and sculling and sea angling from a charter boat (SHEPD, 2019). Canoeing and kayaking takes place around the coastal areas and is a popular activity in Pentland and Orkney waters. Canoeing and kayaking is not limited to any particular location, but it is mostly taking place closer to shore for safety reasons and due to a lack of interesting features away from the coastline (Marine Scotland, 2015). Canoeists and kayakers as well as other boat-based recreational activities may use the slipways and piers in the vicinity of the installation corridor (Aquatera, 2015).

Other recreational activities that may occur in the vicinity of the installation corridor and landfall location of the replacement cable include swimming, climbing, horse riding and walking. Recreational sea swimming is mostly observed on the mainland and designated bathing waters are located in Thurso Bay and Dunnet Bay. The coastal cliffs of Caithness and Hoy also provide good rock climbing and coasteering opportunities and the Old Man of Hoy is a well-known climbing destination (Aquatera 2015). Further details on the spatial distribution of marine recreational activities in the Project area can be found in Appendix B 'Other Sea Users Charts' of the FLMAP (SHEPD, 2019).

12.3.5 Bird and wildlife watching

Much of the northern and western area of Hoy is a designated RSPB reserve, measuring 3926 hectares in extent (RSPB, 2019a). As such it is a popular destination for birdwatchers looking to see species such as puffins, hen harriers, and great skua. In terms of the Project area, the area around Rackwick Bay and the Old Man of Hoy are popular during the breeding season from May onwards, with June typically being the busiest month due to the number of birds and breadth of species visible on the sandstone cliffs of west Hoy (RSPB, 2019a)

Figure 12-1 Royal Yachting Association AIS Data



12.4 Potential impacts and zones of influence

The key potential impacts to tourism and recreational sea users in the installation corridor are loss of access and disturbance of seabirds, and these are detailed in Table 12-1 below. This excludes collision risk as the risk of collision with other vessels, including recreational vessels, is addressed assessed in Section 10.6.1 above. Collision risk is expected to be minimal due to the temporary nature of vessel displacement and mitigation measures to be implemented.

Table 12-1 Potential impacts and zone of influence

Activity	Impact	Receiving environment	Zone of influence
Cable installation (presence of vessels)	Loss of access	Recreational vessels, diving sites	0.79km² (based on a transient 500m safety zone surrounding the vessel).
	Disturbance of nesting seabirds	Birdwatchers	Hoy RSPB Nature Reserve

12.5 Mitigation

Several mitigation measures have been recommended to minimise the risk to tourism and recreation in the FLMAP. These measures are detailed in full in these Project documents and are summarised in Table 12-2 below. In addition to mitigation measure FLMAP 2 'Communication' with other sea users, specific contact will be made with the recreational clubs and organisations that are identified as key stakeholders in the FLMAP. Regular dialogue between the CFLO and these organisations will be maintained prior to and during the installation work. Further details on the proposed mitigation and communication plan can be found in the FLMAP (SHEPD, 2019). The FLMAP Communications Distribution List provides contact information for all relevant stakeholder including the clubs and associations that represent recreational users.

Table 12-2 Overview of proposed mitigation measures for commercial fishing

Mitigation ID	Mitigation measure
FLMAP 1	**Stakeholder engagement -** Continuing effective positive liaison with commercial fishing stakeholders through the pre-construction, construction and operational phases of the cable replacement.
FLMAP 2	**Communication -** Informing other sea users of construction areas and planned activities through the Notice to Mariners (NTMs), Weekly Notice of Operations (WNO) and update emails from the developer and their subcontractors.
FLMAP 3	**CPP -** Provision of details of the schedule for cable lay activities to local ports, ship operators, fishermen and recreational sailing organisations.
NRA 1	**Guard vessel -** A guard vessel will be used for areas of exposed cable where a risk to the asset or a danger to navigation has been identified.
NRA 2	**Timing and schedule** - Through prior fishing liaison undertaken by SHEPD and the FLMAP produced for the Project, the need to organise construction schedules as far as practicably possible in order to reduce the combined loss of fishing area associated with safety zones during the installation phase of the submarine cable replacement has been accounted for.
FLMAP 4	**AIS tracking -** Cable lay vessel to be fitted with AIS so that it can be easily detected by other vessels transiting through the area.
FLMAP 5	**Safety zone -** Implementation of safety zones (500m) around the cable lay vessel will reduce the risk of collision between the cable laying vessel and fishing vessels transiting the area.

