National Grid NSN Link Limited

Norway-UK Interconnector

UK Marine Environmental Statement

March 2014

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1 INTRODUCTION

1.1 Purpose of Report

This Environmental Statement has been produced to support the consent applications for the United Kingdom (UK) marine aspects of the proposed Norway-UK Interconnector.

1.2 Project Overview

National Grid NSN Link Limited (NGNSNLL) and Statnett SF (SSF) are jointly developing an electrical high-voltage direct current (HVDC) interconnector between Norway and the United Kingdom. This is a major international electricity project that will facilitate the cross-border trading of electricity between the two countries and is referred to as the North Sea Network (NSN) project. The link would enable power to flow in either direction at different times, depending on the supply and demand in each country. The proposed route would run from Hylen, in southwest Norway, to the Northumberland coast in northeast England. Figure 1.1 (Appendix 1) provides an overview of the location of the proposed cable route and the landfall location.

1.3 Project Need

The European Union (EU) have set in place the Climate and Energy Package which is binding legislation and aims to ensure the ambitious climate and energy targets for 2020 are achieved.

The targets set three key objectives for 2020:

- A 20% reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency. (EC, 2013)

In order to achieve these targets, integration of North-European power markets and a strengthening of the North European Power Grid is required.

The UK Government has set ambitious targets to increase renewable energy generation and combat climate change. The Norway-UK interconnector will enable cross-border trading of energy, providing market stability which is in line with current European policy.

The interconnector is a cornerstone in the network development plans for the countries surrounding the North Sea basin, and is of high priority. The interconnector will contribute to further integration of North-European power markets, hence buoying the ambitions for increased renewable energy production in the whole region and thereby supporting the EU's 2020 goals.

The Norway-UK interconnector would be the first electrical cable connecting the UK to Norway. The interconnector with a planned capacity of up to 1,400 MW is expected to be completed by 2020. When completed, it will be the world's longest subsea power cable.

Key benefits for the development of the project include the following:

- Supports renewable energy initiative in Europe.
- Improves security of supply for each nation.
- Improves price predictability.
- Promotion of competition has the potential to reduce prices.

1.4 Scope and Objectives of the Environmental Statement

This Environmental Statement covers the UK marine cable elements of the Project. The geographical scope of the assessment extends from the median line between Norway and the UK to the mean high water spring (MHWS) tide mark at Cambois Beach, Blyth. Between these two points the lateral extent of the assessment area broadly covers the 500m cable installation corridor, within which the cable will be laid. The UK marine elements of the Project are referred to in this Environmental Statement as “the proposed development”.

The proposed development does not fall within the types of development specified in Annex I or Annex II of the EIA Directive (Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the impacts of certain public and private projects on the environment). Screening Opinions have been obtained from the relevant marine consenting authorities – Marine Management Organisation (MMO) and Marine Scotland (MS). Both authorities have confirmed that the proposed interconnector does not constitute “EIA development” as described in the Marine Works (EIA) Regulations 2007 and that a statutory EIA of the Project is not required. NGNSNL and SSF have chosen to submit this Environmental Statement voluntarily.

The proposed development requires several consents under other legislation for construction and operation. Details of the legislative and regulatory framework and the consenting requirements are provided in Section 3.

This Environmental Statement provides: details of the environmental data and information used to inform the Project development; the baseline environment of the area where the cable system will be installed; and details of the predicted environmental impacts of the proposed development. The information in this Environmental Statement has been collated to both inform the applications for the required consents and/or to allow the UK regulators (primarily the MMO) to satisfy their statutory obligations.

The objectives of this document are therefore to:

- Enable NGNSNL and SSF to comply with best environmental practice by delivering an ES to a high standard.
- Provide environmental information and data to inform the relevant consent applications as required by law and to allow the UK regulators to satisfy their obligations under European law (in particular in respect of the requirements for Appropriate Assessment under the Habitats Directive).

1.5 Sources of Data and Information

The information contained in this Environmental Statement has been drawn from existing literature, project-specific documentation, personal communications with local experts, and site-specific surveys and studies commissioned by the project. Every effort has been made to obtain data concerning the existing environment and to accurately predict the effect of the proposed development. Assumptions adopted in the evaluation of impacts are reported in the relevant sections. Key literature sources included in this report are included at the beginning of each section. A number of specialist studies and surveys have been carried out to gather environmental information for the project, including:

- Intertidal ecological surveys.
- Geophysical/geotechnical/benthic survey.
- Desk-based archaeological assessment.
- Desk-based shipping and navigation assessment.
- Desk-based Un-exploded Ordnance Assessment (UXO).

More information on these and other studies is given in the relevant sections of the Environmental Statement.

The data collected throughout these assessments and surveys have been used to define the baseline conditions – against which impacts have been measured and predicted, in turn helping to define the mitigation measures required.

1.6 Other Elements of the Project

This Environmental Report is part of a suite of environmental documents for the Norway – UK Interconnector Project. In addition to the UK marine components which are addressed in this Environmental Statement, the Project also includes the following elements:

- **The Norwegian onshore elements**: The construction of an electricity converter station and substation at Kvilldal, comprising buildings, outdoor electrical equipment and internal access roads, and the installation of underground electricity cables from the cable landfall at Hylen to the converter station. Consent has been granted by the Norwegian Authorities for this stage of the project. Applications were supported by a number of project documents which provided a description of the project as well as the environmental impacts.
- **The offshore elements in Norwegian waters**: Cable installation between the Hylen landfall and the UK / Norway median line. Consent has been granted by the Norwegian Authorities for this stage of the project. Applications were supported by a number of project documents which provided a description of the project as well as the environmental impacts.
- **The UK onshore elements**: An Environmental Statement for the UK terrestrial element of the project is being produced by TEP Consultants. The terrestrial section of the project considers the effects of the project from Mean Low Water and above. This report will consider the construction of an electricity converter station and substation on or in close proximity to the site of the former Blyth power station, comprising buildings, outdoor electrical equipment

and internal access roads, and the installation of underground electricity cables from the landfall at Cambois Beach Slipway to the converter station.

- **Bridging/cumulative report**: A bridging document will provide an overall summary of the entire project. The document will include a description of each project element outlined above, and a summary of the likely significant residual and cumulative effects of the project as a whole. The proposed project mitigation measures will also be outlined.

1.7 UK Marine Environmental Statement Structure

The Environmental Statement is split in to two volumes:

Volume 1: Environmental Statement. It is structured around the following section headings:

Section	Title
Volume 1: Environmental Statement	
1	Introduction
2	Development of Project and Alternatives
3	Planning Policy and Consents Framework
4	Scoping and Consultation
5	Project Description
6	Approach to Environmental Appraisal
7	Physical Environment
8	Water and Sediment Quality
9	Protected Sites and Species
10	Benthic and Intertidal Ecology
11	Fish and Shellfish
12	Ornithology
13	Marine Mammals
14	Cultural Heritage and Archaeology
15	Commercial Fisheries
16	Shipping and Navigation
17	Offshore Infrastructure
18	Dredging and Disposal Sites and Military Practice Areas
19	Recreation and Tourism
20	Cumulative Effects

Section	Title
21	Conclusions

Section	Title
Volume 1: Appendix - Figures	
1	Figures

Volume 2: Technical Appendix. This provides supporting technical information which is cross-referenced where relevant within the Environmental Statement.

Section	Title
Volume 2: Appendix - Technical	
2.1	Route Position List
2.2	Habitats Regulations Assessment Signposting
2.3	Assessment of Impact Significance

In addition to the Environmental Report there are a number of supporting documents which have been submitted to the marine regulators as part of the marine licence application. Table 1-1 below summarises the supporting documentation which has accompanied the marine licence application.

Table: 1-1 Supporting Documents to the Marine Licence Application

Document	Description
Requirements for permanent deposits onto the seabed	Provides a projection of cable protection measures for the proposed marine route
Statuatory and Non - Statuatory Consultees	List or organisations and individuals contacted
Benthic Survey Report	Draws together and summarises the results of the Environmental Survey
Geophysical Survey Report	Draws together and summarises the results of the geophysical Survey
Intertidal Survey Report	Reports the intertidal habitat within the landfall area
Archaeology Technical Report	Draws together and summarises the cultural heritage and archaeological features within the proposed route corridor.
Shipping Assessment	An assessment of shipping routes and densities within the vicinity of the proposed

Document	Description
	route.
Navigation Risk Assessment	Draws together and summarises the constraints to navigation within the vicinity of the proposed route.
Un-exploded Ordnance Desktop Study	An investigation in to the potential for un-exploded ordnance within the proposed route corridor.

2 DEVELOPMENT OF THE PROJECT AND ALTERNATIVES

2.1 Introduction

This section summarises the development of the proposed Norway-UK Interconnector (hereafter referred to as the interconnector), including the alternatives which have been considered and the rationale for the selection of the 'Preferred Option'. In particular, it sets out the alternative route options which have been considered in developing the proposed marine cable route.

The proposed marine cable route corridor was identified following initial routing studies. These studies considered the alternative options for the Norway-UK Interconnector route including different offshore routes as well as alternative landing sites. Avoidance of sensitive areas, by carefully designed routing, is the main method for mitigating the potential environmental effects associated with the construction and operation of the interconnector. Finalisation of the UK section of the interconnector has taken account of environmental and technical constraints, the results of detailed surveys and feedback received as part of the consultation process.

2.2 Routing and Siting Studies

The project has undertaken a number of studies which considered a range of environmental, technical and economic constraints influencing the development of the interconnector. The studies were undertaken as part of a constraints driven options appraisal, which included the development and assessment of alternative converter station sites and underground and marine cable routes. The options appraisal concluded with the identification of a 'Preferred Option' which balanced technical feasibility and economic viability whilst ensuring the least disturbance to people and the environment. These studies included:

- Constraints Study (Metoc, 2010a).
- Feasibility Studies (Metoc, 2010b; Metoc, 2011).
- Cable Route Study (Intertek Metoc, 2012).
- Marine Geophysical and Environmental Surveys (MMT, 2012; MMT, 20)

Figure 2.1 (Appendix 1) shows the study areas considered in the constraints and feasibility studies and the marine cable route alternatives that were considered.

2.2.1 Constraints Study

The initial constraints study focused on a wide area along the east coast of England, encompassing the Humber Estuary and the Wash, extending offshore to the UK/Norway median line. This was a high level study to identify potential appropriate areas for consideration. A separate study, undertaken by the onshore environmental consultants, investigated the feasibility of the onshore components of the project (Metoc, 2010a).

2.2.2 *Feasibility Studies*

The feasibility studies focused on identifying potential marine routes and associated landfalls using Geographical Information Systems (GIS) and taking into consideration the following:

- The shortest feasible route.
- Environmental and engineering constraints.
- The feasibility of securing consent.
- Initial consultation with key consultees to establish route feasibility.

The first feasibility study (Metoc, 2010b) expanded on the work undertaken in the constraints study; in particular it identified and assessed eleven landfall and offshore route options. A wide range of environmental and social constraints and technical challenges were identified.

It was concluded that all routes with landings in the Wash should be avoided due to environmental sensitivities and water depth constraints. Other routes were more acceptable in terms of environmental constraints, but were considerably longer in length and therefore prohibitive in terms of cost. As a result of these findings, all routes were deemed unacceptable and a second feasibility study was commissioned.

The second feasibility study (Metoc, 2011) examined a total of eight marine routes from the UK-Norway median line to landfall locations between Newbiggin-by-the-Sea (Northumbria) and Tees Bay. Two of these routes were immediately discounted on technical grounds.

In 2011 National Grid International Limited on behalf of the project entered into a Connection Agreement to connect the cable at Blyth substation in Northumberland. This had the effect of focussing the search for a landfall in the Blyth area. In order to minimise the length of the landward section of the Norway-UK Interconnector, the marine cable landfall needed to be as close to the converter station site as possible. Therefore the search for a suitable marine cable landing focused to the north of the second feasibility study area. The outcome of the constraints report and feasibility studies resulted in four landfall options being considered feasible (see Figure 2.2; Appendix 1). These were:

- Lyne Sands
- Sandy Beach
- Cambois Beach North (Slipway)
- Cambois Beach South

2.2.3 *Cable Route Study*

A detailed desktop study of the cable route was undertaken to: identify a viable cable route corridor, assess the suitability of the four landfall options and to make a recommendation on the preferred landfall option from a marine perspective.

The cable route study included the identification and detailed appraisal of offshore infrastructure, conditions, constraints and considerations (economic, physical and human environment) that might impact on subsea cable routing and installation from the UK-Norway median line to the cable landfalls. Landfall site visits were undertaken to identify landfall site options (to ensure co-ordination with onshore routing constraints).

The NSN project is a successor of the NSI Norway-UK interconnector project which was on the verge of contract award when it was cancelled in 2003. This was a similar joint development between National Grid and Statnett. A considerable amount of development work including routing studies had been undertaken.

The proposed route for the project and the subject of this Environmental Statement follows the original NSI surveyed route from the UK-Norway median line for a distance of 137km before diverging to follow a line towards Blyth on the Northumberland coast. After a further 180km the proposed main route divides into four alternative route options, one to each of the identified potential landfall sites. The four potential landing sites were assessed from an engineering aspect considering the near shore, intertidal, foreshore and installation options.

From a marine engineering, environmental and social perspective the landings were ranked as follows:

1st Cambois Beach North

2nd Sandy Beach

3rd Cambois Beach South

4th Lyne Sands

The final choice of landing site has also been influenced by the location of the proposed converter station and land cable routeing considerations.

2.2.4 *Marine Survey*

Marine geotechnical, geophysical and environmental/habitat surveys were undertaken along the proposed marine cable route corridor (including the four alternative routes to each of the landfall site options). The purpose of the marine surveys was to:

- Identify the location and extent of areas of seabed that are of conservation importance, such as habitats listed under Annex I of the EC Habitats Directive, and to minimise cable routing within these areas.
- Provide information from which the impacts of cable installation on the marine archaeological environment can be assessed and, where appropriate, inform appropriate mitigation measures.
- Identify features on the seabed that represent a hazard to the cable during installation or during the expected cable lifespan – for example areas of bedrock or mobile sediments that could result in exposed cable.

- Locate debris and obstacles that would present a hazard to cable installation.
- Identify targets that may represent unexploded munitions.
- Confirm the position and present status of existing infrastructure, such as pipelines and cables, that the new cable will have to cross, or is in close proximity to. This information is needed to design the cable crossing(s).
- Obtain geotechnical information on properties of seabed sediments that will assist in determining optimal methodologies for cable installation

The results of these surveys were reviewed to identify any need for further route revision and optimisation. It should be noted that during the marine route corridor surveys Client Representatives were onboard the survey vessels to ensure that the survey was a dynamic process and took account of local conditions.

2.3 The Preferred Option

2.3.1 Cambois Beach North (Cambois Slipway)

The preferred landing route option for the interconnector from a marine perspective is Cambois Beach North.

Cambois Beach North is located on the south bank at the entrance to the River Wansbeck, 2.1km north of Blyth on the Northumberland coast line. The topography in the region is generally flat with an elevation of 10m to 15m, on the coastline there are 10m earth cliffs or grass banks descending to the beach. The surrounding land use consists of a mixture of agriculture, heavy industry and residential. There is an existing slipway to the beach in this location which offers access to the beach and a potential route for the cables.

The connection of the marine and terrestrial options at the landfall is a major consideration. It requires a balance to be sought between the terrestrial and marine environmental disturbance. The optimum marine route may not connect to the optimum land route or vice versa due to engineering, environmental, and social constraints. The preferred option has therefore been selected as a balance between the key concerns and preferred options for these elements of the scheme.

The results of the 2012 marine surveys indicated that there were significant areas of exposed bed rock on the nearshore approaches to two of the landings, Lyne Sands and Sandy Beach, there was also some exposed bedrock off Cambois North. The constraints resulting from the presence of bed rock on the route are as follows:

- Cable protection by burial will not be possible and additional protection methods such as rock placement may be required.
- The areas of exposed bed rock are heavily fished with fixed gear. Routing the cable across these areas would create significant disruption to the inshore fishermen.

- The areas of exposed bed rock may qualify as Potential Annex I Habitat for rocky reef (see Section 9).

The initial findings of the 2012 route survey indicate that the route into Cambois Beach South has seabed sediments suitable for cable burial and as such this area is not favoured by fixed gear fishermen. For this reason the Cambois Beach South landing was initially chosen over the other three options.

In 2013 it became apparent that landing at Cambois South would create serious conflict with the NAREC development and that the proposed land cable route via the highway to the East Sleekburn Converter Station site would create a "pinch point" with potential significant disruption during construction.

An alternative land cable route was identified which favoured a land fall at Cambois North. An additional marine infill survey was undertaken to identify a suitable marine cable route in spring of 2013, this survey confirmed that there was a viable route which avoided the previously identified bed rock mitigating the constraints set out above.

Taking the technical constrains associated with the Cambois South land fall into account and the results of the 2013 survey data, a decision was made to make Cambois North the preferred landfall.

This preferred option has been surveyed as part of the EIA, and developed into the final proposed marine cable route corridor presented in this Environmental Statement (see Section 3).

2.4 Alternative Landfall Options Considered

2.4.1 Lyne Sands

Lyne Sands is located 8.5km north of Blyth. The coastline is characterised by a mix of low cliffs and sand dunes, with beaches of fine sand which are subject to coastal erosion. With the exception of key installations and habitations, this coastline is being allowed to erode naturally. The majority of the surrounding land is agricultural with isolated dwellings, farm buildings and industrial sites. This section of coastline is dominated by the Alcan Lynemouth Power Station and the Alcan Aluminium Smelter. The main constraints for developing the landfall at Lyne Sands are the rocky outcrops and hard ground in the inshore area, which would make cable burial difficult. In addition, this rocky area is used intensively for fixed net fishing, and would significantly restrict fishing activities during installation, which in combination with the distance from the converter station would constrain this landfall option.

2.4.2 Sandy Beach

Sandy Beach is located on the north bank at the entrance to the River Wansbeck, 2.9km north of Blyth on the Northumberland coast line. The topography in the region is generally flat with sand dunes and 3m high cliffs. The surrounding land is utilised for agriculture, heavy industry and tourism, with the identified landing site adjacent to a caravan site. The main constraints for developing the landfall at Sandy Beach are the rocky outcrops and hard ground in the inshore area, which would make cable burial difficult. In combination, this rocky area is used intensively for fixed net fishing, and would significantly restrict fishing activities during installation.

2.4.3 Cambois Beach South

Cambois Beach South is located 1.0km north of the port of Blyth on the Northumberland coast line. The topography in the region is generally flat with an elevation of 4m to 6m, on the coastline there are low sand dunes or grass banks descending to the beach. The surrounding land use consists of a mixture of agriculture, former heavy industry sites and residential. The main constraints for developing the landfall at Cambois South are the proximity to residential areas which limits land route options and requires excavation of a busy highway. In addition to these constraints, there is potential conflict with the Blyth Offshore Demonstration Project trial site, which proposes to use this landing site for export cables.