12.6 Impact assessment

12.6.1 Loss of access

There exists the potential for the installation vessels presence to restrict access to areas typically used by recreational vessels, kayakers, diving sites etc., or to cause recreational sea users to deviate from their typical navigation route, resulting in additional fuel costs and disruption of normal recreational activities. The main sites that would potentially be impacted are within the nearshore of both landfall locations, as this is where the majority of recreational use occurs. The temporary nature of the installation activities at both nearshore sites will limit the time in which access for recreational use may be precluded. As the 500m safety exclusion zone will be transient with the vessel, aside from locations that may potentially be subject to post-lay burial users will be able to quickly return to their regularly used locations. Effective communication with local organisations and providing the finalised installation schedule in advance of activities starting will allow these organisations to create alternative arrangements in a reasonable timeframe. As such the impacts of the loss of access to recreational users is expected to be minimal.

12.6.2 Disturbance of nesting seabirds

There exists the potential for installation activities at Rackwick Bay to disturb breeding seabirds on the cliffs nearby, thus impacting on tourists who may have travelled to the area (an RSPB Nature Reserve) to observe the local wildlife. The Hoy RSPB Nature Reserve Site states that breeding seabirds typically start to appear on site during May with peak numbers occurring in June (RSPB, 2019a). Nearshore installation activities are at Rackwick Bay are anticipated to be undertaken early in the project and will occur for a short duration within the ZOI (see Appendix A for project schedule). As such, installation activities are not anticipated to take place at Rackwick Bay concurrently with the busiest time for breeding seabird presence and therefore is expected to not have a significant impact on tourism within the RSPB Nature Reserve.

13. CUMULATIVE EFFECTS

13.1 Introduction

This Section identifies other potential plans or projects that may be progressing in the Pentland Firth at the same time as the Pentland Firth East replacement cable installation activities. Cumulative effects can be described as the net effect of cumulative pressures, which includes both direct and indirect effects resulting from cumulative pressures caused by different activities (MMO, 2014).

13.2 Projects within/in vicinity of the cable corridor

Table 13-1 below details the activities in the Pentland Firth/north of Scotland within/in the vicinity of the cable corridor that may produce similar effects to the Pentland Firth East replacement cable installation activities, with these activities also being displayed in Figure 13-1. Information sources used to inform the potential cumulative effects that may be occurring in the region include the following:

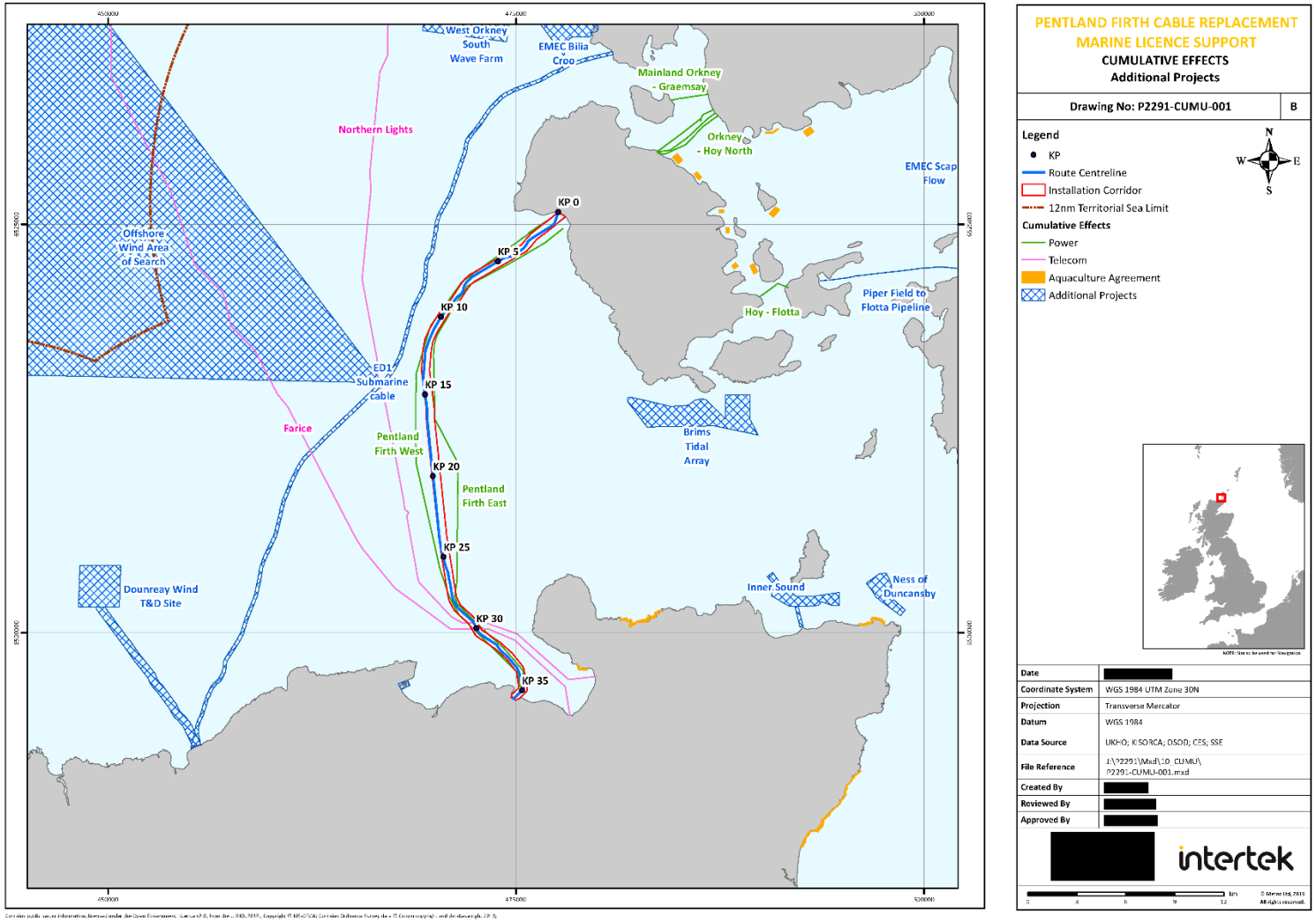
- SEAFISH Kingfisher Bulletin
- UKDEAL: Oil and gas industry information;
- Oil and Gas Authority: Oil and gas industry information;
- KIS-ORCA: Marine cables information; and
- The Crown Estate Website: Offshore wind farm and marine aggregate digital data.
- Marine Scotland: Marine licensing website

Table 13-1 Activities found in the Pentland Firth/north of Scotland and their distance to the cable corridor

Activity/Project	Activity Type	Owner	Status	Approximate Distance from cable corridor (km)
Orkney – Mainland HVAC 220kV Subsea Link	HVAC Transmission Cable	SHE Transmission	In development, installation works due to begin in approximately June 2020	2.4km
Offshore Wind AOS	Offshore Wind Farm	Crown Estate Scotland	Potential development area for new wind farms	2.45km
Brims Tidal Array	Tidal Energy	OpenHydro Site Development Ltd (OpenHydro) and SSE Renewables	Fully consented but on hold following the liquidation of OpenHydro in July 2018.	11.7km
Hexicon Dounreay Tri Floating Wind	Offshore Wind Farm	Hexicon AB	In development, no construction currently planned	20.1km

No oil and gas developments are currently or likely to be located near the installation corridor. There are currently no military practice and exercise areas within the vicinity of the installation corridor. The EMEC testing facility at Bilia Croo, due to its location around the northern Hoy coastline away from the installation corridor, does not have the capacity to create any cumulative effects with this project.

Figure 13-1 Other projects and activities present within the Pentland Firth and Orkney waters



13.3 Cumulative effects

13.3.1 Orkney – Mainland HVAC 220kV Subsea Link

Due to the growth of renewable energy technologies in Orkney, and the export capacity of the islands being completely saturated as a result, Scottish Hydro Electric (SHE) Transmission is in the process of seeking a marine licence for a new High Voltage Alternating Current (HVAC) link between Orkney and mainland Scotland which will possess a minimum capacity of 220MW (SSEN, 2019). The cable is currently planned to route from Warebeth on the west coast of Orkney and Dounreay, Caithness. The currently available indicative installation schedule for the project (Xodus Group, 2019a) states that HDD works for the project will commence between June 2020 and March 2021, with further works such as cable laying taking place in the Summer of 2022. Given this indicative timeline, and the proposed installation schedule for the Pentland Firth East cable replacement project, there is no risk of installation activities for these projects overlapping and no potential for cumulative effects to occur.

13.3.2 Offshore Wind Area of Search (AOS)

Marine Scotland have recently completed a scoping study aimed at identifying areas of search in Scottish waters to potentially be developed into draft plan options for offshore wind energy, such as the upcoming Scotwind leasing round due to be conducted by The Crown Estate Scotland (Marine Scotland, 2018b; Crown Estate Scotland, 2019). Within this study they identified an area of search located at the north of Scotland, which at its closest point is located 2.45km from the installation corridor (see Figure 13-1 above). While this area could potentially be taken forward for future development, with the first decisions from Crown Estate Scotland on successful applications for Scotwind due to take place between May and July 2020 at the earliest (Crown Estate Scotland, 2019), there is no risk of installation activities for the Project overlapping with any developments in this identified development area.