The final proposed marine cable route presented in Figure 1.1 (Appendix 1) is considered, on balance, to be the most technically feasible and least environmentally disturbing option.

2.5 References

Intertek Metoc (2011), National Grid International Ltd North Sea Network Desk Top Study

Intertek Metoc (2012), NSDN Norway – UK HVDC Interconnector Cable Route Study Report No.:P1568_RN2824

Metoc (2010a), North Sea Network Constraints Study Report No.: P1391_RN2355_REV1

Metoc (2010b), Route Feasibility Study UK Waters Report No.: P1391_RN2423_REV0

Metoc (2011), Route Feasibility Study UK Waters Study Area 2 Report No.: P1391_RN2523_REV4

3 PLANNING POLICY AND CONSENTS FRAMEWORK

3.1 Marine Planning Policy

3.1.1 The Marine Planning Concept

This section describes the background to and rationale for marine spatial planning and summarises UK planning policies. It is helpful to establish the marine planning policy and framework of each of the two consenting authorities (Scotland and England) through which the proposed marine cable route corridor passes and to consider the development of marine plans in specific areas.

Boundaries for terrestrial plans essentially follow existing or historic administrative jurisdictions. For marine areas, while the land/sea boundary and international boundaries provide onshore and offshore limits, clear boundaries are not always apparent. Marine spatial planning (MSP) is a new approach to the management of our seas. The aim is to ensure a sustainable future for our coastal and offshore waters through managing and balancing the many activities, resources and assets in our marine environment (MMO, 2013). MSP seeks to translate spatial planning concepts to marine space taking account of the challenges unique to the environment.

3.1.2 UK Policy

In order to rationalise planning in the marine environment a UK Marine Policy Statement (MPS) has been prepared in accordance with Section 44 of the Marine and Coastal Access Act, 2009 (MCAA) and is the first part of the new system which will direct marine planning activities. The document sets out the policies intended to help achieve sustainable development in the UK marine areas and provides the framework for preparing marine plans and for taking decisions that affect the marine environment. Marine plans will provide more detailed policy and spatial guidance at a country or regional level.

The MPS will be used, or referred to, by a wide range of public authorities (including planning authorities) as well as developers and other users of the marine area. The UK Act requires all public authorities taking authorisation or enforcement decisions that affect or might affect the UK marine area to do so in accordance with the MPS and relevant marine plans unless relevant considerations indicate otherwise (HM Government, 2010). Authorities taking decisions that affect or might affect the UK marine area which are not authorisation or enforcement decisions must have regard to the MPS and relevant marine plans.

In Scotland the Marine (Scotland) Act 2010 similarly requires public authorities to take authorisation or enforcement decisions in accordance with marine plans, unless relevant considerations indicate otherwise.

3.1.3 Marine Plans

Responsibility for the development of marine plans has been delegated to the Marine Management Organisation (MMO). The will provide policy and spatial guidance for specific areas and help ensure that decisions within a plan area contribute to the delivery of UK, national and any area specific policy objectives.

Marine plans in coastal areas will overlap slightly with the area of jurisdiction of local authorities. Plans will cover the area up to Mean High Water Spring (MHWS) tide whereas local authorities' responsibilities run down to the low water mark. Local authorities are expected to play an important role in the marine planning process, leading to the integration of terrestrial and marine plans, where they overlap.

The East Coast Inshore (Area 1) and East Coast Offshore (Area 2) Marine Plan are the first Marine plans to be drafted within UK waters. The Norway-UK Interconnector project falls within these Marine Planning areas (see Figure 3.1). The East Coast Marine Plan is expected to be adopted during 2013. This will provide a framework and governance for managing the North Sea area.

The establishment of marine plans on a regional or local scale is not anticipated to conflict with the proposed development. The project has been designed to minimise interaction with current and future marine activities and route selection has followed principles which complement those on which marine planning is based. Comprehensive consultation has been carried out at a stage in the project where the input of stakeholders can be acted upon effectively.

3.2 Legislative Requirements

As the installation of cables is not a form of development that is listed under Annex I or II of the EIA Directive as amended (on the assessment of the effects of certain public and private projects on the environment), the works do not fall under the remit of those regulations and a Statutory EIA is therefore not required. However, there are a number of other policies and laws which require decision makers to consider the environmental impacts of projects and are outlined below.

3.2.1 Marine Licensing

The Marine and Coastal Access Act (MCAA) 2009 provide the framework for the marine licensing system. The Act modernises marine licensing and provides a more streamlined, transparent, and effective marine licensing system.

The Marine Management Organisation (MMO) is responsible under Part 4 of the MCAA for licensing of activities related to construction or removal of any substance or object in English territorial waters (up to 12 nm) and also for such activities where they are undertaken outside of UK territorial waters. Under the same Act the Marine Scotland Licensing Operations Team (MS-LOT) have responsibility for licensing and enforcement for the Scottish offshore region from 12-200 nm.

Under the Marine (Scotland) Act 2012 the Scottish Government is responsible for the marine licensing activities carried out in the Scottish inshore region of UK waters (0 – 12 nm). As the NSN interconnector does not pass through the Scottish inshore region a marine licence will not be required under the Marine Scotland Act, however MS-LOT still need to be given notice of the activity.

A marine licence is required for the installation of the Norway-UK Interconnector within UK inshore waters. A review of the marine licensing process has been undertaken to ensure correct understanding of the requirements for the NSN project, including a review of the potential for an exemption under Section 81

(1) of the MCAA for marine licence requirement outside of the 12nm territorial water limit in UK offshore waters.

The MMO *must* grant consent for an international electricity cable under Section 81 2(1) of the MCAA. However, conditions for the design and routing of the inshore section of the cable may be attached to take account of other marine users and conservation designations.

Consultation with the MMO and MS-LOT has confirmed the following:

- Laying of inshore cables within UK territorial waters (up to 12nm) requires a marine licence under Part 4 of the MCAA
- If the cable is an international cable then the MMO must grant the application but still has the power to attach conditions (up to12nm).
- Anything done in the course of laying or maintaining the offshore section (beyond 12nm) of the Norway-UK Interconnector is exempt for marine licence requirement under Section 81(1) of the MCAA.
- MS-LOT consider that any cable protection works i.e. the laying of rock or mattressing in conjunction with laying the marine cable would fall under Section 81(1) of the MCAA and therefore be exempt from Marine Licence requirement.
- The MMO consider that any form of cable protection works, is a licensable activity, whether the need for such protection works is identified before or after the laying of the cable.
- The Marine Licence would apply to the section of the cable between Mean High Water Springs (MHWS) and the 12 nm limit. However the MMO will consider the project as a whole and can include consent for cable protection in the offshore section of the cable within the Marine Licence if required.

3.3 Habitats Regulation Appraisal

Where construction projects are within or adjacent to a European site, the need for a Habitats Regulation Appraisal (HRA) under The Conservation of Habitats and Species Regulations 2012 (as amended) may be triggered.

European marine sites (EMS) are marine areas which are designated as Special Areas of Conservation (SACs) under the Habitats Directive and Special Protection Areas (SPAs) designated under the Wild Birds Directive. The closest European site to the proposed landfall site is the Northumbrian Coast SPA, which is approximately 0.9km south of the proposed landfall at Cambois Beach. Given the distance from the European site there is potential, that the requirement for an HRA may be triggered, however this will need to be confirmed as part of consultation on the findings of the EIA.

3.4 Crown Estate Licence

The Crown Estate own and manage the majority of the seabed out to the 12nm territorial limit. Permission is needed for rights to lay, maintain and operate cables on areas of seabed for which they are the landlord. The Crown Estate also request that they are informed of cables that transit the UK continental shelf (within the 200nm limit), as other activities may be impacted. A Crown Estate Licence will be required for the right to install and operate the Norway-UK Interconnector.

Applicants are required to obtain all necessary consents from government, and crossing and proximity agreements from existing tenants in close proximity to the works and works restriction zone. The Crown Estate licence is considered to be the final piece in the jigsaw and entrance to it must not be taken until the applicant is fully committed to the works.

The Crown Estate permission for cables is given as a seabed licence, associated with which are certain rights to enter onto the seabed, install, operate, maintain and repair. Occupation of any site and performance of works cannot commence until a legal agreement has been completed. Negotiations with the Crown Estate are at an advanced stage. The Crown Estate lease will require all other consents to be in place.

3.5 Port Authorities

Blyth Harbour Commission (Port of Blyth) is the Statutory Harbour Authority responsible for navigation on the River Blyth, with jurisdiction from 1nm seaward of the entrance piers to the navigable extent of the river, approximately 3 miles upstream. The proposed marine cable landfall is approximately 1.7nm north of the port of Blyth jurisdiction.

3.6 Protection of Wrecks Act

Under the Protection of Wrecks Act 1973 (PWA 1973), wrecks and wreckage of historical, archaeological or artistic importance can be protected by way of designation. It is an offence to carry out certain activities in a defined area surrounding a wreck that has been designated, unless a licence for those activities has been obtained. Offences include:

- Tampering with, damaging or removing any part of a vessel;
- Carrying out diving or salvage without permits;
- Removing objects from the wreck site; and
- Depositing, so as to fall and lie abandoned on the seabed, anything that would obliterate the site, obstruct access to it, or damage any part of the wreck.

Under the PWA, protection is provided for wrecks that are designated as dangerous due to their contents and is administered on a UK-wide basis by the Maritime and Coastguard Agency (MCA) through the Receiver of Wreck.

3.7 Ancient Monuments and Archaeological Areas Act

Although primarily land based, in recent years the Ancient Monuments and Archaeological Areas Act 1979 (AMAA 1979) has also been used to provide some level of protection for underwater sites. The Act provides for the scheduling of monuments, which encompasses buildings, structures or work, cave or excavation, vehicle, vessel, aircraft or other moveable structure. To be eligible for scheduling, a monument must be of national importance. Sites range from standing stones to deserted medieval villages, and include recent structures such as collieries and wartime pillboxes.

3.8 References

Marine and Coastal Access Act (2009), Chapter 23, available at: http://www.legislation.gov.uk/ukpga/2009/23/pdfs/ukpga_20090023_en.pdf [accessed Jan 2013]

MMO (2012) Marine Plan Areas, available at: http://www.marinemanagement.org.uk/marineplanning/areas/index.htm [accessed Jan 2013]

Marine (Scotland) Act (2010), available at: http://www.legislation.gov.uk/asp/2010/5/pdfs/asp_20100005_en.pdf [accessed Jan 2013]

4 SCOPING AND CONSULTATION

4.1 Introduction

Consultation has been a key element in the development of the Project and has also informed the scope of the Environmental Statement. This section provides a summary of the consultation undertaken that is relevant to the proposed marine cable route.

4.1.1 Overview

Consultation with statutory and non-statutory consultees and stakeholders has been undertaken during key stages of the project (including scoping) with the following aims:

- To provide all consultees and other stakeholders with the opportunity to inform the development of the Project and the final design submitted as part of the marine license application.
- To provide statutory consultees with the opportunity to comment on the proposed approach to, and scope of the ES.

4.2 Scoping

In order to ensure that the Environmental Statement covers the main issues of concern, a scoping report was produced and submitted to the appropriate statutory and key consultees in the UK. The objective of the scoping report was to provide sufficient information on the project and the environment in which it would be constructed and operated, so that the regulators (with the assistance of statutory and other consultees) could advise which issues should be the focus of the full appraisal of potential impacts.

4.2.1 Summary of Scoping and Consultation Responses

Table 4.2 provides a summary of the scoping and consultation responses received and the sections of the Environmental Statement that address these comments.

Table 4-2: Summary of Consultation Responses

Stakeholder	Summary of Consultation Responses to Project	Report Section
Marine Management Organisation	Benthic Environment:	
	Follow guidelines for the detection and quality assessment of habitats.	07, 09, 10,11, 12,13,20
	For the cable burial footprint and wider area affected the impacts on Annex I and UKBAP species should be considered.	09, 10,11, 12, 13,20
	Marine Protected Areas & changing legislation – the cable passes in close proximity to East of Gannet and Montrose field, which may be designated by the construction date.	09, 10, 20

Stakeholder	Summary of Consultation Responses to Project	Report Section
	Conservation of habitats and species:	
	Proximity to Northumberland Shore SSSI and species with functional value – potential for disturbance.	09, 10, 12, 20
	Designation of MCZs is expected in 2013 – avoidance of primary reasons for designation.	09, 10, 20
	Risks to seals from the use of ducted propellers – recommend following guidelines of Statutory Nature Conservation Bodies (SNCBs).	11, 15, 20
	Disturbance - Consideration of BAP and OSPAR species, prey items of SPA species.	09, 10,11, 12, 13,20
	Search area for sensitive bird species should be widened – effects foraging birds/mammals.	09, 12, 13,20
	Mitigation to include avoidance of sensitive times of year. Impacts of disturbance to bird species	09, 12, 20
	Fish & Shellfish	
	Migratory fish – impacts of work on migration routes and damage to health.	10,11
	Potential impacts to local fishermen and the Nephrops season	11,15
	Coastal Processes:	
	Flood risks or surface/ground water contamination posed by the cable landfall construction.	7, 8
Marine Management Organisation	Archaeology:	
	Potential to encounter peat deposits close to the shore in the vicinity of the proposed cable route; Interpretation of the geotechnical material obtained in the coastal margin should be undertaken.	7, 14
Natural England & Joint Nature Conservation Committee	Benthic:	
	Characterisation of benthic communities – follow current survey advice	10
	Protected Areas:	
	Proposed cable route runs through the Coquet Island proposed MCZ. Close proximity to NG14 Farnes East & NG 15 Rock Unique & NG16 Swallow Sand. East Gannet and Montrose Field within Scottish waters has been proposed as a MPA.	09, 10, 11, 12, 13, 21
	Marine Mammals	
	Harbour Seals & Grey Seals - high risk if within 4nm of Harbour Seal SAC and medium risk if between 4 to 30nm. Advise	07, 08, 20, 21

Stakeholder	Summary of Consultation Responses to Project	Report Section
	alternative to ducted propellers or avoidance of breeding season (1st June - 31st August. 1st Oct - 31st December respectively) or adopt a Seal Corkscrew Monitoring Scheme. Impacts on the prey items of the SPA species (sandeel) should be considered. Avoid priority Features of Conservation Interest (FOCI).	
	Sediment:	
	Re-suspended sediment in oil & gas areas or dredge and disposal sites is likely to introduce contamination to the water column.	08, 10, 11, 20
	Cable:	
	Landfall - Sea level rise and route through sediment - impacts on wave base should be considered Specification – Consideration to be given to the footprint of the cable and wider area affected and residual impacts on Annex 1 & UKBAP habitats.	07,08, 09, 10, 11,13,20,22
The Crown Estate	Offshore Wind/Other users:	
	Blyth Offshore Demonstration Project – Wind farm is in the immediate vicinity of the proposed cable landfall.	16,17,18,19,20,
	Recreation & Tourism:	
	Potential impact to Newcastle Wildfowlers shooting club - have a comprehensive management plan in place for the region of Sunny Beach.	16,17,18,19,20,
National Renewable Energy Centre	Cable Corridor:	
	Potential for the Norway-UK Interconnector and NAREC projects to develop alongside one another. Importance of information sharing	17,20
Centre for Environment, Fisheries and Aquaculture Science	Protected Areas & Species:	
	Include any reference to OSPAR list of threatened species.	09, 10, 11, 12, 13, 20
Maritime and Coastguard Agency	Shipping and Navigation:	
	Consider collision risk during construction Cable burial depths – ensure depth is sufficient for shipping safety Marking & lighting – ensure construction vessels are effectively marked and notified. Electromagnetic deviation on ships' compasses. The MCA would be willing to accept a three degree deviation for 95% of the cable route. For the remaining 5% of	3,11,16,19

Stakeholder	Summary of Consultation Responses to Project	Report Section
	the cable route no more than five degrees will be attained.	
	Recreation & Tourism:	
	Consider visual intrusion and noise impacts. Consider electromagnetic deviation effect on ships' compasses.	16, 19, 20
Scottish Environmental Protection Agency	Flood Risk:	
	Land based connection - SEPA should be consulted once consultants have been appointed.	20
Scottish Natural Heritage	Not SNH jurisdiction (outside 12nm) emphasised the proposed East of Gannet & Montrose MPA	9
Eastern Link Project	Crossing Agreement:	
	Eastern Link has not announced their landfall locations but a crossing with the NSN project is likely.	3
Scottish Fishermen's Federation	Cable Installation:	
	Burial depth – Ensure that burial is sufficient to allow fishing activities to continue. Cable crossings design to be sympathetic to 'rock hopper' trawling gear (berms with a 1 in 3 slope profile and the correct grade of stone).	3,11,15, 21, 20
	Highlighted the potential need for post installation 'over-trawling' trial to confirm that the crossing is not a risk.	15
Northumberland Inshore Fisheries and Conservation Authority	Inshore Fishermen:	
	Provision of sightings data to represent the inshore fishing interests (0-6nm) in the vicinity of the proposed NSN cable route.	11, 15, 20, 20
Royal Yachting Association	Shipping and Navigation/Recreation & Tourism:	
	Maintenance of craft safety – after rock placement activities would like to see 4m draft maintained for recreational craft. Would like to see recreational craft included in the navigational risk assessment.	16,19
Marine Scotland	Fisheries:	
	Recommends the use of sediment distribution maps, VMS and landings data to evaluate fisheries, in addition to Cefas Fisheries sensitivity maps.	8, 11,15
	Recommend consultation with Scottish Fishermen's Federation.	15
	Sediment:	
	Recommends avoidance of cuttings piles in oil and gas development areas to minimise suspension of sediments and potential	8

Stakeholder	Summary of Consultation Responses to Project	Report Section
	contamination.	
	Hydrodynamic modelling, siltation patterns and chemical/physical analysis of the seabed including sampling locations - consideration of the extent of the decrease in water quality.	8
	Protected Areas:	
	Consider Scottish MPA proposals during the process.	9
	Information Sharing:	
	Recommends the use of datasets held in the MEDIN/DASSH archive.	9
Environment Agency	Flood Risk:	
	Consider flow and drainage issues in all phases of construction and operation.	20
	Biodiversity:	
	Review impacts on local, regional and global scale.	20
	Protected Areas:	
	Provision of compensation habitat if damage to a protected area occurs.	20
Trinity House	Cable Burial:	
	Rock placement is the least preferred method of cable protection.	3, 5
	Shipping & Navigation:	
	Confirm any vessels used to exhibit signals as per collision Regulations.	16, 19
Department of Environment and Climate Change	Shipping & Navigation:	
	Ensure other operators in the area are aware of proposals and installation operations	15, 16, 17
Newcastle Wildfowlers	Bird Sensitivity:	
	Particular consideration during winter as the inlet provides important feeding areas when other inland areas are frozen.	9, 12
	Preferred option is Cambois Beach South – due to the existing infrastructure from Blyth power station and cables currently land in this area.	17, 20
Northumberland County Council	Protected Areas:	
	Consider proximity of the SSSI and features of conservation interest (notably bird species) to the proposed development.	9, 12, 20

5 PROJECT DESCRIPTION

This section provides a description of the marine elements of the proposed marine cable route within the UK Exclusive Economic Zone from the UK/Norwegian median line to the landfall on the Northumberland coast. It describes the aspects of the project relating to the installation, operation, maintenance and decommissioning of the marine cables including:

- **Installation**: Details of the marine cable installation process including the pre-installation surveys, the range of vessels to be used and different installation techniques which could be employed in cable laying, jointing and burial.
- **Operation**: The physical characteristics of the marine cables including information about their design, operation and maintenance as well as details of electro-magnetic fields (EMF).
- **Decommissioning**: The recovery and dismantling activities involved in decommissioning a typical marine power cable at the end of its operational life.