13.3.3 Brims Tidal Array

Brims Tidal Array is a 200mw offshore tidal array that was previously being developed as a joint venture between OpenHydro Site Development Ltd (OpenHydro) and SSE Renewables (Holdings) UK Ltd (SSER) (Tethys, 2019). The proposed development was to be deployed as two phases, with Phase I consisting of up to a 60MW capacity. Construction of the first phase was expected to begin in 2019. An Agreement for Lease (AFL) was agreed upon with the Crown Estate in 2013 (prior to Crown Estate Scotland's creation), with an EIA and marine licence application for the site being submitted to Marine Scotland in 2016. In July 2018 however OpenHydro's parent company decided to liquidate OpenHydro. As such development of the project has been put on hold, with no current plan for the future of the site being evident. As such, there is no risk of installation activities for this Project occurring simultaneously with any works on the future Brims Tidal Array.

13.3.4 Hexicon Dounreay Tri Floating Wind

The Dounreay Tri Floating Wind project is currently in its development phase by the project's current owner Hexicon AB. Although a marine licence was granted for the site and construction began in March 2017, financial issues forced development to be halted, with the current timeframe for the projects future unclear (Hexicon, 2019). As such there is no risk of the Pentland Firth East cable replacement installation activities coinciding with the Dounreay Tri Floating Wind development and no potential for cumulative effects to occur.

13.4 Mitigation

No mitigation measures have been proposed for cumulative effects occurring between this Project and other activities in the Pentland Firth, owing to the lack of potential effects identified in the assessment above.

14. MITIGATION SUMMARY

The Pentland Firth East replacement cable includes a range of primary mitigation measures that have been 'designed' into (or 'embedded' in) the development proposals to reduce or prevent significant adverse effects arising. Tertiary measures such as legislative compliance and best practice are also included in the embedded mitigation measures. The assessment of effects has therefore considered all measures that form part of the development to which SHEPD is committed. These mitigation measures are detailed within each Section (where relevant to the topic) and gathered together in Table 14-1 below. As mitigation measures have been proposed from several documents including this report, the EPS Risk Assessment and the FLMAP, each mitigation has been given an ID to indicate what the source of the mitigation is.

Table 14-1 Mitigation measures - project design

ID*	Aspects	Embedded mitigation
Pre-installation measures		
FLMAP 1	Stakeholder engagement	Continuing effective positive liaison with all interested parties through the pre-construction, construction and operational phases of the cable replacement.
FLMAP 2	Communication with sea users	Informing sea users of construction areas and planned activities through the Notice to Mariners (NTMs), Weekly Notice of Operations (WNO) and update emails from the developer and their subcontractors.
FLMAP 3	Construction Phase Plan (CPP)	Construction Phase Plan (CPP) - Provision of details of the schedule for cable lay activities to local ports, ship operators, fishermen and recreational sailing organisations.
NRA 2	Timing and schedule	Organising construction schedules as far as is practicably possible in order to reduce the combined loss of fishing area associated with safety zones during the surveys and construction phase of the submarine cable replacement.
EPSRA 12	Tool-box talks	Installation vessel crew will be made aware of all protected species within the marine environment through the following guidance; the Marine Conservation Society (MCS) Basking Shark Code of Conduct and good practice measures for boat control near basking sharks and the Scottish Marine Wildlife Watching Code and Guide to Best Practice for Watching Marine Wildlife.
EPSRA 14	Otter survey	A pre-installation survey at the cable landfalls will be conducted at least two months prior to works commencing. This survey will be followed up with a walkover survey immediately prior to works commencing. An ECoW will be responsible for the otter survey and for advising appropriate mitigation measures, which will be detailed in the relevant onshore CEMPS and SSEN Otter SPP, as required.
Installation measures		
ESI 1	Reducing impact of installation activities (e.g. penetration and/or disturbance of the substrate below the surface of the seabed, physical change (to another seabed type) on the receiving seabed.	Micro-routing will be used to avoid sensitive species/habitats Deployment of anchors/anchor chains on the seabed will be kept to a minimum in order to reduce disturbance to seabed. Cable installation activities will be short term. Cable installation footprint is spatially small relative to the extent of the surrounding subtidal environment Rock bags, grout bags and concrete mattresses will be used in some areas to ensure cable protection and stability. The footprint of the deposits will be the minimum required to ensure cable safety and stability.