5.1 Project Overview

The proposed 1.4 Giga watt (GW) transmission capacity of HVDC technology will be used to provide a link between the proposed Norwegian converter station and the UK converter station at Blyth.

The proposed marine cable route corridor is shown in Figure 1-1 (Appendix 1) and incorporates the following:

- Approximately 340km of marine cable route corridor in UK waters into which two marine cables will be laid. Generally the cables will be buried at depths between 1m and 2m below the seabed. However, certain sections, at cable and pipeline crossings and where burial may not be feasible, will be laid on the seabed and additional protection will be installed over the cables post installation.
- A landfall at Cambois Beach North Slipway which will connect, at a transition joint pit, to an underground HVDC cable route to the converter station
- The final route of the installed marine cable will be within the 500m wide survey corridor, with further micro-routeing used to avoid areas of sandwaves, bedrock and boulders.
- The most likely cable configuration, or project “base case” on which the EIA is based, is a bi-pole HVDC system, consisting of two cables separated by between 20m and 50m depending on marine easements and seabed conditions.

This EIA considers the Norway-UK Interconnector between the UK/Norway median line and UK mean high water springs (MHWS), which includes the intertidal area. A separate terrestrial EIA has been prepared which covers the cable route from the mean low water (MLW) to the converter station. Both reports therefore consider the intertidal zone. A full description of the project is provided in the Norway-UK Interconnector bridging document.

5.1.1 Marine Cable Route Description

From the UK/Norway median the proposed marine cable route is routed south west through Scottish administered offshore waters for a distance of approximately 116km passing through the Curlew, Elgin and Lomond oil fields before entering English administered waters 209km east of Montrose. The route through the oil fields has been designed to minimise the number of pipeline crossings and to avoid offshore structures. The cable route continues south west for approximately 230km passing to the south of the Devils Hole and through the Farne Deeps before reaching landfall at Cambois Beach on the Northumberland Coast. A description of the sediment types encountered along the cable route is provided in Chapter 7.

It should be noted that the proposed marine cable route corridor and potential installation techniques discussed below have been identified based on a combination of desk studies and sea bed surveys. Prior to marine cable installation, NGIL and SSF's appointed Contractor will undertake a final seabed survey to confirm sea bed conditions and finalise the exact cable route and techniques to be employed. This Project description describes the suite of techniques which could be used and which have been assessed in the technical chapters of this Environmental Report.

5.1.1.1 Marine Cable Route

A description is provided below outlining the development history of the proposed marine cable route corridor which was based on the original North Sea Interconnector (NSI) route to KP 500, approximately 127km south west of the median line. From this point the route diverges from the NSI route towards the proposed Norway-UK Interconnector landing at Blyth.

The proposed marine cable route corridor considered as part of the EIA was surveyed by MMT between April and October 2012. Analysis of the geophysical, geotechnical and benthic habitat data from the survey works identified further areas along the route which for technical, engineering and environmental reasons had characteristics that were not ideal for final route selection. A key consideration was the identification of the presence of hard seabed sediments along the nearshore sections of the alternative route options to landfall. Four potential landfall options on the Northumberland Coast were originally identified; Lyne Sands, Sandy Beach, Cambois Beach North Slipway and Cambois Beach South. All four landing options were surveyed and analysis of the 2012 survey results indicated that Cambois Beach South was the preferred landing from a marine point of view due to the presence of bed rock on the other three routes. However, assessment of the onshore routing options to the proposed converter station site indicated that Cambois Beach North Slipway was the preferred landfall option from an onshore point of view. Therefore further infill survey works were undertaken of the nearshore area during May and June 2013 to provide additional information on the seabed and to investigate options for final route optimisation on the approach to the Cambois Beach North Slipway landfall

The key route development decisions and constraints which apply to the final marine cable route corridor are outlined below. To aid this description, kilometre points (KP) have been assigned to the route in the direction from Norway to the UK.

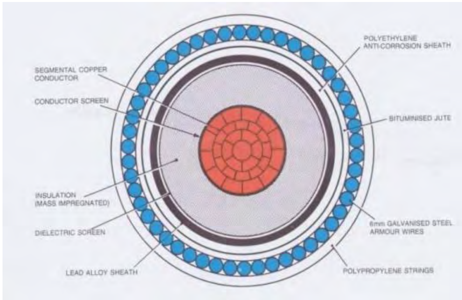
Table 5-1: Route Development/Key Constraints

Route section	Route development / Key constraints
KP 372 – KP 395	From the UK/Norway median line the cable route was moved to the North of the Lomond platform, this eliminates the isolated crossing of the CNS Fibre Optic cable, and the crossings of the Erskine to Lomond 20” Oil and 16” Gas lines
KP 406 – KP 440	Re-routing of cable to the north to eliminate the crossing of two umbilicals and a 20” gas pipeline running between the Shearwater and Starling facilities.
KP 440 – KP 475	Optimised pipeline crossing alignments where the route crosses five pipelines at four separate crossing locations.
KP 500 – KP 560	Analysis of the BGS Devils Hole Quaternary chart revealed that the cable route passed through an area of over consolidated clay in the region of KP 520. The route was optimised to the North East of this area through soft silty clay where sediments are less cohesive and allow burial to target depth.
KP 580 – KP 650	The original route passed through the edge of two Marine Conservation Zones (MCZ). While there is no legislation which prevents the installation of cables within a MCZ, it was considered prudent to avoid them when this could be achieved with a relatively minor change of route. While adjusting the route, opportunity was taken to enhance the burial potential by remaining in sandy/silty sediment where possible.
KP 650- KP 714	Four route options were surveyed during the 2012 marine survey, Lyne sands, Sandy Beach, Cambois Beach North Slipway and Cambois Beach South. Cambois Beach South was initially the preferred option, as the routes to the other landfalls crossed areas of exposed bed rock. However there were overriding engineering issues which constrained the Cambois Beach South landfall. Additional marine survey was commissioned in 2013 to investigate an alternative route into Cambois Beach North Slipway, this survey confirmed there was a viable route into Cambois Beach North Slipway avoiding areas of exposed bedrock and Cambois Beach North Slipway then became the preferred landfall option.

5.2 Physical Description of Marine Cables

Electricity will be transmitted using High Voltage Direct Current (HVDC) cable technology; the cable structure is similar to that shown in Figure 5.2. Each cable is approximately 150mm in diameter, and weighs approximately 50kg/m. The cables have a copper core, are insulated by mass impregnated (MI) paper (or alternatively mass impregnated polypropylene paper laminate (PPL)) and are protected by steel cable armouring.

Figure 5-2: Typical Mass-Impregnated (MI) HVDC cable



The Norway-UK interconnector will comprise what is termed a “bipolar converter station configuration”, with two HVDC marine cables installed alongside each other. Bipolar systems transmit power through two high voltage conductors of opposite polarity (e.g. +550 kV and – 550 kV).

It is proposed that in general the cables will be installed with a separation of approximately 50m. This is intended to offer a degree of protection from both cables being damaged in one incident. In the approach to the landfall the last 200m will be separated by approximately 20m.

Installing the cables separately is the preferred option from an operational and logistical viewpoint as it approximately halves the number of cable joints required compared to the other options and cable burial is significantly easier. Project research indicates that the separated cables create only a minor magnetic field and that any magnetic field will also be mitigated by the east-west orientation of the cables. Research also indicates that separated cables generate very little heat.

Mass impregnated (MI) cable is currently the only type of cable used to date for long (over 50km), high capacity (greater than 1GW HVDC) submarine links. MI type cable is a proven technology and has been widely used on similar HVDC cable projects (e.g. the UK-France interconnector, BritNed interconnector between UK and the Netherlands and the SwePol link between Sweden and Poland). In the case of the Norway-UK interconnector a Polypropylene Paper Laminated (PPL) cable may also being considered.

The MI cable is a stranded type single copper core cable that has paper insulation impregnated with high viscosity mineral oil. This cable type is not pressurised like a fluid (low viscosity oil) filled cable and has no free oil to leak out in the event of a cable sheath rupture. In the case of PPL cable the paper insulation is replaced by a Polypropylene Paper Laminate which has improved electrical and thermal characteristics compared to paper insulation.

A typical section of an MI cable is shown in Figure 5-2. The MI cable core has a concentric construction comprising a central stranded low resistivity copper conductor with a screen, mass impregnated paper insulation layers, and an outer dielectric screen made of semi-conducting paper. The core is contained in a lead sheath to protect the insulation from water ingress and a polyethylene sheath is extruded over this to protect it from corrosion. One, and sometimes two, layers of galvanised steel armour wires are applied in a helix to provide mechanical strength during cable handling and installation and protection from external damage. The armour wires are bedded into a layer of bituminised jute strings and a layer of polypropylene string is applied over them to bind them in and provide abrasion resistance to improve handling.

A fibre optic Distributed Temperature Sensing System may be installed in association with each marine cable for monitoring and control purposes along the entire length of the marine cable route.

This Environmental Statement has been prepared on the basis that the cable configuration for the 1400 MW Norway-UK interconnector, will be a bipolar HVDC system, with a pair of single core, MI cables laid in trenches separated by between 20m and 50m depending on marine easements and seabed conditions.

The key design features of a typical MI cable suitable for the ratings envisaged on the proposed Norway-UK Interconnector project are described in Table 5-2 below.

Table 5-2: Design Features of a Typical Mass Impregnator Cable

Specification	Capacity
Nominal Voltage	500 + / - kV
Maximum Operating Voltage	525 kV
Maximum Operating Current	1450 A
Maximum cable system losses	3%
Typical section losses per unit length	26 W/m
Maximum conductor temperature	Ca. 50ºC
Outer Cable diameter	Ca. 130 mm
Weight	Ca. 50 kg/m
Minimum bending radius	3 m
Maximum allowable Pulling tension	Ca. 250 kN

5.2.1 Pre-Installation Survey Requirements

Marine surveys have been undertaken in order to confirm the viability of the proposed marine cable route corridor with regard to seabed conditions, bathymetry and any other seabed features. Geophysical and geotechnical marine surveys were undertaken over a generally 500m wide survey corridor

The collection of this survey data was also essential in the identification of appropriate installation methods and the selection of the best options required to achieve the desired level of protection for the cable system.

Geophysical survey methods obtain information through measurements of reflected acoustic energy or ambient fields. The geophysical survey used the following non-invasive techniques: bathymetry, side-scan sonar, sub-bottom profiling, and magnetometry.

Sea bed samples are then taken during a geotechnical survey. The purpose of the geotechnical sampling methods is to derive *in-situ* measurements of the properties of the seabed sediments. Geotechnical sampling methods are invasive in that there is a physical interaction between the sampling device and the sediments. For the Norway-UK interconnector surveys both vibrocore and piezo-cone penetrometer testing (CPT) methods were used.

Benthic surveys were also undertaken using a combination of grab samples, still photographs and video transects. These surveys have enabled the benthos to be described in key areas.

Remote Operated Vehicle (ROV) surveys were carried out to identify the status of pipelines and cables which cross the route and inspect spot targets for routing and archaeological purposes.

A contractor was appointed by NGNSNLL and SSF to conduct the marine route surveys, which took place between April 2012 and October 2012. A follow up infill survey of the nearshore area was also undertaken between May 2013 and June 2013. The main objectives of the surveys were to:

- Identify bottom type (e.g. sand, rock, mud) to optimise the proposed marine cable route corridor (by avoiding hard substrate areas);
- Identify potential geological constraints, such as dykes, rock pinnacles, sand waves, incised channels etc;
- Identify locations of potential engineering constraints and/or safety hazards, such as existing pipelines and cables (either in use or out of service), wrecks, marine debris, unexploded ordnance etc; and
- Identify areas of potential biological importance (Annex I habitats); such as biogenic and rocky reefs, carbonate gas escape features etc.

The final cable installation route will be optimised within the survey corridor to take account of the fact that achieving adequate cable burial will be easiest in areas of soft sediments.

The main geophysical and geotechnical survey techniques are briefly described below:

5.2.2 Bathymetry

Swathe, multi-beam and single beam acoustic echo sounder systems are used to record water depth, thereby describing the seabed topography along the proposed marine cable route corridor.

Water depths have been corrected to allow for tidal and other variations and referenced to the vertical datum of Mean Sea Level (MSL). MSL represents a suitable reference level from which the local UK vertical datum (Ordnance Datum Newlyn (ODN)) used for topographic surveying can be derived.

5.2.3 *Side-scan sonar (SSS)*

This technique enables mapping of the seabed surface and identification of sediment types. The shallow surface geology can also be assessed using this technique but the thickness of the sediments cannot be determined.

The sonar signal is emitted from a towfish towed behind the survey vessel along the route corridor. Reflections from sediments and other hard objects are received back at the towfish and processed onboard the survey vessel to produce an image of the seabed.

At selected locations samples of seabed sediment are taken using a small mechanical grab to correlate reflections on SSS image with the characteristic reflections of known sediment types.

Obstacles lying on the seabed, such as wrecks, trawler debris and surface-laid or exposed pipelines and cables that might impede cable installation can be identified from the SSS image.

5.2.4 *Shallow Sub-Bottom Profiling*

The thickness of sediment layers can be determined by the use of sub-bottom profiling. This technique involves injecting a pulse of acoustic energy into the seabed and detecting the reflections from the sub-surface geological units. From the reflections the thickness of the sediment can be assessed, but the type of sediment can only be inferred until “ground-truthing” geotechnical data is obtained.

5.2.5 *Magnetometry*

Magnetometers are passive devices which measure variations in the earth’s magnetic field such as those caused by geological faults and buried metallic objects such as pipelines and cables that may not be detected by the SSS survey. A magnetometer survey is used to confirm the positions of known pipelines and cables and detect obstructions to cable installation such as uncharted cables, metallic debris or wrecks.

5.2.6 *Vibrocore*

A vibrocore consists of a vibrating head weight which pushes a hollow tube, generally 3-6m in length, into the seabed sediments. The vibration causes water saturated sediments to liquefy, thus enabling the core barrel to be pushed through them. The sampling device stops penetrating the sediments when either the core length is reached, or the sediments are too hard for the weighted head to push through.

The core is removed by the vessel pulling on the vibrocore frame and a core catcher (a set of metal leaves) prevents the material from falling back out of the core. The sample is then cut into more manageable lengths (usually one metre sections), and the end of each section sealed to prevent water from escaping.

In the laboratory the core is logged (i.e. a description is made of the sediments that occur down the length of the core). Samples are extracted from sections of the core and physical tests are undertaken to determine a range of parameters such as the particle sizes of the sediments and the shear strength.

5.2.7 Cone Penetrometer Tests (CPT)

This test uses a pointed cone shaped sensor attached to a steel rod which is pushed into the seabed sediments. The tip of the cone has sensors which measure certain physical properties of the material as it is passing through them – typical measurements include tip resistance, sleeve resistance, and pore water pressure. From an analysis of these measurements it is possible to derive geotechnical properties of the sediments.

Many systems now use a piezometric cone tip; these systems are referred to as Piezocone Cone Penetrometer Tests (PCPT) and such systems were used on all surveys - the terms PCPT and CPT can be synonymous.

5.2.8 Remote Operated Vehicle (ROV) Inspections

To inspect existing pipelines and cables which cross the route and to identify spot targets located during the geophysical survey, an ROV was deployed which made a visual inspection of the seabed or tracked the target with a pipe tracker to establish the depth of burial of the pipeline or cable.

5.2.9 Pre-Installation Route Surveys

Prior (3-6 months) to the marine cable installation the appointed contractor will conduct a pre-installation route survey. This will involve using a range of standard geophysical survey techniques such as multi-beam echo-sounder, side-scan sonar, sub-bottom profiler and magnetometer. The main objectives of the survey will be to:

- Confirm the results of the initial route survey and ensure that there are no new engineering constraints (e.g. debris)
- Optimise the marine cable route in areas of mobile sediments (i.e. sandwave fields)
- Identify exactly the locations of the engineering constraints and/or safety hazards, such as the cables, wrecks, marine debris, reefs, unexploded ordnance etc.

Any modifications to the proposed marine cable route will be developed to minimise environmental impacts within the cable route corridor and to optimise cable protection by ensuring adequate burial.

5.2.10 Cable Route Clearance

Prior to the start of marine operations it is essential to ensure the proposed marine cable route is clear of obstructions that may hinder the operation.

Seabed debris, such as scrap trawler warps or ships' crane wires that may have been jettisoned by vessels onto the seabed, abandoned communications cables and other debris can seriously impede the progress of a burial machine. Before the start of cable laying operations the cable route is surveyed using a magnetometer to identify wires and cables so they can be removed.

To clear the route of the detected and also any undetected debris a small vessel will be mobilised to remove them during an operation known as a 'pre-lay grapnel run' (PLGR). The PLGR vessel tows a wire with a series of specially designed hooks, or grapnels, along the centreline of the cable route until it encounters debris. The tow winch is fitted with a strain gauge which will detect the rise in tension as an object is hooked. Most old cable and scrap wire is normally found at, or just below, the seabed. The PLGR grapnel will be designed to penetrate the seabed to a depth of approximately 1m. The grapnel will have a maximum width of approximately 200mm.

Any debris encountered will be recovered to the deck of the vessel for appropriate licensed disposal ashore. Should any unexploded ordnance be discovered during this process, a registered Explosives and Ordnance Disposal (EOD) specialist will be available during the installation process to identify any suspicious items and provide advice on appropriate remediation. Abandoned communications cables may be kilometres long. The vessel will cut out and recover a section of the cable to open a gap through which the burial machine can pass. The two cut ends of the cable at either side of the gap will be fitted with weights to secure them against movement before they are returned to the seabed.