ID*	Aspects	Embedded mitigation
ESI 2	Prevention of the introduction of non-native invasive species	Ballast water discharges from Project vessels will be managed under the International Convention for the Control and Management of Ships' Ballast Water and Sediments standard. The latest guidance from the GB non-native species secretariat (2015) will be followed and a Biosecurity Plan produced pre-installation.
FLMAP 1	Stakeholder engagement	Continuing effective positive liaison with all interested parties through the pre-construction, construction and operational phases of the cable replacement.
FLMAP 2	Communication with sea users	Informing sea users of construction areas and planned activities through the Notice to Mariners (NTMs), Weekly Notice of Operations (WNO) and update emails from the developer and their subcontractors.
FLMAP 3	Construction Phase Plan (CPP)	Construction Phase Plan (CPP) - Provision of details of the schedule for cable lay activities to local ports, ship operators, fishermen and recreational sailing organisations.
FLMAP 4	AIS Tracking	Cable lay vessel to be fitted with AIS so that it can be easily detected by other vessels transiting through the area.
FLMAP 5	Safety zone	Implementation of safety zones (500m) around the cable lay vessel will reduce the risk of collision between the cable laying vessel and other vessels transiting the area.
FLMAP 6	Fishing Industry Representatives (FIR) and Standard operating procedures (SOP)	In most cases a FIR will be present on board of the installation vessel to prevent fishing gear interactions. Should a FIR not be present on a vessel a SOP has been created for the FIR and crew of the installation vessel to follow.
NRA 1	Guard vessel	A guard vessel will be used for areas of exposed cable where a risk to the asset or a danger to navigation has been identified.
NRA 2	Timing and schedule	Through prior fishing liaison undertaken by SHEPD and the FLMAP produced for the Project, the need to organise construction schedules as far as practicably possible in order to reduce the combined loss of fishing area associated with safety zones during the installation phase of the submarine cable replacement has been accounted for.
ARCH 2	Mitigation during installation	In order to manage the potential for impacting unknown heritage, the Crown Estate's PAD reporting protocol (2014) produced by Wessex Archaeology will be implemented. The use of vessels with DP positioning systems rather than anchors will further prevent accidental impact.
EPSRA 1 & 2	Marine mammal monitoring Use of Marine Mammal Observer(s)	There will be MMO coverage for the entire duration of activities. During daylight hours the MMO(s) will observe the sea for the presence of marine mammals and basking sharks and will have the power to delay and / or halt work activities should an individual of these species be sighted within 500m of the activities (100m when avoiding critical delays).
EPSRA 4	Basking shark mitigation zone	During survey works, the MMO will monitor for the presence of basking sharks, in addition to marine mammals and otters, and will delay start of the survey if any are seen within 500 m of the survey vessel.
EPSRA 5	Cetacean and seal mitigation zone	Should any cetaceans or seals be detected within 500 m of the vessel prior to the commencement of geophysical surveys (or after breaks in geophysical survey activity of more than 10 minutes), operations will be delayed until their passage, or the transit of the vessel, results in the cetaceans or seals being more than 500 m away from the vessel.
EPSRA 6	Pre-soft-start search	Visual and (if required) acoustic monitoring will occur 30 mins prior to commencement of installation activities to determine if any marine

ID*	Aspects	Embedded mitigation
		mammals or basking sharks are present within 500m of activities (100m in event of critical delay as per EPSRA 2 above).
EPSRA 7	Soft-start	For all equipment that has soft start capability: Power will be built up slowly over at least 20 minutes to give any cetaceans, seals or basking sharks adequate time to leave the area. Build-up of power will occur in uniform stages to provide a constant 'ramp-up' in amplitude.
EPSRA 8	Passive Acoustic Monitoring (PAM)	PAM will be utilised by a qualified MMO/PAM operator in times of poor visibility (e.g. fog).
EPSRA 10	Standardised reporting	All recordings of cetaceans, seals and basking sharks will be made using JNCC Standard Forms. A monitoring report detailing the features of interest recorded, methods used to detect them, and details of any problems encountered will be submitted to Marine Scotland and SNH at the end of operations.
EPSRA 11	Slow moving survey vessel	The installation vessel will be moving at a maximum speed of 4 knots to allow any basking sharks time to move away from the vessel should they be disturbed by the vessel presence or noise. Should a basking shark be found to be in the direct way of the survey route, the installation vessel will slow down further or, if possible, alter course to avoid collision.
EPSRA 12	Tool-box talks	Installation vessel crew will be made aware of all protected species within the marine environment through the following guidance; the Marine Conservation Society (MCS) Basking Shark Code of Conduct and good practice measures for boat control near basking sharks and the Scottish Marine Wildlife Watching Code and Guide to Best Practice for Watching Marine Wildlife.
EPSRA 15	Otter monitoring	There will be MMO coverage for the duration of the marine activities, with adequately trained and experienced MMO(s) working standard 12-hour shifts. If an otter shelter is discovered at the landfall nearshore areas, a protection zone with a minimum of 30 m radius will be set up and will be clearly demarcated/fenced off.
EPSRA 16	Rafting seabirds	The survey vessels will be moving at a maximum speed of 4 knots to allow any rafting seabirds time to move away from the vessel should they be disturbed by the vessel presence.
EPSRA 17	Wintering birds	When within a SPA which has been designated for wintering birds that may roost or feed in close proximity to the installation corridor or the landfall, further consultation will be undertaken with SNH on the requirement for any seasonal restriction to be implemented for cable installation in order to avoid disturbance to qualifying species.
EPSRA 18	Breeding birds	When within a SPA which has been designated for breeding birds that may nest or feed in close proximity to the installation corridor or the landfall, further consultation will be undertaken with SNH on the requirement for any seasonal restriction to be implemented for cable installation in order to avoid disturbance to qualifying species.
EPSRA 19	Light disturbance	When within a SPA and where there is potential for 24-hour working, lighting on-board the cable survey vessel(s) will be kept to the minimum level required to ensure safe operations and lights will be directed or shielded to prevent upward illumination and minimise disturbance.
Post-installation measures		
FLMAP 1	Stakeholder engagement	Continuing effective positive liaison with all interested parties through the pre-construction, construction and operational phases of the cable replacement.
FLMAP 7	Raising awareness of as-laid cable position	The as-laid position and route of the cable will be provided to the UKHO and KIS-ORCA for inclusion on all marine charts in the region so fishing vessels can take care along the cable route.