Cable installation may be carried out in a number of campaigns, the length of which is related to the cable carrying capacity of the main lay vessel. The PLGR operation may be phased to ensure that the route is clear of any recently dumped debris before each campaign.

5.3 INSTALLATION

It is proposed to bury the proposed marine cables along the majority of the marine cable route except for where burial is not possible for example at crossings with existing cables or pipelines. The results of the 2012 route survey indicate that, with the exception of a small area close to the landfall at Blyth, full burial should be feasible for the majority of the route within the UK sector, however a number of areas have been identified where full burial may not be possible and in these regions it may be necessary to protect the cable by other means such as rock placement. The exact details of the installation technique will be confirmed when the contract for installation is awarded. It is envisaged that a variety of installation and burial techniques will be required due to the highly variable nature of the seabed along the proposed marine cable route corridor.

5.3.1 Seabed Preparations

5.3.1.1 Pre-sweeping

Along the route areas of sandwaves will be avoided where possible. However, where sandwaves cannot be avoided pre-sweeping may be required in order for the burial techniques to be employed effectively. The occurrence of sand waves has been identified over the part of the route that traverses the Northeast banks near KP 643, however these have a magnitude of only 0.75m. Depending on the burial technique it may or may not be necessary to carry out pre-sweeping of these sand waves.

In the event that pre-sweeping is employed this would involve either dredging a passage through the sandwave or ‘clipping’ off a part of it to give a smoother overall profile.

The marine cables will be buried into the seabed for protection from environmental conditions and third-party interactions, such as fishing operations. The types of burial machines expected to be used have a limited ability to work on inclines, where their stability is affected. The proposed marine cable route corridor crosses some areas of sandwaves where the seabed incline may be outside the capability range of the equipment. In these areas the excessive inclines will be removed with a dredger or mass flow excavator to create a flatter profile, or ‘working profile’, for the burial machine. The “footprint” of this operation is likely to be approximately 20-30m wide.

The sandwaves along the marine cable route may be mobile, changing shape and position over time. The mobility of sandwaves creates the risk that the buried cables will become exposed when a covering sandwave crest moves away from it. Burial machines have the ability to bury cables to a range of depths, but the practical limit with commonly available machines is 3m. To ensure durability of protection, the seabed will be modified in places to augment the capability of the burial machine. By removing a proportion of a particular sandwave a burial machine is able to reach further down and place the cables below the level at which it may be affected by mobility of the feature. This type of operation is called pre-sweeping.

A dredger or mass flow excavator will be deployed in advance of the main lay spread to create the necessary seabed profile based on a bathymetric survey of the route. It is expected that a bathymetric survey will be undertaken in the period immediately before installation to ensure that the actual and current profile of the seabed is captured, and to confirm the areas already identified from previous surveys where pre-sweeping is required.

The pre-sweeping work if required will be scheduled to ensure the profile maintains its shape prior to the arrival of the installation spread. The schedule will depend on an assessment of the sedimentary processes and the existing weather conditions and the need to ensure the main lay spread is not held up in any way.

It is currently envisaged that little or no pre-sweeping will be required.

5.3.2 Installation Vessels

Although exact details may change, it is likely that the vessels to be used will consist of:

- **Cable lay vessels (CLVs):** these will be dedicated CLVs, (see Figure 5-3) which will deposit the cables onto the seabed. The vessel will be equipped with specialised equipment including cable tensioners and turn-tables, a full survey suite is provided to accurately detail the final cable position on the seabed. Depending on the vessel capability the cable may also be buried by this vessel at the same time as it is laid i.e. “simultaneous lay and burial”, or the cable may be buried in a separate operation i.e. “post lay burial”. These vessels will use dynamic positioning (DP).

Figure 5-3: Cable Installation Vessel

- **Cable lay barge:** a shallow water cable lay barge (Figure 5-4) may be required to lay and bury the cables at the Cambois Beach North Slipway landing, depending on the installation technique selected by the contractor. The vessel will use anchors for positioning, and be equipped with specialised equipment including cable tensioners, cable burial tools and a full survey suite to provide accurate details on the final cable positions. Burial work may take place simultaneously or a short time after the laying operation.

Figure 5-4: Cable Lay Barge

- **Cable burial vessel**: dedicated cable burial vessels (Figure 5-5) may be used to bury the cables using a variety of equipment depending on the seabed conditions encountered along the route and based on environmental factors. This work may take place simultaneously or a short time after the laying operation. The vessels will use dynamic positioning.

Figure 5-5: Cable Burial Vessel

- **Guard vessel(s):** these are often local fishing vessels commissioned specifically for the purpose of ensuring cable laying operations occur safely and with minimal interaction with/disruption to local fishing/shipping activity.
- **Supply vessel(s):** one or more local, non-specialised vessels may be used for re-supply of installation vessels and to provide logistical support.

5.3.3 *Ports and Supply* Bases

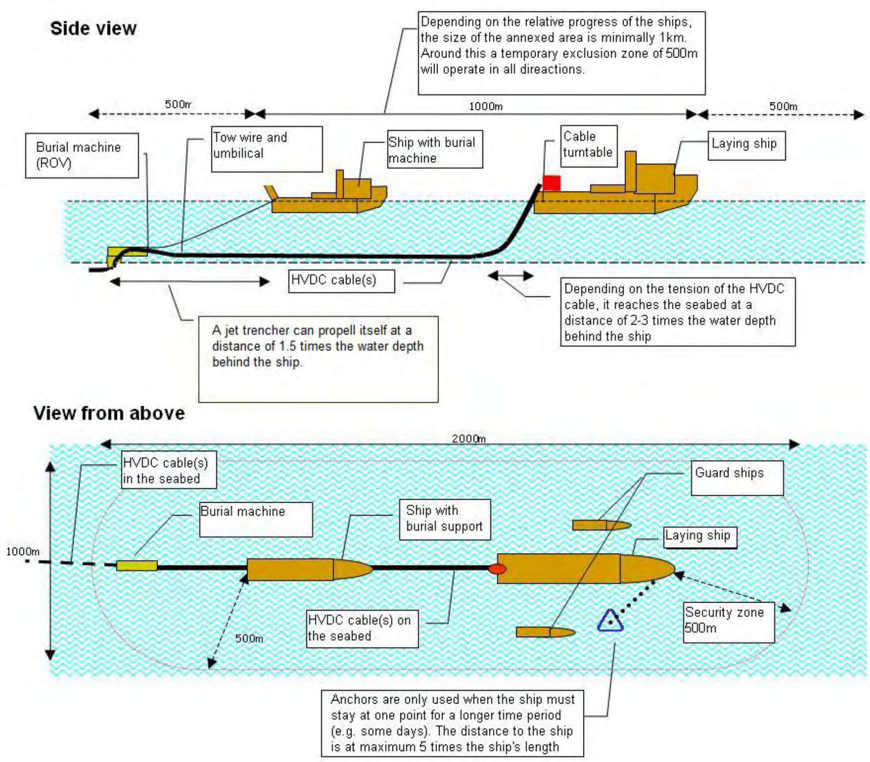
Vessels will operate from established ports (e.g. Newcastle, Blyth, Montrose, Aberdeen) that will also be used as supply bases (space will be required on the quayside for storage and temporary site facilities).

5.3.4 *Cable Laying Operations*

The cable lay operation will be performed on a 24-hour basis to ensure minimal navigational impact on other users and to maximise efficient use of suitable weather conditions and vessel and equipment time. Notifications will be issued in accordance with statutory procedures to ensure navigational and operational safety.

The main cable length in the open sea, seawards of the shore-end or any shallow water section will most probably be installed with an installation spread comprising the vessel carrying and laying the cables (cable lay vessel) and a separate vessel that deploys the burial machine (cable burial vessel). Ideally these vessels will operate as one installation spread as schematically shown in Figure 5-6, however it is probable that the cable lay and cable burial vessels will operate independently due to the different speed of operations.

Figure 5-6: Cable Laying Operation



In areas of high density shipping or fishing activity, where deemed necessary, the cable installation spread may be accompanied a guard vessel. The guard vessel will maintain surveillance around the spread to ensure that other vessels keep clear of the spread to avoid the threat of collision and to protect the cable prior to burial. Navigational warnings will be broadcast by the spread and guard vessels to warn approaching vessels of the position and course of the spread and inform fishing vessels of the presence of the cable.

During the installation process the main lay vessel will surface lay one cable, and in a later operation surface lay a further cable separated by 20m to 50m and parallel to the first cable. The burial support vessel, if practical, will follow closely behind the laying vessel and bury the cables using either a jetting or mechanical trenching machine.
Present survey information indicates that seabed sediments on the route are primarily fine to medium sand and soft clay with only limited sections of possibly stiff to very stiff clay. There are areas where sediments may be very thin (<0.5m) over very stiff clay or very coarse cobble-rich gravel of firm to stiff clay.
A jetting machine is thought to be capable of cable burial in sediments found along 80-90% of the route but may be required to be augmented by mechanical trenching in the very stiff clay or very coarse cobble-rich gravel of firm to stiff clay found along short sections of the route. The final choice of burial technique and machinery will be confirmed by the installation contractor, although under due diligence requirements the Norway-UK Interconnector project will satisfy itself that any solution is viable and can provide the necessary level of protection.
It is not possible for any currently available cable lay vessel to carry the full length of cable in one load and therefore the operation will be composed of a

number of campaigns. The campaigns will be separated by the time required for the main lay vessel to transit to the cable factory, load the next section of cable and return to site. During this period guard vessel(s) may be left behind to guard the cable ends which will have been capped to prevent water ingress, and deployed onto the seabed by the main lay vessel. The period of time between campaigns will not be known until the location of the cable factory is known, as the distance to and from the factory affects the timing, but this is likely to be several weeks.

A large cable vessel may carry up to 100-120km of cable which will weigh between 6000-7000 tonnes. Once this length of cable has been laid the vessel will have to return to Port and the next section of cable collected from the cable factory. The proposed marine cable route within the UK sector is approximately 340km long and it is therefore anticipated that 3-4 sections (campaigns) will be installed for each cable (in total 6-8 campaigns for entire project) by the main cable lay vessel. In addition 1-2 campaigns using a cable lay barge will be required to install the bundled shallow water section on the approach to the landfall. The burial vessel may be stood down during the period the main lay vessel is off-site unless there is any burial work to be done on the already laid cable sections.

When the main lay vessel has returned to the site of completion of the previous campaign it will recover the cable ends and commence jointing the new cable sections to those already laid.

Following jointing the installation spread will continue laying and burying the cables until the cable loaded is again exhausted, repeating the above process until the cable system installation is completed. Details regarding the direction and timing of the offshore installation will ultimately be defined by the installation contractor (however, an indicative installation programme is outlined in Section 5-6).

Vessels involved in main lay and burial will use dynamic positioning (DP).

5.3.5 Cable Jointing and Joint Installation

As discussed above the cable installation will be performed in a number of campaigns, the lengths of which will depend on the cable carrying capacity of the lay vessel or vessels.

Between each section a joint will be required in each HVDC cables; therefore between four to five joints will be required for each cable. The jointing and joint installation processes will essentially be the same regardless of joint location. Each cable joint required will be made onboard the relevant vessel and may take anything from four days to a week to complete. During the extended timescale required for jointing HVDC MI cables the vessel will normally remain in DP mode, in exceptional circumstances, the vessel may deploy anchors to maintain its position during the process.

In most cases, after jointing the cable lay will resume in the same direction as the section already laid and the joints will be “in-line” with the cable route. However, if operational reasons or unforeseen circumstances arise a ‘final’ joint or interim joint in the system may be required between two already laid sections of cable. The joints have to be made onboard the vessel which means extra cable equal to twice the depth of water is introduced into each of the two cables to allow for the jointing operation to take place.

When final or interim joints are deployed onto the seabed they are laid down in a loop formation, referred to as an “omega” owing to its shape. The loop size and shape are controlled as the cables are deployed onto the seabed to ensure the cable minimum bend radius requirements are met.

The joints and the short section of adjacent cables left on the seabed at the ‘final’ joint location will be buried using a jetting machine as this is best able to conform to the relatively tight radii of the omega loop, and is the most effective method for the post-lay burying of joints and cables in this situation.

The location of joints, including the final joint, is largely dependent on the length of cable that the lay vessel can carry in one load. However the jointing of cables in areas that are sensitive for either environmental or technical reasons, such as the navigation channels, may not be desirable. Cable lengths, the sequence of laying and hence joint locations will be managed at the system design stage. The Norway-UK Interconnector project will ensure that, as far as possible, joints are not located in sensitive areas, e.g. shipping channels, anchoring grounds, where the prolonged location of the installation spread is not desirable, but exact joint locations can only be determined once the cable manufacturer and installation contractor have been appointed.

5.4 Cable Burial

The cables will be buried as a safety measure to avoid damage and entanglement with, for example, trawling gear and anchors and also to minimise the risk of “free spanning” cable over gaps, causing cable fatigue.

The expected depth for burial is between 1m to 2m below seabed level, although this may vary depending on the nature of the substrate: this may be increased up to 3m where there is anchoring activity or in areas of mobile seabed. The “base case” for the project is for installation of two power cables, which will be separated by 20m to 50m and buried 1 – 2m beneath the seabed.

It will be necessary to use rock protection or “mattresses” over some parts of the route to protect the cables at cable and pipeline crossing locations and possibly in areas of hard seabed where burial is not possible. The recommended target burial depths along the cable length were determined in a detailed engineering burial study undertaken in April 2013 (NSN Risk Assessment and Protection). This considered cable route, seabed composition and dynamics, and risk of damage from external sources such as fishing gear and ship’s anchors.

The alternative burial methods and equipment which could be used for installing the marine cables to the target burial depths will be considered against the following selection criteria:

- Minimising turbidity and disturbance to the seabed
- Minimising the space used on the seabed
- Ability to achieve reinstatement of the original situation
- Demonstrating suitability to seabed conditions
- Using proven technology

- Minimising installation costs

5.4.1 *Burial Depth Recommendations*

The cables will be buried into the seabed along the maximum length possible. The target burial depth at any given location is determined by the hazard profile and the geotechnical properties of the soil at that location. The target burial depths are given in Table 5.3 below which shows the general burial/rock installation requirements for different sediments along the route.

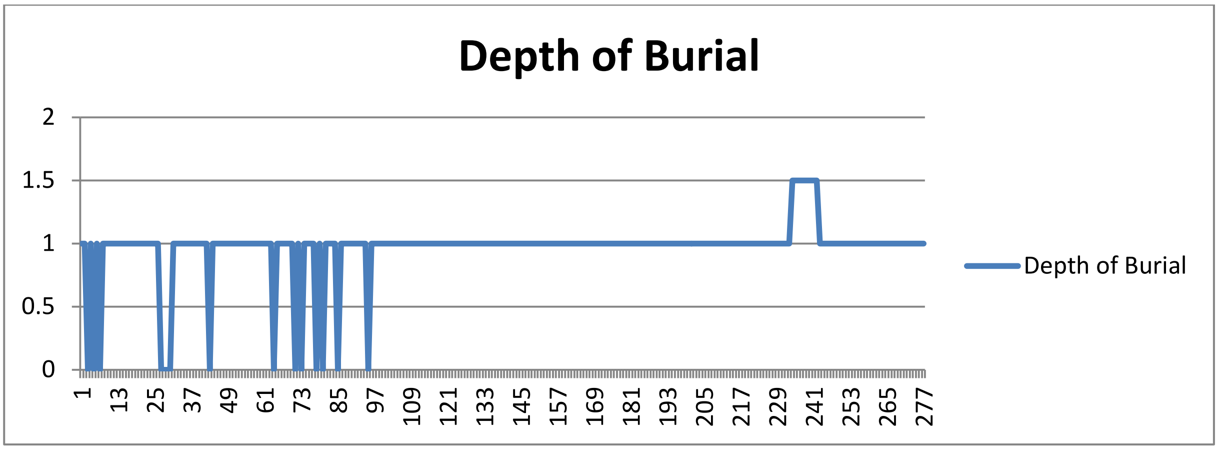
Table 5-3: Proposed Target Depth of Burial for Various Sediments

Soil (undrained shear Strength)	Minimum Depth of Burial
Very Stiff Clay (>150kPa)	1.0
Sand and Clays (20-150 Pa)	1.5
Very Soft Clay (<20kPA)	2.0

In areas subject to erosion, such as is potentially the case in the UK landfall area and areas of sandwaves, the cable burial and method of protection will be engineered to withstand such erosion/sediment migration and hence deeper burial depths may be proposed.

From a preliminary burial assessment the target burial depth for the majority of the route is likely to be 1.0 – 1.5m, with 1m being proposed for areas where geological conditions such as boulders bank is at or very near the seabed. The boulder clay is typically very stiff to hard, which is much more resistive to penetration than the sediments found along the rest of the route and offers equivalent protection at reduced burial depth. The preliminary proposed target burial depths along the route are shown on Figure 5.7.

Figure 5-7: Target Burial Depths UK-Norway Median line to UK Landfall



5.5 Cable Burial Methods and Equipment

A number of alternative methods are available for cable burial; however, the options are restricted by the characteristics of the seabed into which the cable is installed.

The exact specification of the installation machinery will be determined in the detailed design phase, the sediment type along the route and also the availability of suitable equipment will be among the factors considered. Typical equipment is shown in Figure 5-8.

Figure 5-8: Installation Equipment: Cable Plough (left) Jetting Trencher (right)

As noted previously, from an examination of the preliminary route survey results and the known seabed conditions it is likely that more than one type of burial device will be required on the cable route, depending on local seabed conditions such as the presence of boulder clay, muds, sand or glacial till.

The cables will be buried into the seabed either by a plough, jetting or trenching machine deployed by the main laying vessel directly or by a support vessel ideally following closely behind to ensure cable is protected as soon as feasible.

There are three generic types of equipment for installing cables into the seabed:

- Ploughs
- Jet trenchers
- Mechanical trenchers

5.5.1 *Ploughs*

Ploughs are generally used for simultaneous lay and burial operations where the cable vessel controls cable laying speed to match plough performance and residual tension targets. The cables may be guided into the trench or directed into it by cable depressors on the plough. Although essentially passive, ploughs can be steered, and share penetration (and hence cable depth) controlled remotely from the surface via an umbilical cable. There are two principal types of cable plough: displacement ploughs and non-displacement ploughs. Both types of plough are towed either by the cable vessel or a separate cable burial vessel moving along closely behind the cable ship.

5.5.2 *Displacement Ploughs*

Displacement ploughs create an open v-shaped trench into which the cable is laid. This type of plough is typically used for pipeline installations and generally requires high pulling forces (bollard pull), possibly 200 tonnes or higher, as a large amount of seabed material is displaced. A displacement plough is suitable for most types of sediment including soft rock. The trench may be back filled by the use of back fill blades at the rear of the machine, left to backfill naturally or by the use of a separate backfill plough.

The displacement plough can make a trench of up to 5m in width and the footprint of the plough itself can be up to 10m. The equipment can only be used in water depths of greater than 10m due to its large size and is therefore not suitable for shallow water installation.

5.5.3 *Non-Displacement Ploughs*

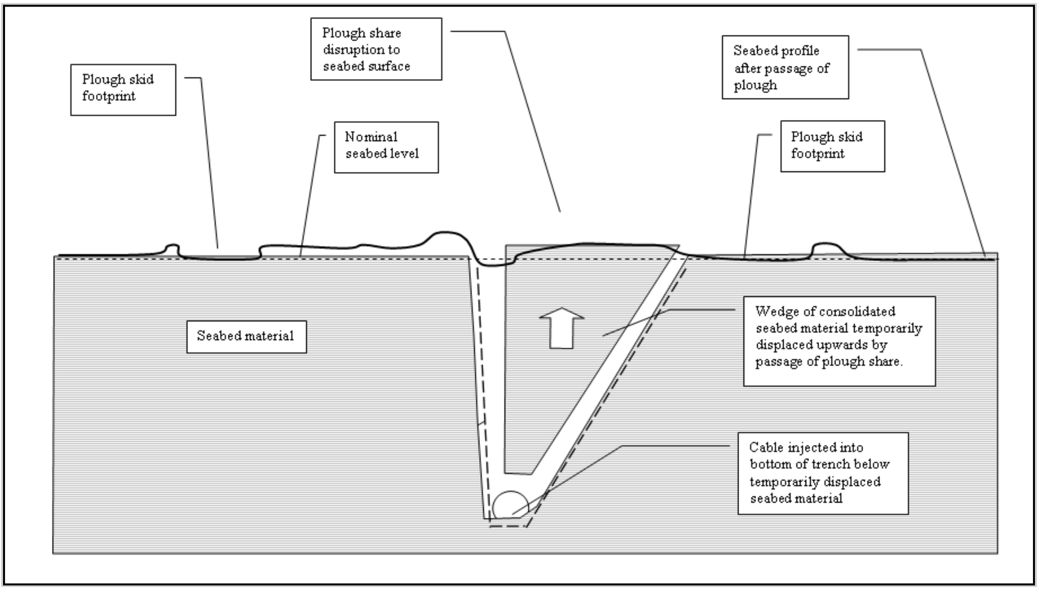
A non-displacement plough uses a thin blade-like share that slices through the seabed without creating an open trench and causes minimal disturbance to the seabed. The cable runs through the heel of the share that slices through the seabed. Pulling forces for this type of plough are generally less than for the displacement plough but can still be in the order of 100 to 150 tonnes.

The non-displacement plough can make narrow trenches of between 0.3-1.0m and the footprint of the plough itself is normally 5 - 10m depending on the size of the equipment (Figure 5-9). The trench back fills naturally.

A non-displacement plough performs well in most sediment types but is not optimal for use in sandy sediments where frictional forces and wear rates are high.

A development of the basic non-displacement plough is the jetting plough, which uses water jets to lubricate the passage of the share. The jetting plough has a good performance in all sediment types including sand and requires less bollard pull to achieve the same burial depth as a conventional plough.

Figure 5-9: Typical profile of a non-displacement plough trench



5.5.4 Jet Trenchers

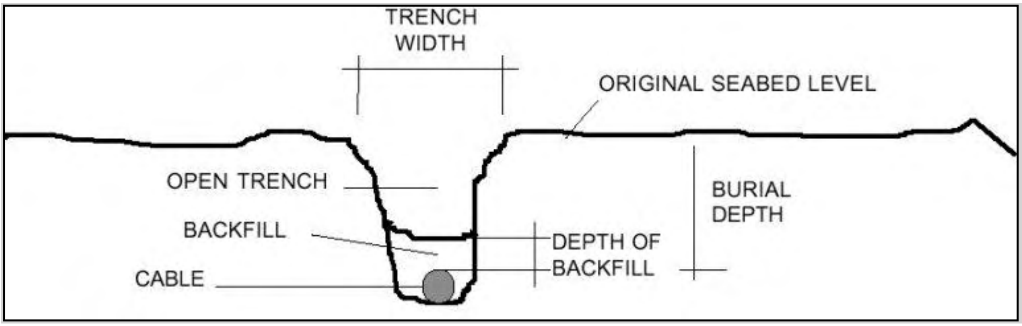
Jet trenching machines use water jets, mounted in "swords" lowered either side of the cable, to disrupt the seabed underneath the cable, forming a trench full of fluidised sandy material or "cutting" very soft to soft clays. The cable sinks into the trench through the fluidised material under its own weight or is directed into it by a depressor arm (Figure 5-10). The jetting action may be augmented in some cases by eductors that suck disrupted material out of the trench and deposit it to the side. There is little or no trench created by the jetting machine in fluidised sands, whilst the seabed is normally left to naturally backfill.

Jetting machines may be deployed directly behind the cable ship or onto a cable that has been laid previously.

Jetting machines may be: sled mounted and towed by the cable laying vessel or an auxiliary vessel; mounted on free swimming remotely operated vehicles (ROVs); or mounted on self-propelled tracked vehicles. In all cases machine function is remotely controlled from the surface vessel via an umbilical cable.

Using water jets results in slightly more turbidity than that created by a non-displacement plough. Jetting is a viable technique in a wide range of sediments but performance decreases with increase in sediment shear strength and cohesiveness (e.g. contents of clay and peat); however, tool designs are becoming available that are augmented mechanically to improve performance in firm to stiff clay. Jetting will not be viable in areas where stiff to hard glacial till or gravels are present.

Figure 5-10: Typical Seabed Trench Profile produced by a Jetting Machine



5.5.5 *Mechanical Trenchers*

Mechanical trenchers can work in all sediments including those with high shear strength and even weak bedrock. These machines are usually mounted on tracked vehicles and use chain saws or wheels armed with tungsten carbon steel teeth to cut a defined trench. Most spoil is ejected from the trench by the cutting action and the cable is guided into the trench base by a depressor. The mechanical action may be augmented in some cases by eductors that suck disrupted material out of the trench and deposit it to the side. The open trench can be back filled or left to refill naturally. A typical mechanical trencher can make a trench of 0.3-0.7m in width and the footprint of the mechanical trencher is approximately 5-10m.

For all burial techniques, machine function is controlled from the surface vessel via an umbilical cable. However, in shallow water less than 5m deep, some trenchers require the assistance of divers, to load the cable to the cable depressor.

Trenchers may be used for simultaneous lay and burial operations where the cable ship controls laying speed to match machine performance and also for post-lay burial of cable or burial of repaired sections.

Mechanical trenching is a viable technique in a wide range of sediments but is not usually deployed unless sediment shear strengths are known to be high. This is because of the complexity of these machines which have many moving parts, high wear rates and relatively slow installation speeds which potentially result in higher costs and possible delays during installation. In addition to the above points mechanical trenchers also typically cause a higher level of turbidity compared to other burial tools.

5.5.6 *Protection by Rock installation/ Concrete mattressing*

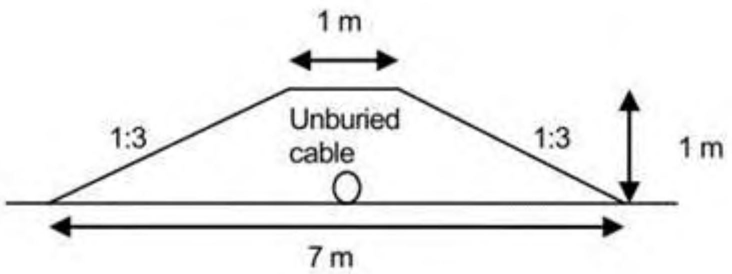
In areas where cable burial is not possible (e.g. at cable/pipeline crossings and areas of bedrock) or where the cable was inadequately buried the cable will be protected by installation of rock (gravel) or mattress armouring.

Rock or mattress installation will be the primary means of protecting the cable(s) in areas where adequate protection has not been obtained by burial due to unfavourable seabed conditions or where an existing cable or pipeline obstructs burial. The grain size distribution and rock installation profiles will be engineered according to recognised principles and be based on relevant local conditions to at least withstand hydro-dynamic forces and normal human activities such as trawling (rock berms will be designed to be safely over trawlable).

The total distance along the Norway-UK Interconnector (within UK waters) where cable protection measures may be required based on preliminary survey information is 9.2km of rock protection at cable and pipeline crossings. It is also possible that a further 17.6km of rock protection is required per cable where adequate burial depth may not achievable (up to 7.0m width, total footprint of 0.31km^2). Rock protection is currently the preferred method, but if concrete mattressing is used a similar amount will be required.

A schematic profile of a rock installation on an unburied cable is shown in Figure 5-11 below:

Figure 5-11: Typical Profile of Rock Installation



5.5.7 *Comparison of Cable Burial Techniques*

It is preferable from a logistical perspective to use one method and machine for the burial of the whole route. However, given the highly variable nature of the seabed it is probable that a number of burial techniques will be required along the proposed Norway-UK Interconnector route. The cable lay campaigns may, however, be optimised such that for each section of cable laid (campaign), the number of required burial techniques is minimised, ideally to a single technique.

The actual equipment used will only be confirmed on award of an installation contract. Table 5-4 below indicates that a non-displacement plough/jet trencher or a jet trencher/mechanical trencher combination appear to be the most suitable methods of installation for the proposed marine cables. However, a displacement plough could also be appropriate particularly in areas of glacial till although the large size of these machines, high bollard pulls, seabed disturbance and subsequent requirement for backfilling, mitigates against their general use along the route.

Table 5-4: Comparison of Marine Cable Burial Techniques

Installation Technique	Displacement Plough	Non-Displacement Plough	Jet Trencher	Mechanical Trencher
Limiting Turbidity and disturbance to the seabed	●	●	●	●
Limiting the space used on the sea bed	●	●	●	●

Installation Technique	Displacement Plough	Non-Displacement Plough	Jet Trencher	Mechanical Trencher
Reinstatement of original situation	🟠	🟢	🟠	🟠
Suitability for seabed conditions	🟢	🟠	🔴	🟠
Proven technology	🟢	🟢	🟢	🟢
Limiting installation costs	🟠	🟢	🟢	🔴
Limiting risks to the cable	🟠	🟠	🟢	🟠

🟢 High efficiency/suitability 🟠 Medium efficiency/suitability 🔴 Low efficiency/suitability

The action of the displacement plough causes a relatively large amount of ground displacement (because, as the material is displaced from the trench, it is piled up at either side of the trench) and the footprint is in general greater than that left by other machines. In addition to this, ploughing methods requires the cable to be attached to the plough and forced into the seabed which puts the cable at greater risk of damage than jet trenching techniques.

Mechanical trenchers are principally designed for hard substrates. They can also temporarily create relatively high levels of turbidity and need to be used at slow installation speeds which would increase the cost and duration of the installation process. There is one section of the proposed cable route corridor, close to the landfall, where use of mechanical trenchers may be required.

The jet trencher would cause some turbidity during the installation process but would be an efficient installation method as risks to the cable are minimised and footprint of the machinery is generally small in comparison to the plough/mechanical trencher machinery. Jet trenching is expected to be feasible along 95% of the route within UK waters.

Sediment displacement and turbidity are minimised by the non-displacement plough method, which could make it a particularly attractive for the installation of the proposed marine cable. However ploughing is not the preferred method of burial for Norway-UK Interconnector as there are technical challenges which may present a risk to the integrity of the cable during installation.

5.5.8 Subsea cable/pipeline crossings

The proposed marine cable route corridor will cross two Fibre Optic Cables, one Control Umbilical and ten Pipelines.

The crossing of third party infrastructure is made with agreement of the owners following a negotiated formal Crossing Agreement (CA). The CA describes the rights and responsibilities of the parties and also the detailed physical design of the crossing. The design addresses the need to protect both the cables and the third-party infrastructure and other aspects such as crossing angle and vertical separation. In some cases the crossing location, relative to sensitive structures, e.g. subsea valves or cable repeaters, is specified.

The crossing physical design will vary according to, among other things, the size, type, location and burial state of the crossed infrastructure. Generally the cables will cross over infrastructure on a ‘bridge’ comprised of either aggregate or concrete mattresses. This section will subsequently be covered over with a protective layer of either aggregate or mattresses. Various crossing designs are illustrated in Figures 5-12, 5-13 and 5-14 below.

The exact physical design will depend on both the negotiated CA and the resources of the installation contractor and may vary from location to location.

Prior to constructing a cable or pipeline crossing the location will be surveyed in detail to establish the exact position of the pipeline or cable and its condition including the depth to which it is buried. The bridging materials will be deposited on the infrastructure by a support vessel approximately two days before the approaching cable lay spread. The support vessel may be a subsea construction vessel (if mattresses are used) or a fall-pipe rock dump vessel (if aggregate is used). The construction of the ‘bridge’ will be closely monitored using acoustic profilers and video cameras to ensure it is compliant with the terms of the CA.

Prior to the arrival of the cable lay spread, acoustic markers will be placed on the seabed to form a ‘gate’ either side of the centreline of the cables route across the ‘bridge’. The burial support vessel will cease burial of the cables at a distance from the crossed infrastructure agreed in the CA. If crossing a pipeline the burial machine will be recovered to the deck of the vessel before crossing the pipeline; if crossing a cable the machine may be lifted from the seabed and ‘flown’ to the other side of the cable.

The main lay vessel will continue laying cables on to the seabed, and then use acoustic tracking devices to accurately place the cables on the centreline of the crossing ‘bridge’. The accurate positioning of the cables will be confirmed by visual touchdown monitoring via a remotely operated vehicle (ROV).

At a distance on the far side of the pipeline or cable agreed in the CA, the burial machine will be returned to the seabed, re-engaged on the cables, and the lay and burial process will continue. When the main lay spread has cleared the area, the support vessel will return to the crossing and use a jetting machine to jet in the sections of cable exposed on the seabed leading up to agreed limits from the cable or pipeline. The remaining exposed cables will then be covered with a layer of mattresses or aggregate to stabilise the cables and protect them from third-party activity. Mattresses with polypropylene ‘fronds’ may be used as these are capable of trapping transient water-born sediment, thereby creating additional natural protection.

The completed crossing will be surveyed using acoustic devices and video cameras (where visibility allows) to ensure the crossing design has been achieved.

Figure 5-12: Sleeved Cable or Pipeline Crossing Design

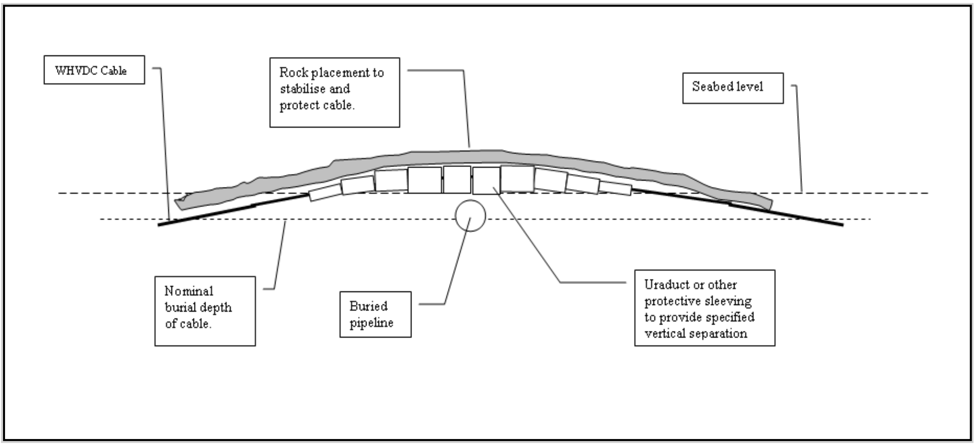


Figure 5-13: Cable Crossing over Buried or Semi-Buried Pipeline (Side Elevation)

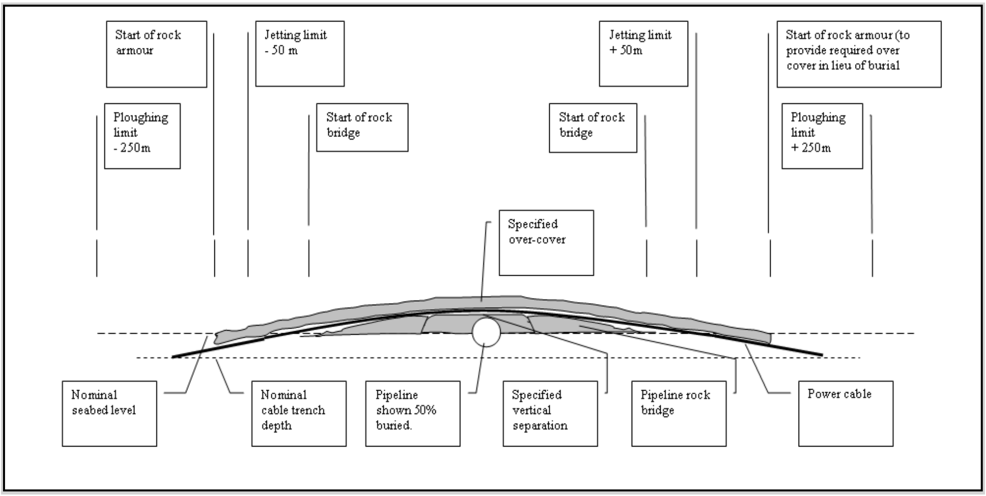
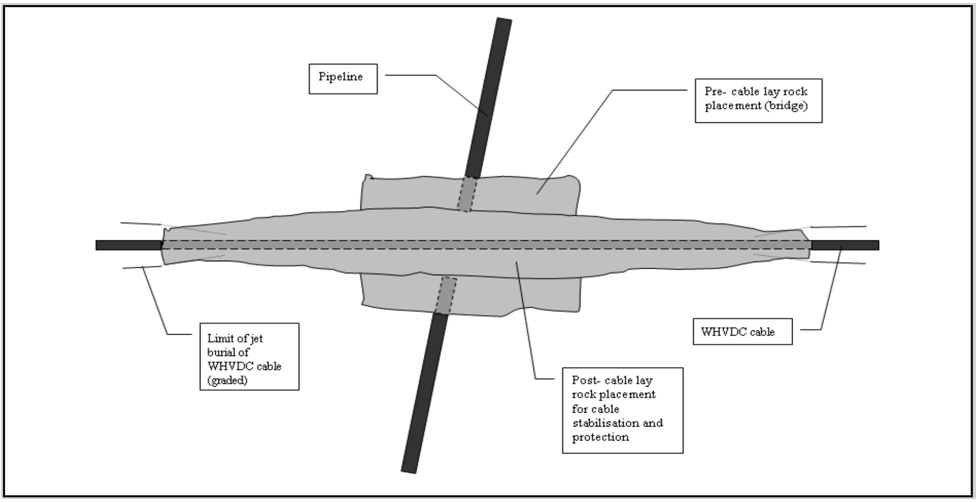


Figure 5-14: Cable crossing over buried or semi-buried pipeline (plan view)



The crossed cables and pipelines would normally be structurally protected from the weight and effects of the new cable by use of concrete and/or stone material. Cable/pipeline crossings do not usually present significant engineering or environmental difficulties, but methods for crossing would be agreed between NGNSNLL and SSF and the owners of the existing cables/pipelines.