ID*	Aspects	Embedded mitigation
ARCH 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. The maintenance and inspection teams should be informed of the locations of any known assets so that they can avoid any accidental impacts upon them.

*ESI – Mitigation introduced in this ESI Report

FLMAP – Mitigation introduced in the Fisheries Liaison Mitigation Acton Plan

NRA – Mitigation introduced in the Navigation Risk Assessment

ARCH – Mitigation introduced in the Marine Archaeology report

EPS – Mitigation introduced in the EPS Risk and Protected Sites and Species Assessment

15. SUMMARY OF IMPACT ASSESSMENT

15.1 Introduction

This section of the report summarises the assessment outcomes of Sections 3 – 12. Where applicable, it will be stated whether the assessment agreed with the outcomes of the other key documents supporting this application such as the EPS Risk and Protected Sites and Species Assessment and the Navigation Risk Assessment.

15.2 Physical processes

The only potential impact of the installation activities that may affect the physical environment was determined to be sediment deposition, should cable burial be utilised. However, due to the highly energetic conditions of the Pentland Firth, any low-grain sediment will be rapidly dispersed in the water column and so will not settle in an appreciable depth on the seafloor. Only gravel and (to a lesser extent) sand are likely to form an appreciable depth of deposits, but this is generally likely to be limited to within 20m of the trench, even in extreme current conditions.

No significant impact on the physical processes of the Pentland Firth is expected to occur as a result of installation activities.

15.3 Benthic and intertidal ecology

Assessment of the impact of installation activities on the benthic and intertidal ecology found within installation corridor determined that there would be no significant impact on such habitats. This is due to the limited spatial and temporal extent of the installation activities reducing the footprint of effect, along with the embedded mitigation measures that will ensure habitat along the route is not adversely impacted.

As such, no significant impact is expected to occur to benthic and intertidal ecology as a result of the installation activities.

15.4 Fish and shellfish

The impacts of physical change (to another substratum type) on spawning and nursery habitat and *Modiolus modiolus* beds, and the risk of collision with basking sharks were determined to be the impacts most likely to have a potential effect on fish and shellfish within/in the vicinity of the cable corridor. Regarding physical change, there were few/no individuals of notable species identified during surveys along the installation corridor and the extent of cable protection measures along the corridor will be minimal in extent. This will ensure that a minimal area of seabed will be subject to physical change. Regarding collision risk, due to the slow-moving nature of the vessels and low likelihood of the vessels overlapping with basking sharks within the installation corridor due to the species' low population distribution in the area, the risk of vessel collisions occurring is minimal.

Therefore, after consideration and assessment these impacts were determined to not have a likely significant effect on fish and shellfish in the Pentland Firth. The findings of the basking shark assessment are in agreement with those concluded in the EPS Risk Assessment.

15.5 Marine mammals

It was concluded in the EPS Risk and Protected Sites and Species Assessment that the effects of underwater noise on pinnipeds and cetaceans within the vicinity of the installation corridor would not be expected to be significant. This is due to the short-term and localised nature of the installation

activities, minimal zone of influence of the noise generated by the installation activities and recommended mitigation strategies outlined in the report.