The footprint of cable/pipeline crossings for the Norway-UK Interconnector will be circa 1000m (rock and/or concrete mattresses) by 7m (width of bridge over existing cable/pipeline).

5.5.9 Marine Cable Footprint

Jetting has a maximum footprint of 10m which incorporates the temporary trench created by the fluidisation of the sediment and the footprint of the machine. Trenching machines typically have a footprint of up to 10m. Within this area they will create a trench of 1 – 5m depending on the technique. As the footprint of both types of machine used during cable burial is 10m this has been used in the calculation of the footprint. It is estimated that cable burial will impact 6.8km^2 of seabed.

In addition to the cable burial, cable protection measures may be required along 10.2km of the route. Rock berms could be up to 7.0m wide. The total seabed footprint is estimated to be 0.14km^2 from this activity.

5.5.10 Cable Landfall

The proposed landfall location for Norway-UK Interconnector (i.e. where the cable passes from the subsea environment to onshore, via the intertidal) is at Cambois Beach North adjacent to Blyth in Northumberland.

Engineering techniques for the landfall site will not be confirmed until the detailed design stage. However, NGIL and SSF are currently proposing an onshore pull technique which will involve the construction of temporary facilities at the landfall site.

The land cables will be connected with the marine cables in a transition jointing pit (TJP) buried in the ground above the high water mark. In all areas the cables will be buried below surface, i.e. into the beach.

The cable is likely to be buried directly (Open Cut) from the TJP to the MLWM or alternatively; conduits may be installed beneath the car park, slipway and possibly the beach. On completion of jointing, excavations will be backfilled and the surface reinstated. An inspection chamber and cover over the joint may be required.

The installation vessels will locate offshore as close as possible to the landfall. The “open cut” installation method may be used in the intertidal and nearshore area of the landing site. This will involve using mechanical diggers to construct a trench across the beach from low to high water and floating the cable from the ship to the lower end of the trench.

The cables will be landed from a vessel which will approach as far inshore as is possible considering the water depths and vessel draught. A pulling rope will be attached to each cable end and passed through the cable conduits. Floats will be attached to the cables which will be floated ashore at high tide and guided into the conduits. When sufficient cable is ashore the floats will be progressively removed to allow the cable to sink to the seabed.

Once the cable pulls have been completed, with the cable ends at the jointing chamber, the cables on the beach will be progressively buried using land based excavators as the tidal conditions permit. The cables will be buried across the beach to a depth of approximately 1-2m in order to protect the cables.

5.5.11 Preparatory Construction Works

Preparatory construction works at the landfall relate to constructing the Transition Jointing Pit (TJP), which houses the joint between marine and land cables, and installation of conduits, for crossing the car park, slipway and possibly the beach, between the intertidal zone and the TJP. The TJP is a reinforced-concrete structure that will not project above ground level, and will be connected to the trench that forms the land cable route.

The TJP will be connected to the intertidal zone by an open cut trench across Cambois Links and the car park; and then either two conduits each of approximately 400mm diameter, installed within the concrete slipway or, via a cable trough constructed within the slipway. The conduits will be installed within the re-built slipway and will not affect its structure in any way. If the cable trough option is employed this will be incorporated at one side of the re-built slipway , measuring approx 1.5m wide and 1.0m deep, the cables will be laid in the trough and stabilised with cement bound sand. The trough will then be covered with a number of fitted concrete slabs, which will be flush with and make up part of the slipway surface.

TJP, trench and conduit/ cable trough construction will be completed well in advance of cable landing operations to avoid any possibility of delay to the landing operation.

5.5.12 Cable Landing Operation

The precise resources used to land the cables to shore will be confirmed once an installation contractor is appointed. However it is likely that a separate shallow draft cable lay barge capable of grounding at low water of the type used for shallow water operations in depths of 10m or less will be used.

In preparation of the cables being hauled ashore, the works area will be marked off with a tape or a buoy line to protect the site and the public.

The conduit ends will be exposed using a mechanical excavator, if the ends are above the water line, or by divers if submerged. The conduits will be cleaned and prepared for installation of the cables by installing running gear at the seaward ends to help guide the hauling lines and cables.

On the rising tide the vessel will move into position as close to the top of the beach as the tidal conditions allow. A beach landing team will have prepared the site with a pulling device, which may be a winch or a tracked vehicle, and any rollers and quadrants necessary to guide the hauling rope and subsequently the cables. A hauling rope will be installed between the beach pulling device and the cable end on the vessel running through the TJP and the first conduit to be used.

Once all preparations have been completed, the beach landing team, in co-ordination with the vessel, will pull a cable end ashore. Depending on the state of the tide the intervening distance between the vessel and the conduits may be entirely water, entirely dry (with the installation vessel resting on the seabed) or more probably a combination of both scenarios. The cable will be supported at the sea surface by floats attached as the cable leaves the vessel and supported on rollers placed on the seabed where it is above the water line.

The cables will be hauled through the conduit under the beach, slipway and car park and into the TJP, floats being removed as necessary before the cable enters the conduit. When sufficient cable has been passed to the shore to allow for its correct alignment in the TJP and for jointing to the land cable, it will be secured in the TJP or, temporarily, on a “deadman” anchor.

It is anticipated that the installation operation will not involve 24 hour working. However, it is possible that the pulling of the conduits into the bores drilled under the seawall could run over one 24 hour period as this operation, once commenced cannot be interrupted. Also the cable pull ashore may run over a 24 hour period to take advantage of optimum weather and tidal conditions.

Once both cables have been landed, secured at the TJP, and tested to confirm that they have not been damaged in the installation process, each cable will be manoeuvred into its correct alignment in relation to the route and the other cable. It is expected that the cables will be laid separately, spaced initially by approximately 20m. For cable sections still afloat, the manoeuvring will be accomplished using workboats, before the remaining floats are cut free and the cable allowed to sink to the seabed. Any cable on dry land leading up to the conduits will be manoeuvred using excavators or similar machines into the correct alignment.

The seaward conduit ends will be sealed around the cables and finally the conduit ends will be re-covered with the excavated material.

With the landing complete the marine cable laying process can commence. Depending on the draught of the vessel and the state of the tide the lay may commence immediately or it may be necessary to wait until the tide has come in sufficiently to re-float the vessel. Regardless, once the vessel is able to commence it will move off along the designated route with the cables fed over a laying sheave or chute at the stern of the vessel.

5.5.13 Beach Cable Protection

The proposed cable will be sealed into the end of its conduit and the conduits filled from the shoreward end with bentonite, which is used to improve thermal conductivity. The cable armouring will be secured mechanically to a strong point in the TJP. In the intertidal area, to where the marine burial machine has been able to start work, the cables will be protected by burial using terrestrial machines or marine based machines. There will be some overlap of these methods with the most appropriate method being determined on site, taking account of the tidal range and dry and wet working windows.

For the terrestrial operation a trench will be excavated alongside the cables using mechanical excavators adapted for working on soft soils and the excavated material placed to one side for re-use. Using the mechanical excavators the cables will be manoeuvred into the trench bottom and covered with the material excavated from the trench. For marine operations the cables are expected to be either jetted into the seabed using a barge-deployed jetting machine operated remotely.

Thermal testing of the beach sediments may indicate the need to install engineered sand, typically sand that is carefully graded to provide good compaction, to reduce the thermal resistivity and improve the transport of heat away from the cables. A layer of engineered sand approximately 300 mm thick may be placed in the bottom of the cable trench around the cables and then excavated material backfilled to the surface. Small amounts of beach material not replaced in the trench will be disposed of onto the beach locally where natural processes can be expected to distribute it into the wider environment. The requirement to use engineered sands will be determined by the cable manufacturer based on the surveyed thermal properties of the existing soil but it is currently thought unlikely that it will be required.

5.6 Installation Programme

Cable laying is planned to take place between 2018 and 2019, and is likely to take place over two seasons. The cables will be separated by approximately 20m within the 12nm limit and approximately 50m from the 12' limit to the median line. The cable within UK waters are expected to be laid in 3 segments (per cable) of around 100-120km and it is anticipated that each segment will take around 14 days to lay, but burial operations may take significantly longer (six - eight weeks) in some areas due to the nature of the seabed. Shallow water operations will comprise of one campaign using a cable lay barge to lay and bury the cables. These operations are likely to take of the order of 2 weeks and are currently planned to commence in the spring/summer of 2018. It is anticipated that lay and burial operations will proceed from deeper waters towards the coast.

A pre-installation geophysical and UXO route survey is likely to be conducted by the installation contractor, 3 – 6 months prior to the marine installation works.

Immediately prior to the installation, 1-2 weeks, a Pre Lay Grapnel Run (PLGR) will be carried out along the entire route to clear and debris, such as discarded wires, ropes and nets.

5.7 Cable operation

5.7.1 Introduction

Once installed, marine cables do not require routine maintenance. The proposed marine cables will be monitored for electrical integrity to provide early indication of fault conditions. Arrangements for maintenance and repairs are described below

5.7.2 Cable Maintenance and Repairs

In-service Survey Operations

It is likely that routinely, particularly in the initial years of operation, and should the local environmental conditions change or be suspected as having changed, it will be necessary to conduct surveys using standard geophysical survey equipment and/or remotely operated vehicles (ROVs) to monitor their buried depth. Regular survey of pipeline crossings may also be a requirement of a particular pipeline crossing agreement. Periodic inspections may be undertaken to identify cable exposures or spanning.

Marine Cable Repairs

Cable repairs to correctly installed and protected marine cables are infrequent but require operations which temporarily intrude on the environment and the activities of other users of the sea.

The most common reason for repair of a submarine cable is damage caused by external interaction, typically by trawlers and commercial ships' anchors. Such damage may be localised or widespread depending on the energy of the interaction and whether the cable is merely impacted, mauled (where something is dragged with force along the cable for a distance) or dragged from the seabed.

A repair will typically be carried out by a single vessel. A shallow water repair, in less than 10m of water, will typically be made using an anchored barge. In deeper water a dynamically positioned cable vessel will be used. Vessels carrying out cable repair operations are restricted in their ability to manoeuvre and will display the required navigational lights and signals.

The actual operational details and the exact configuration of a repair spread will depend on the type of repair and the contractor's facilities.

Typically the phases of a repair operation are as follows:

- Loading of spare cable to the repair vessel
- Location of the damage
- Cable deburial
- Cable recovery to the surface
- Repair of the cables
- Re-deployment of cable onto the sea bed and re-burial

- A cable repair cable repair invariably requires the insertion of additional cables and two additional cable joints, the initial and the final. The additional cable length in the case of point damage may be equal to approximately three times the depth of water at the site and longer if the cables have been damaged over a distance.
- The extra length of a repaired short cable section means it cannot be returned to its exact previous alignment on the seabed. The excess cable will be laid on the seabed in a loop off to one side of the original route. The excess cable and first joint of a longer repair section can be laid 'in-line' along the original route whilst the final joint will form an 'omega' loop on the seabed.
- The additional joints and the extra cable length will be buried, typically using jetting machines deployed from either the repair vessel itself or a separate specialised vessel.

- A cable repair operation might be expected to have a duration of several weeks or months depending on the type and extent of damage and operational constraints such as weather.
- For the repair of a single cable in a bundled pair, the damaged cable would need to be separated from its partner and brought to the surface, although it is possible both cables might be repaired as a precaution against undetected damage.
- Spare marine cable will normally be stored at the premises of the nominated repair contractor or a nearby port facility.

5.8 Emissions

5.8.1 Introduction

During operations of the cable, emissions to the environment consist of electric and magnetic fields, and heat. The nature and magnitude of these emissions are discussed in this section. Noise produced during installation of the cables and associated marine infrastructure is also discussed in this section.

5.8.1 Electric and Magnetic Fields (EMF)

During operations of the cable, emissions to the environment consist of electric and magnetic fields, and heat. Some marine species are magnetically sensitive and have the ability to detect emissions from operating HVDC cables. Species with this ability include European Protected Species. Therefore the emissions of electric and magnetic fields will be considered in this report.

The interconnector will carry 1.4GW of power and nominally operate at ±550kV. The proposed cable design comprises a bipole system, whereby current is transmitted along two, separate cables in opposite directions (one with positive polarity and the other with negative polarity), thereby completing the circuit. The design of the cables, including lead sheathing and armoured cores, prevents the propagation of electric fields (E fields) into the surrounding environment. Current flowing along HVDC cables also generates a magnetic field (B field), which can permeate through the cable surround and emanate into the surrounding environment. The magnitude of the magnetic field produced is dependent on the amount of current flow. The B field attenuates rapidly with distance (both horizontally and vertically) from the cable conductor.

Currents are converted from AC to DC to pass along the interconnector. Harmonic currents caused by conversion may transmit along HVDC cabling and induce varying electric fields (iE fields). In addition, localised, static iE fields may be induced as seawater (tidal flow) or other conductors such as marine organisms pass through the DC cable's B field. Owing to the dependence of iE field magnitude upon B field magnitude, iE fields will attenuate with both horizontal and vertical distance from the cable conductor in the same way as B fields.

There is a degree of cancellation of magnetic fields in the environment when opposing fields from adjacent cables interact, the resultant magnetic fields will vary according to the installation methodology, their bearing within the Earth's geomagnetic field and separation distance utilised. The influence of the Norway – UK Interconnector dual-cable HVDC system on the background geomagnetic field along the design route is very low and insignificant due to its generally east-west orientation and mostly deep water. A two hundred meter long section in shallower waters approaching the landfall at Cambois Beach North requires the cable to be installed with a reduced cable spacing of approximately 20m to meet a 3-degrees compass deviation requirement (Statnett, 2013). A separation distance of approximately 50m is proposed for cable installation for the remainder of the route.

The entire cable will be buried to a target depth of approximately 1.5 – 2m. While B field propagation will not be diminished through the sediment any more than through water (in the absence of magnetic rocks), burial is likely to reduce the maximum magnitude of EMF experienced at the sediment-seawater interface since the very strongest fields are present on the surface of the cable (Gill *et al.*, 2005)..

There is currently relatively little data available for similar, industry standard cables, therefore, informed predictions and assumptions have been made. The predicted B and iE fields for a similar HVDC cable (Western HVDC Link cable with a 50m separation, 2GW, ±550kV, buried to a depth of 1.5m) has been used for comparison. However it should be noted that the Western HVDC Link cable is orientated in a North /south direction as opposed to the proposed cable which is predominantly East /West. Therefore the magnitude of the B field emissions for the proposed route are likely to be less. The Norway-UK Interconnector is planned to operate at 70% of the operating capacity of the Western HVDC Link cable (1.4GW). The worst case magnitude the B fields are expected to propagate to is illustrated in Table 5.5 below.

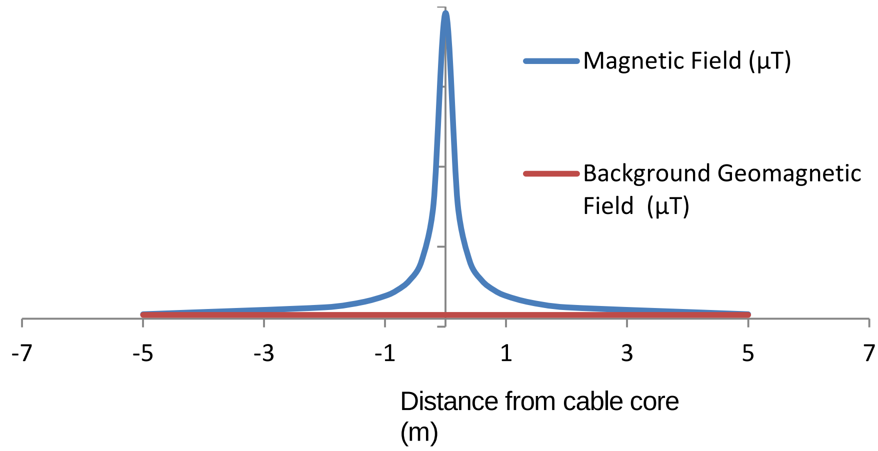
Table 5-5: Expected Field Intensities – Western HVDC Interconnector

50m separation				
Distance from cable	Magnetic Field (µT)		Induced electric field (µV/m)	
	WHVDC Link Buried	Norway-UK Buried 70% capacity	WHVDC Link Buried	Norway-UK Buried 70% capacity
Cable Surface	5459	3821.3	6823	4776.1
0.2m	2047	1432.9	2559	1791.3
0.4m	1023	716.1	1279	895.3
0.6m	682	477.4	851	595.7
0.8m	512	358.4	639	447.3
1.0m	409	286.3	511	357.7
1.4m	292	204.4	368	257.6
2.0m	205	143.5	256	179.2
5.0m	82	57.4	103	72.1

Source: Aecom & Intertek-Metoc (2011)

The Norway-UK Interconnector HVDC cable is of a comparable design as that for the proposed Western HVDC Link marine cables, however is expected to attenuate more rapidly as field strengths are likely to be 70% of Western HVDC Link properties. The background geomagnetic field for the central North Sea is approximately 49µT - 50 µT (NOAA, 2014). By comparing this value with the expected magnetic field for the Western HVDC cable (less 30%), it is evident that the B field is likely to be between 204-143(µT) at the seabed-seawater interface and attenuate to background levels within approximately 5-6m from the cable core.

Figure 5-15: Expected Magnetic field (µT) with distance (m) from cable core – for a cable with 50m separation



Predicted EMF generated for another 500kV HVDC cable (assuming no burial) has estimated similar emissions of B fields as the Western HVDC Link of approximately 5000 µT at the cable surface, with attenuation to approximately 800 µT at 0.5m distance and approximately 80 µT at 5m for cable separation of 50m (CMACS, 2012).

5.8.2 *Compass Deviation*

The influence of the Norway-UK Interconnector dual-cable HVDC system on the total geomagnetic field along the design route is expected to be insignificant to compass deviation, due to its generally east-west orientation and mostly deep water.

Only very shallow area of approximately 200m from the shore (centered on KP 712.954 (E 213205.44, N 6121671.07)) requires reduced cable spacing to comply with the nominal maximum 3-degrees compass deviation due to the bearing of the cable within the Earth's magnetic field. All other sections of the route will have 3 degrees or less compass deviation with a cable separation of 50m. There are no expected or calculated compass deviation issues related to the installation of the interconnector cable (Statnett, 2013).