The conclusions of the EPS Risk Assessment are considered to still stand, and therefore no significant impact is expected to occur to marine mammals as a result of the installation activities.

15.6 Protected sites and species

It was determined that the only protected sites within the vicinity of the installation corridor at risk of being disturbed by the installation activities were Hoy SPA and the North Caithness Cliffs SPA. This is due to the large assemblages of breeding seabirds that are resident at these sites during the summer months. However, the assessment of these sites concluded that no likely significant effects would occur to either site, with the integrity of each site being maintained. This is because the installation activities within these sites are estimated to take place outside of the birds breeding seasons, thus limiting the number of birds available to be disturbed. This is further aided by the limited spatial and temporal extent of the activities, already likely habituated nature of the birds to vessels in the area and mitigation measures proposed in the EPS Risk Assessment.

Therefore, the conservation objectives of these sites will not be hindered and the species within them will not be significantly impacted by the installation activities. This assessment is in agreement with the assessment conducted in the EPS Risk Assessment.

15.7 Marine archaeology

After review of the geotechnical and geophysical data acquired for the installation corridor, along with a desk-based study identifying any potential wrecks in the area, it was concluded that the potential for encountering any archaeological remains along the installation corridor were low. Mitigation measures were also proposed to further reduce the risk of damaging any other previously undiscovered remains in the unlikely scenario they are encountered along the route.

Therefore, no significant impacts are expected to occur to any known or unknown marine archaeological sites along/in the vicinity of the installation corridor.

15.8 Human health

Due to the lack of radioactive particles discovered at Murkle Bay over the last 30 years and distance of the site from the Dounreay Nuclear Power Station, the risk of disturbing radioactive particles as a result of the installation activities and subsequent harm to human health was considered negligible.

As such, the potential for radioactive particles to be disturbed is considered to be not significant.

15.9 Shipping and navigation

Three potential impacts to shipping and navigation were assessed in this section; collision risk, loss of access and damage to existing infrastructure. Regarding collision risk, while the route transits through both the *Hamnavoe* ferry route and the shipping lane in the Pentland Firth, through the use of mitigation measures including the use of a 500m safety zone surrounding the vessel, notices to mariners and communication of the installation schedule with other vessels at the earliest opportunity, the risk of vessel collisions is low. This assessment also applies to commercial fishing vessel and recreational vessels in the area.

The potential risk of loss of access to navigation routes and the subsequent disruptions this causes was also assessed to be low. This is because the 500m safety zone surrounding the vessel will be transient and follow the installation corridor in a linear fashion, so the area of sea inaccessible at any particular point time will be negligible in spatial and temporal extent. No damage to existing

infrastructure is expected due to the cable protection measures that will be implemented at each crossing point.

Due to the mitigation measures and limited spatial and temporal extent of the installation activities, it is expected that there will be no significant impact on shipping and navigation within the Pentland Firth. This assessment is in agreement with the findings of the Navigation Risk Assessment conducted for the route.

15.10 Commercial fishing

The impacts of loss of access to local fishermen in the area is expected to be minimal, due to the small footprint of the 500m safety zone and transient nature of it enabling fishing vessels to return to their potting grounds soon after the vessel has passed through. There is little risk of snagging events occurring along the route, with trawling and dredging activity along the installation corridor already seeing little fishing effort. The loss of fishing grounds is not expected to be significant due to the minimal spatial extent the cable will cover on the seabed and non-invasive cable protection measures planned across the route.

It is therefore expected that there will be no significant impacts to commercial fishing in the Pentland Firth.

15.11 Tourism and recreation

The impact of the loss of access to commonly used recreational areas is expected to be low due to the limited spatial and temporal extent of the installation activities reducing the number of affected groups and enabling those who may be affected to quickly return to the area. Communication of the finalised installation schedule will be made with any potentially affected group on advance of installation activities starting to allow these groups sufficient time to create alternate plans during this time period. As the installation activities at Rackwick Bay are anticipated to begin in the early phase of the project over a short duration, there will be minimal impact to the birds found within the Hoy RSPB Nature Reserve and thus impact on tourism in the area will be limited.

As such, it is expected that there will be no significant impacts to other recreation and tourism groups within the vicinity of the installation corridor and wider Pentland Firth area.

16. COMPLIANCE WITH MARINE PLANS

SHEPD has considered all the relevant policies within the NMP when developing the Pentland Firth East replacement cable project. Due to the aging nature of the existing Pentland Firth East cable and increasing number of repairs required to maintain it, the need to replace the cable is of over-riding public concern. The design of the replacement cable route has been conducted with regards to other local sea-users as far as practically possible.