5.8.3 *Heat*

During the operation of an HVDC cable heat losses occur as a consequence of the resistance in the cable/conductor. The Norway-UK Interconnector will utilise Mass Impregnated Paper insulated or Mass Impregnated Polypropylene Laminated Paper (PPL) insulated cable. These cables have maximum design operating conductor temperatures of 55°C and 80°C respectively. When the interconnector is in operation there will be localised heating of the environment surrounding the cables (i.e. sediment for buried cable or water in the interstitial spaces of rock armouring). The rate of heat dissipation, and magnitude of environmental heating, will be determined by a number of factors; most notably: the amount of power passing through the cables, the design of the cables and the thermal properties of the surrounding media.

Evidence from other HVDC and AC cable installations indicates that heating effects from cables buried to a depth of 1m do not have an effect on infaunal organisms in the upper 20cm of the sediment. As the Norway-UK Interconnector cables will be buried to a depth of between 1-1.5m, any heating effect would be very localised, only occurring in the sediment immediately surrounding the buried cables, and furthermore the seawater would remain at background temperatures very close to the seabed surface.

5.8.4 Noise

Noise produced by the cable installation in the marine environment is set against a background of noise produced by other shipping activity in the area. These ships include merchant vessels, tankers and ferries of up to 40,000 dead weight tonnes. With this in mind it is anticipated that noise emissions associated with the offshore and shallow water operations will make only a very minor contribution to the typical noise levels found in the vicinity of the cables. The types of vessels and activities to be used in the installation of the proposed marine cable are described in the preceding sections. The predominant noise generating activities identified are:

- Cable ploughing and trenching
- Mechanical chain cutter use on harder ground
- Rock or mattress placement;
- Vessels using dynamic positioning;
- Support vessels

Likely noise levels associated with these aspects of the project installation are described below.

<u>Cable Trenching, Ploughing and Cutting</u>

Information on noise levels associated with cable installation by trenching and ploughing (which are expected to result in similar noise levels) and cutting (which by nature of the high energy contact between metal cutting edges and hard rocks is expected to produce relatively higher noise levels) is available from studies undertaken in relation to offshore wind energy developments which have installed many hundreds of km of cabling in recent years

Measurements during cable installation works understood to have involved trenching were made by Subacoustech Ltd on behalf of COWRIE (Nedwell *et al*., 2003). Measurements were made of noise levels during cable installation works at North Hoyle using a hydrophone 160 m from the source at a depth of 2m. Sound pressure was recorded at 123 dB re 1 Pa. Because of the variability of noise it is difficult to establish the unweighted Source Level of the noise, but assuming a transmission loss of 22 log (R) the Source level was 178 dB re 1 μPa @ 1m.

Nedwell *et al*. (2003) reported that trenching noise was a mixture of broadband noise, tonal machinery noise and transients (probably associated with rock breakage). It was noted that noise levels and character were variable and depended greatly on the type of seabed being cut at the time. After being run through a dBht filter (to relate noise levels to the hearing thresholds of various marine organisms) all but one measurement were below the 70dBht threshold that would be expected to induce a behavioural reaction from fish or marine mammals.

The above measurements are comparable to the stated source noise levels for dredging activity in Richardson *et al*. (1995) of between 172 and 185 dB re 1 µPa @ 1m. Limited activity of this nature may be required where seabed topography requires smoothing before cable burial.

No specific measurements of noise levels produced by rock cutting equipment used during cable laying have been found; however, a relatively large number of impact assessments have stated that noise associated with cable installation works is significantly lower than that created by hammer piling of monopile foundations (e.g. Npower Renewables, 2005) and recent reviews of wind farm construction related noise effects have focused solely on hammer piling with little or no mention of cable laying as an important source of underwater noise (Nedwell *et al*., 2007; Thomsen *et al*., 2006). The latter has then been focused upon as the maximum likely scenario in terms of noise generation with relatively lower levels of noise expected from activities such as cable installations. Where specific assessments have been made these have either referenced the COWRIE work summarised above or compared cable installation to dredging activities.

Rock Placement

Limited information is available on noise levels associated with rock placement. SVT Engineering Consultants (2010) provide a recent assessment for this activity. They determined that it was unlikely to induce physical injury or damage to marine mammals but could induce behavioural disturbance. Source noise levels were expected to be in the region of 120 dB re 1 µPa @ 1m and behavioural disturbance to be limited to within 450m. This absolute source level may be an underestimate; Nedwell et al (2003) for example discuss expected noise levels for rock placement and similar activities and suggest that source noise levels of around 177 dB re 1 µPa @ 1m could be anticipated. This is broadly comparable to cable laying procedures.

Dynamic Positioning (DP) Systems

Vessels operating under DP maintain station using thrusters. These can create cavitating bubbles which can implode causing high acoustic energy in the water. Cavitation can cause damage to impeller and tunnel materials and also lead to propagation of underwater noise in the marine environment.
The source noise levels and sound characteristics will depend on the exact vessels used but quoted levels associated with DP systems range between 177 and 197 dB re 1 µPa @ 1m and frequencies lie towards the lower end of the spectrum, up to around 3 kHz.

- Talisman Energy (2006) report source noise levels of 177 dB re 1 µPa @ 1m;

- Lawson et al. (2001) reported source levels for dynamic positioning thrusters to be 162 to 180 dB re 1µ Pa @ 1 m;
- McCauley (1998) sound generated by DP rig supply vessels were significantly greater than that arising from drilling operations. When rigs were operating the effects of noise on cetaceans was reported to be confined to behavioural changes within a few hundred metres;
- AT&T (2008) reported source noise levels between 121 – 197 dB re1 µPa @ 1 m (and that these were relatively low frequency, between 50 and 3,200 Hz).
- The shallow water installation spread will be based upon a single vessel that will both lay and bury the section of cables between the intertidal area and deeper waters of approximately 10 m water depth. It will have a shallower draft to enable it to manoeuvre in the shallow waters.

Support Vessels

Richardson *et al* (1995) provide typical figures for source noise levels from vessels underway. Broadband noise for vessels of the type proposed for cable installation works range between 171 dB re 1 µPa @ 1 m (tug/barge, assumed equivalent to Guard Vessel) to 181 dB re 1 µPa @ 1 m (supply ship, assumed equivalent to Installation Vessel). These are believed to represent approximations of the noise levels expected as vessels transit to site but during operations engine-derived noises are anticipated to be below these levels as speeds will be low.

No noise will be produced during operation of the cables.

5.9 Decommissioning

5.9.1 Introduction

The Norway-UK Interconnector project recognises the importance of considering the decommissioning process at an early stage, and should decommissioning be undertaken, the operation will be conducted according to the standard industry protocol at the agreed time. In some situations, the least environmentally damaging option may be to leave the cable in-situ. This option raises the issue of liability for any claims from fishermen or other third parties that come in contact with the cables. This issue will be addressed in the planning stage of cable decommissioning. The decommissioning programme is expected to be similar to that during installation, and involve similar vessels and timescales to the installation phase.

5.9.2 Recovery

ROV Method

If buried the cables need to be exposed and this can be done by excavating a pit using water jets mounted on the ROV. The pit size need only be sufficient to allow the ROV access to cut the cables and attach a clamp (a “cable gripper”) and lifting rope to the cables. Once exposed, cut and gripped, the ROV does not take any further part in the operation. If the seabed is particularly strong above the cables, the ROV water jets can be used to weaken the soil along the route line and reduce the resistance on the cables.

Diver Method

This is essentially the same as the ROV method except that the operations are diver controlled. The operation is again precise but the main down sides of diver operations, e.g. human safety and weather dependency are significant.

Grapnel Method

Special hooks or “grapnels” come in various configurations that can cut, hook and hold a cable, whether it is exposed on the seabed or buried into it. Various types and sizes of grapnels are used for different cable sizes, burial depths and soil conditions.

The grappling process is essentially the same in all cases though with the grapnel towed across the seabed at right angles to the cable line with the point of the device penetrating into the seabed at the expected depth of the cable. Initially a grapnel fitted with cutting blades is used to cut the cable and then another is used to hook and hold it a safe distance away from the cut end. In this way a small “bight” of cable is recovered to the ship and recovery can be started. For smaller cables special grapnels that can both cut and hold (one end of) a cable in a single operation are available, but none exist for a large power cable.

The advantages of grapnel recovery are that it is a relatively simple operation that has been used many times. The main downside is that the grapnels may be dragged across the seabed for some distance before the cable is hooked, creating physical disturbance. Also grapnel operations may be restricted by the proximity of other cables or other infrastructure.

Once a viable cable end has been recovered the cable or cables are then just recovered to the vessel in what is, in effect, a reversal of the installation operation, however only one vessel is usually necessary. Once the ship’s capacity has been reached, the cable end would be abandoned to the seabed, probably with a marker buoy attached, and the ship would return to port to discharge. The recovery spread probably does not need to be protected by guard vessels as it is free to cut the cable if necessary, except perhaps in major shipping lanes.

It is usually preferable to recover a cable in a single length and transport it to a port where it can be dismantled after it is discharged to a shore facility. This, however, requires the cable to be in good enough condition for it to be handled safely and effectively and the ship to be large enough to store the cable. Whilst the Norway-UK Interconnector cables are likely to be in good mechanical condition, their physical construction means a ship with carousels will be needed. Although it is difficult to speculate about the availability of a suitable cable ship some forty years in the future it is prudent to assume there will not be many more then than there are now, as it is a niche market. It is unlikely that it will be economic or practical to use an established cable installation vessel as these will be at a premium. The alternative is that a spread is constructed for the purpose based on a large offshore support vessel or barge. In this case it is unlikely that two carousels to handle the bundled Norway-UK Interconnector would be installed as these machines are both rare and very expensive to purchase and install. Also a long single length would need comparable storage facilities ashore during the dismantling phase. It is perhaps more likely that a spread would be assembled that could process the cables into short lengths onboard the vessel such that it could be offloaded in bundles rather than single lengths.

Dismantling

A few attempts have been made to develop machines capable of dismantling and separating the various components of telecommunications cables. However, NGNSNLL and SSF are not aware of any machines to dismantle MI power cables; all the cable components are “stuck together” and separating them is a difficult task for a machine. Dismantling of telecommunications cables has up to now often been carried out in the Developing World where labour rates are low enough to make the process economic. In the UK, scrap telecoms cables have been landed to the premises of scrap metal merchants but it is not known how they have subsequently been handled.

Dismantling is an operation which will required a lot of space and therefore would almost certainly be carried out on land, not onboard ship (apart possibly from cutting the cables into manageable lengths).

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6 APPROACH TO ENVIRONMENTAL APPRAISAL

6.1 Introduction

This section outlines the EIA methodology used for the proposed Norway-UK Interconnector Project.

The proposed development has three distinct phases: installation, operation and decommissioning. The EIA considers the impacts of cable installation and operation on the receiving environment. The final requirements of decommissioning the cable will be assessed separately, towards the end of the cable life. This will take the form of a decommissioning plan which will outline the basis on which decommissioning works are to be performed and reviewed during the term of agreement.

6.2 EIA Process and Guidance

In summary the EIA involves the following steps:

- Identification of the environmental character of the area likely to be affected by the proposed marine cable through baseline studies and evaluation of its sensitivity;
- Prediction of the potential impacts that the proposed marine cable may have on the environment, both beneficial and adverse;
- Development of mitigation measures to be incorporated into the design, construction and operation of the marine cable to mitigate adverse impacts and enhance beneficial impacts.
- Assessment of the significance of impacts taking in to account the sensitivity of the existing environment, magnitude of effect and mitigation which is proposed.
- Preparation of an Environmental Statement which describes the EIA process and sets out the results of the assessment of potential environmental impacts.

A set of evaluation and assessment criteria have been developed for the assessment of significance based upon IEMA guidance and the general approach set out in the guidelines for the marine and coastal environment, published by the Institute of Ecology and Environmental Management (IEEM), August 2010.

Specific guidance in relation to individual topics (e.g. benthic ecology, archaeology) has been referenced where relevant.

6.2.1 The Environmental Statement

The Environmental Statement (ES) (this report) provides the following:

- An outline of the main alternatives considered and an indication of the reasons for the proposed development (Section 2).
- A description of the proposed development including the physical characteristics, land use requirements during construction and

operation and a description of the operational processes (Section 5).

- A description of the aspects of the environment with the potential to be significantly affected by the development including:
- direct, indirect and cumulative impacts;
- short, medium and long-term impacts;
- permanent and temporary impacts;
- and positive and negative impacts (Sections 7-20).
- A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse impacts on the environment and enhance beneficial impacts (Sections 7-20).
- An indication of any difficulties encountered in compiling the required information (Sections 7-20).

The method used to undertake the study and reporting of the EIA is outlined below.

6.2.2 Scope of the EIA

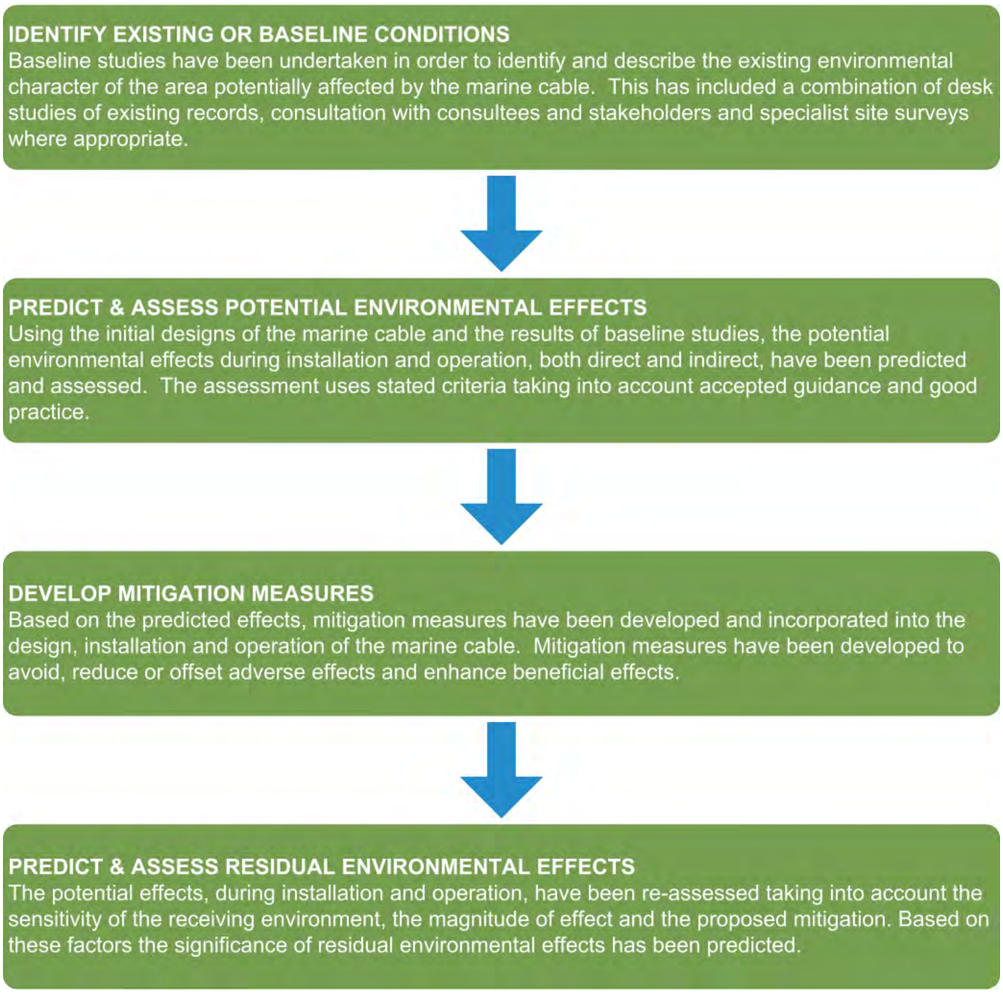
Scoping has been undertaken as a preliminary part of the EIA process. A Scoping Report setting out the proposed approach to, and content of the proposed marine cable route corridor was prepared and circulated to the statutory and non-statutory consultees. This identified the aspects of the environment which are considered within this Environmental Statement.

- The scope of the EIA considers the potential temporary and permanent impacts of installation and operation of the proposed marine cables.
- The geographic scope of the appraisal includes the area along and adjacent to the proposed marine cable route corridor as illustrated in Figure 1.1 (Appendix 1).
- Throughout the Environmental Statement any reference to the proposed marine cable route corridor refers to the area within which the marine cables will be laid, and any reference to the marine cables refers to the separately laid cables.

6.3 Approach to the EIA

The aim of the EIA has been to integrate environmental considerations in to the design process. As described in Section 2, this has primarily been achieved through the Feasibility, Desktop and Cable Route studies which sought to avoid or reduce environmental disturbance in the development of the project through careful site selection and routing.

The EIA has identified and evaluated the potential environmental impacts of the installation and operation of the proposed Norway-UK Interconnector marine cables. Through the identification of potentially significant adverse environmental impacts; mitigation measures to avoid, reduce or offset adverse environmental impacts or maximise environmental benefits have been incorporated into the design, construction and operation of the marine cables. The main steps which have been undertaken in the EIA process are as follows:



Sections 7-20 provide further details on the specific methods used to identify baseline conditions and to predict and assess potential environmental impacts.

6.3.1 Approach to the Assessment of Environmental Impacts

The determination of the significance of impacts arising from the project is a key stage in the environmental assessment process. In order to assess the overall significance of an impact it is necessary to establish:

- The sensitivity or importance of the receiving environment or receptor.
- The magnitude of the effect i.e. the extent of the potential change to the existing baseline conditions as a result of the development.

6.3.2 Magnitude

The magnitude of the potential effects on environmental baseline conditions is guided through detailed consideration of the development and resulting change to the baseline, taking into account the following:

- Likelihood – the probability of the impact occurring.
- Spatial Extent – the spatial extent over which the impact may occur.
- Level of Change – the potential level of change form baseline conditions taking into account natural variation.
- Duration – the length of time over which the impact is expected to occur prior to recovery or replacement of the feature.
- Using professional judgement and guided by the classifications outlined in Table 6-1 below an environmental effect has been given a value of magnitude.