Although the installation corridor for the cable does not pass through or in the vicinity of any NCMPA's, marine surveys carried out to assess the installation corridor have identified a number of PMF's and an example of the Annex I stony reef habitat. The cable installation methodology has been designed to ensure that disturbance of these habitats is kept as low as reasonably practicable. Assessment of the benthic and intertidal ecology in Section 4 of this report determined that with the cable being surface laid (with potential cable protection i.e. URADUCT) across the Annex I stony reef habitat, and abrasion of other sensitive habitats being limited due to the use of rock bags pinning the cable to the seabed, any potential impact to these areas will be localised to the cable footprint which is minimal in extent. In addition, a pre-installation survey will be conducted to enable the cable to be micro-routed around sensitive habitats present along the route.

The marine cable installation methodology has been designed to take as little time as possible (worst case 88 days (including weather contingencies)) to limit the projects potential impact and disturbance on the receiving environment and species. Installation activities are scheduled to commence from March 2020, with nearshore works at the Rackwick Bay and Murkle Bay landfall sites planned to start prior to the start of breeding season for the majority of protected bird species potentially present within the installation corridor.

Policies on sea fisheries, specifically policies 1, 2 and 3, were considered throughout the development of the installation corridor and methods. Specific contact has been made throughout all stages of the project with commercial and non-commercial fishermen's groups in the area to understand what commercial fishing activities occur in the area, their extent and what impact the cable installation could have on these activities. Assessment of the spawning and nursery grounds in the area, along with the presence of commercially significant species, determined that the impact of the installation activities on such areas and species would be low due to the negligible presence of such species along the route and minimal spatial extent the cable will occupy. As the duration of the offshore works will take a worst case of 88 days (including weather contingencies) to complete and take place on a linear path so the whole route will not be excluded simultaneously, exclusion from fishing grounds will be temporary in nature. Further assessment is provided in the FLMAP (SHEPD, 2019 which includes measures to manage any potential conflicts with fishermen and methods of informing them (and other sea users) of the installation works and progress throughout the installation campaign.

Regarding the Submarine Cables policies of the NMP, SHEPD has carried out a series of consultation and public engagement exercises with regulators, stakeholders and the general public, which are presented in the Pre-Application Consultation report (Global Marine, 2019b). This report documenting and assessing the potential impacts on sensitive receptors, the FLMAP (SHEPD, 2019) and the CEMP (Global Marine, 2019a) form part of the Marine Licence application that is required for cable replacement activities, as detailed in Cables policy 1 of the NMP.

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

Surface-laying of the cable will be the primary method of installation along the cable route. Should surface lay not be possible in specific instances however, cable burial may potentially be undertaken using post-lay jetting. Where the cable is surface laid, rock bags will pin the cable to the seabed ensuring the cable does not move. This will limit the impact of the cable to sensitive habitats and

ensure the position of the cable on the seabed is well understood allowing for accurate documentation on navigational charts and systems. As such, Cables policy 2 has been complied with as far as practically possible.

It is proposed that the existing cable is left in-situ once taken out of service as removal has the potential to unnecessarily disturb sensitive habitats within the benthic environment, ensuring the requirements of Cables policy 3 have bene considered. The existing landfall sites of Rackwick Bay and Murkle Bay have been retained as the existing electrical infrastructure is largely fixed and tied to the distribution of power to homes and businesses' and would therefore be extremely difficult and costly to change the locations of the landfalls. As such Cables policy 4 has been considered in the development of the cable landfall sites.

The above information demonstrates that SHEPD has complied with all relevant policies within the NMP as far as practically possible. As the policy requirements of the pilot Pentland Firth and Orkney Waters MSP relating to the development of subsea cables reflect those of the NMP, it can be determined that these have been considered in conjunction with the NMP during the cable design process.

17. CONCLUSIONS

This ESI Report provides a summary of the baseline receiving environment of the Pentland Firth and the landfall locations of Rackwick Bay and Murkle Bay. This utilised publicly available information online and information drawn from other supporting documents (such as the EPS Risk and Protected Sites and Species Assessment and the FLMAP) to inform the desk-based study. Following this baseline review, aspects of the receiving environment considered to be at risk of being impacted by the installation activities of the Project were assessed. These assessments were made using data sourced from survey data gathered specifically for the Project, information drawn from other supporting documents and publicly available information online. Through these assessments, it can be concluded that no significant impacts are expected to occur to the receiving environment of the Pentland Firth and the landfall locations of Rackwick Bay and Murkle Bay. These conclusions are in agreement with those reached in the other documents supporting the marine licence application.

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