Table 6-1: Magnitude of Effect Criteria Classification and Definition

Criteria	Classification	Definition
Likelihood	Definite	Will occur during project
	Possible	Likely to occur several times per year
	Unlikely	Occurs infrequently (e.g. <1 per year)
Spatial Extent	Wider environment	Regional, national or global
	Local	Within range (few km) of development footprint
	Immediate vicinity	Within development footprint
Level of change	High	Large change compared to variations in baseline
	Medium	Change which may be noticeable
	Low	Change to baseline is within the existing limits of natural variation
Duration	Long-term	Design life of the project (up to 40 years)
	Medium-term	Up to 5 year after the construction phase
	Short-term	Duration of construction activities (up to 1 year)

Table 6-2 below provides an example of how the level of magnitude can be determined for a particular impact taking into account a combination of the factors outlined in Table 6-1 above. Specific impact magnitude criteria have also been outlined in each specialist section.

Table 6-2: Generalised criteria for assessing Magnitude

Magnitude Classification	Definition
High	Long term and/or regional level loss or major alteration to key elements /features of the baseline conditions such that post development character/composition of baseline condition will be fundamentally changed;
Medium	Medium term loss and/or alteration to one or more key elements/features of the baseline conditions such that post development character/composition of the baseline condition will be materially changed;
Low	Short term localised and minor shift away from baseline conditions. Changes arising from the alteration will be detectable but not material; the underlying character /composition of the baseline condition will be similar to the pre-development situation; and
Negligible	Very little change from baseline conditions. Change is barely distinguishable, approximating to a “no change” situation.

6.3.3 Sensitivity or Importance of Receptor

The receiving environment or receptor has been assessed according to the relative importance of existing environmental features on or near to the site (e.g. whether it is of national, regional or local importance), or the sensitivity of receptors which would potentially be affected by the development. This takes into account:

- Relevant legislative, policy standards or guidelines.
- The environmental value of the receptor.
- The capacity of the receptor to absorb change.
- The recoverability of the receptor.

The criteria outlined in Table 6-3 provide a general definition for determining the sensitivity of receptors. In each specialist section of the ES sensitivity criteria have been explained.

Criteria for determination of sensitivity, importance or value (e.g. ‘international’, ‘national’, ‘regional’ or ‘authority area’) are established based on approved guidance, legislation, statutory designation and/or professional judgment.

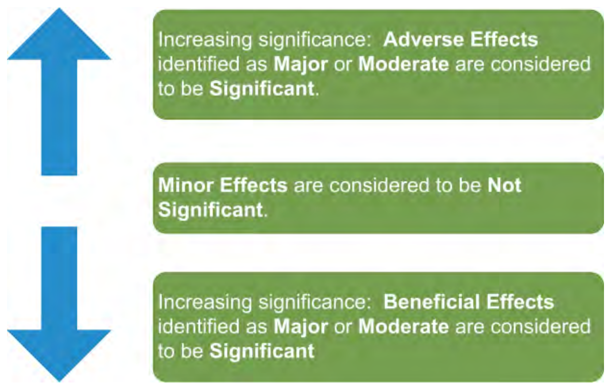
Table 6-3: Generalised criteria for assessing Sensitivity

Sensitivity Classification	Definition
Very High	The receptor has little or no ability to absorb change without fundamentally altering its present character, and is of very high environmental value, or of international importance e.g. impacts on a Special Area of Conservation (SAC) whose interest features have a high sensitivity and low recoverability, such as biogenic reef or saltmarsh.
High	The receptor has low capacity to absorb change without significantly altering its present character, has some environmental value, or is of national or international importance. E.g. impacts on a potential Annex I habitat for biogenic reef that has not been designated under the Habitats Directive.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some environmental value, or is of national or international importance e.g. impacts on an SAC or SSSI whose interest features are not highly sensitive to the project impacts, such as sandy sediment communities.
Low	The receptor is tolerant of change without detriment to its character, is low environmental value, or local importance e.g. impacts on species and habitats not protected by national or international legislation
Negligible	The receptor is resistant to change and is of little environmental value.

6.3.4 Determination of Impact Significance

The significance level of the Project impacts can be Beneficial or Adverse. The significance of potential impacts resulting from the proposed development has been assessed in each specialist impact section. The assessment of significance has used a seven-point scale as follows:

- Major Adverse
- Moderate Adverse
- Minor Adverse
- None
- Minor Beneficial
- Moderate Beneficial
- Major Beneficial



The general approach adopted in the assessment of significance is outlined in Table 6.4 below. A combination of the magnitude of the effect under consideration and the sensitivity of the receiving environment determines the impact significance. For some specialist topics, alternative or additional categories may be added where a greater level of definition is required. It should be noted that this general approach is a framework and should not be treated as a matrix.

Table 6-4: Assessment of Significance

Magnitude of Effect	Sensitivity of Receptors				
	Negligible	Low	Medium	High	Very High
High	Minor	Moderate	Moderate	Major	Major
Medium	None	Minor	Moderate	Moderate	Major
Low	None	None	Minor	Moderate	Moderate
Negligible	None	None	None	Minor	Minor

An impact significance assessed as none denotes 'No Significant Impact'. An impact significance of Minor is considered to be manageable. Such impacts are also considered to be 'Not Significant'. An impact significance assessed as Moderate or Major is considered to be 'Significant'. The significance of the impact has been assessed pre and post mitigation; this allows for the effectiveness of mitigation to be gauged and further mitigation developed if required.

6.3.5 *Types of Impact*

Potential impacts have been separated into two types based on the phase of development. These are construction impacts and operational impacts. Each specialist section of the ES provides an assessment of Installation Impacts followed by an assessment of Operational Impacts. A summary of the potential impacts is provided below in Table 6.4.

6.3.6 *Installation Impacts*

Installation impacts are temporary, short term impacts that occur during the installation phase only. This will include impacts resulting from installation of the marine cable as well as any impacts resulting from other temporary works such as presence of installation vessels.

6.3.7 *Operational Impacts*

Operational impacts are those long term impacts that would occur as a result of the development. These include the impacts as a result of its operation such as EMF or heating effects and those resulting from the continued operation and maintenance of the marine cables.

6.3.8 *Decommissioning Impacts*

The Norway-UK Interconnector has a design life of 40 years and the final requirements for decommissioning the marine cables would be assessed towards the end of this period. Consultation with the Crown Estate has indicated that the Norway-UK Interconnector will need to be decommissioned to the satisfaction of the Crown Estate and an initial decommissioning plan prepared in advance of the lease being entered. The initial decommissioning plan will outline the basis on which decommissioning works are to be performed and reviewed during the term of the agreement and will be updated over time as knowledge of decommissioning works improve.

Within recent leases let by the Crown Estate there has been a requirement to remove the cables at expiry of the lease. Recovery is only presently required out to the 12nm limit. NGNSNLL and SSF would comply with any lease conditions imposed in terms of decommissioning the cables. Within the removal requirement there is normally a caveat that states the cables may be left in place if the environment is best served by doing nothing. The decision as to whether to leave the cable (s) in-situ or to remove it/them will be taken in conjunction with the Crown Estate based on an assessment of the options and their potential impacts.

The effects of decommissioning have not been assessed in this document. However, should the marine cables be removed on decommissioning the potential effects would be similar in nature to those predicted to occur during installation. They would include temporary, short term impacts associated with the presence of vessels, disturbance of the seabed and the removal of subsea cable sections. Decommissioning would require an Environmental Assessment to be undertaken of potential environmental effects of removing the marine cable in support of Marine Licence applications to the marine Regulators.

6.3.9 Indirect or Secondary Impacts

For the purposes of the EIA, the potential impacts of the project are considered in terms of effects on each of the discrete environmental topic areas. However, the inter-relationship between topic areas such as ‘water quality’ or ‘ecology’ means effects cannot always be considered in isolation, since changes affecting one factor may often have secondary implications for other areas.

For example, if one effect of the project is to affect water quality, flora and fauna may be affected as a secondary effect. Under some circumstances, it is possible for the secondary or indirect impacts to be more significant than the changes that triggered them. Where there is potential for secondary or indirect effects this is highlighted in the EIA.

6.3.10 Cumulative and In-Combination Effects

Cumulative and In-Combination effects on specific resources or receptors are described, where relevant, in each of the specialist sections of the ES. Cumulative effects may arise, where for example ecological receptors or other marine users are affected by other developments in addition to the Norway-UK Interconnector. Cumulative effects have been considered within the EIA and are discussed within Section 20.

6.4 Uncertainty, Assumptions and Limitations

6.4.1 General

The EIA process aims to assist good decision-making based on information about the potential effects of the proposed development. However, there will be some uncertainty as to the exact scale and nature of the environmental effects. This uncertainty arises because the level of detail and information about the project available at the time the assessment was undertaken and/or due to limitations to the prediction process itself. Key issues relating to assumptions about the project design are outlined below. Where assumptions have been made in undertaking the EIA these are set out in each specialist section.

6.4.2 *Level of Design Detail for the EIA*

It is acknowledged that the development which is eventually designed and constructed may differ slightly from the design details that have been used in the EIA and reported in the ES. At the time of writing, Contractors have not been appointed to undertake the cable installation work, and therefore the proposed installation methodology has not been finalised. However, in order to ensure the EIA is as robust as possible, the ES assesses the range of likely installation methods to ensure that the envelope of effects assessed will encompass the actual installation method, once confirmed.

The envelope of potential effects assessed within this Environmental Statement has taken into account the range of parameters within which the detailed design will be developed. Generally potential environmental impacts will be similar for each discrete environmental topic. For certain topic areas there may be slight differences in the assessment where maximum and minimum dimensions are considered.

6.5 Mitigation

6.5.1 *Approach to Mitigation*

A standard hierarchical approach to identifying mitigation requirements has been used to inform the EIA:

- **Avoid or Prevent:** In the first instance, mitigation should seek to avoid or prevent the adverse effect at source for example, by routing the marine cables away from a sensitive receptor.
- **Reduce:** If the effect is unavoidable, mitigation measures should be implemented which seek to reduce the significance of the effect.
- **Offset:** If the effect can neither be avoided nor reduced, mitigation should seek to offset the effect through the implementation of compensatory mitigation.

Mitigation measures fall into two categories; mitigation which forms part of the project design and mitigation which is part of the construction and operation of the project. Mitigation measures which form part of the marine cables design are an inherent part of the proposed development and are considered the ‘base case’. Mitigation measures which are to be adopted and implemented during the construction and operation of the project are measures put in place to mitigate adverse effects.

6.5.2 *Mitigation by Design*

As described in Section 2 the Norway-UK Interconnector has been developed through an iterative process which involved seeking to avoid or reduce potential environmental effects through routing of the marine cables. This was the first project-specific step in mitigating potential effects by seeking to avoid or reduce environmental disturbance.

Following route selection, the EIA process has identified further mitigation measures to be incorporated into the marine cable design proposals.

6.5.3 *Mitigation by Practice*

The EIA has identified mitigation measures to be implemented during the construction and operation of the marine cables to avoid potentially adverse effects as well as reduce the likelihood or significance of potential impacts.

6.6 References

Institute of Environmental Management and Assessment (IEMA) (2004), Guidelines for Environmental Impact Assessment 2004.

Institute of Ecology and Environmental Management (IEEM) (2010), Guidelines for Ecological Impact Assessment, Marine and Coastal 2010.

European Commission (1997) Environmental Impact Assessment Directive (97/11/EC). Available at: http://ec.europa.eu/environment/eia/eia-legalcontext.htm [accessed Jan 2013]

7 PHYSICAL ENVIRONMENT

7.1 Introduction

This Section provides a description of the seabed conditions and seabed processes along and adjacent to the proposed marine cable route corridor. It also provides a description of meteorological and oceanographic (metocean) conditions in the region of the cable route which influence sediment transport processes. The potential changes that the marine cables may cause to the physical environment have been investigated.

7.2 Data Sources

Pre-construction geophysical and geotechnical surveys were conducted between April and October 2012 (MMT, 2013a; 2013b), with supplementary geophysical surveys undertaken between May and June 2013 (MMT, 2013c). The results from these surveys were reviewed along with other publications within the public domain to establish seabed baseline conditions along and adjacent to the proposed marine cable route.

Geophysical data comprised side scan sonar (SSS) and sub-bottom profiler (Chirp and/or Sparker) records. Bathymetric data collected by multibeam echo sounder have been processed and water depths mapped. SSS data have been used for interpretation of surface geology and identification of seabed features and objects. Sediment classes distinguished from SSS records are correlated with vibro-cores, box-cores and cone penetration test (CPT) results. Topographic features present in SSS records have been correlated with bathymetric records. Magnetic anomalies have been correlated with SSS and sub-bottom profiler data. Shallow geology interpretations are based on sub-bottom profiler data correlated with the geotechnical sampling results. SSS data are also used along the route to corroborate the interpretation in the uppermost layers.

Following a Horizontal Directional Drilling (HDD) feasibility study to identify the geotechnical risks, and identify potential constraints to installation methods at the landfall (Cathie Associates, 2013), trenching across the intertidal area is the preferred method.

7.3 Methods

The description of the physical environment is based primarily on existing known charted data and the results from the pre-construction geophysical and geotechnical surveys undertaken in 2013. The survey data were reviewed along with other publications in the public domain for the following bathymetric and topographic baseline conditions along the proposed marine cable route corridor.The potential impacts of the installation and operation of the proposed marine cables on the physical environment have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

The geographic scope of the appraisal includes the area along and adjacent to the proposed marine cable route corridor as illustrated in Figure 1-1 (Appendix 1).

7.3.1 Magnitude of Impact

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential impact and takes into account the likelihood of the impact occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of an impact are described in Table 7.1.

Table 7-1: Magnitude Criteria

Magnitude	Description
High	A long-term effect which has implications for the physical environment such changes to coastal features which extend beyond the vicinity of the marine cable route.
Medium	A medium or long-term change to the physical environment, a permanent change to the local seabed which does not have any impact on the regional physical environment at significantly greater levels than those expected from natural processes.
Low	A temporary, small-scale change to the physical environmental conditions lasting for the duration of installation works, such as creating the cable installation trench, or cable burial within comparable levels to those expected from natural processes.
Negligible	No measurable change to the physical environment.

7.3.2 Sensitivity or Importance of Receptor

The sensitivity of the baseline conditions has been assessed according to the relative importance of the marine mammal habitat and species present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance).

The sensitivity of seabed conditions and processes has been assessed in accordance with the criteria outlined in Table 7.2

Table 7-2: Sensitivity Criteria

Sensitivity	Description
Very High	Feature is of very high value, quality or rarity on a national scale and/or has little or no ability to absorb change without fundamentally altering its character.
High	Feature is of very high value, quality or rarity on a national scale and/or has little or no ability to absorb change without fundamentally altering its character.
Medium	Feature is of medium environmental value, quality or rarity on a local scale and/or has a moderate capacity to absorb change without significantly altering its character.
Low	Feature is of low environmental value, quality or rarity on a site scale and is tolerant to change without detriment to its character.
Negligible	Feature is of low or no environmental value, quality or rarity on a local scale and is resistant to change.

7.3.3 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the magnitude of a potential impact and the sensitivity or importance of the receptor. Impacts are identified as Beneficial and Adverse and their significance as Major, Moderate, Minor or None.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account any mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques. Residual impacts identified as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. A summary of the environmental appraisal results for the assessment of sensitivity and magnitude and significance of impacts is presented in Appendix 2.3.

7.4 Existing Conditions

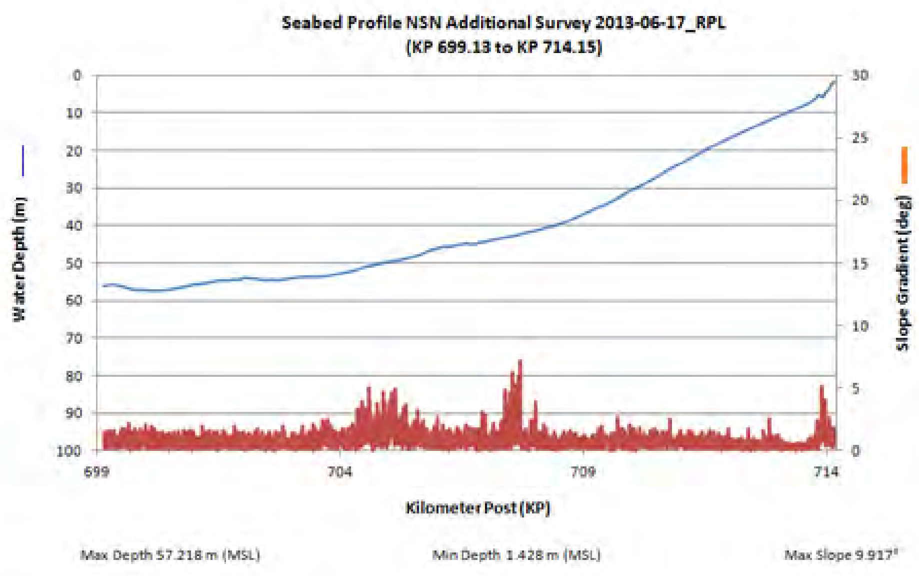
For the purposes of describing existing (baseline) conditions, the marine cable route has been divided into two sections. The first section covers the 15km closest to the UK landfall at Cambois Beach North Slipway, between KP714 and KP699. The second section covers the offshore cable route between KP699 and the median line at KP368. This division is somewhat arbitrary but allows a distinction to be made between near-coast and offshore conditions. In reality, the physical environment will vary as a continuum along the entire cable route corridor.

7.4.1 Bathymetry

Cambois North Landfall Approach (KP714 – KP699)

Surveyed depths along the route range between 1.4m near the coastline at KP714.15 (obviously dropping from 0m at the shore itself), to 57.2m at KP700.24 (approximately 14km along the route from the landfall). The seabed profile and slope of this section of the route show the gentle gradient of the seabed over the survey area (see Figure 7-1). The mean slope between KP714 and KP699 is 0.8°, with some areas of higher slope where seabed features are encountered.

Figure 7-1: Seabed Profile for Cambois North Landfall Approach



Source: MMT, 2013c

The cable has been routed to avoid two large areas of outcropping bedrock which occur to the north of the proposed cable route corridor between 3.5km and 5.5km from the coast. These areas cause steep changes in slope gradient.

Offshore Cable Route (KP699 – KP368)

The seabed slope remains gentle throughout the offshore route to the UK/Norway median line, and water depth varies between 60m and 100m (Figure 7.2; Appendix 1). The seabed generally remains flat throughout the offshore route.

From KP699 for approximately 35km the seabed is mostly flat and featureless with water depths increasing gradually away from the coast. Over the next 98km (KP664 - KP566) moving northeast along the cable route, the seabed consists of a more irregular seabed in combination with flat areas with small variations in depth to approximately 70m. Features include sand wave formations, sand ripples and outcropping gravel. Over the next 35km of the cable route (up to KP531), the seabed is flat and featureless again and water depths continue to increase to approximately 85m. The final 163km of the offshore cable route to the median line passes through an area of seabed which contains large areas of potential pockmarks and possibly gas seepage features. The seabed across this section is approximately 100m deep rising to approximately 80m at the median line (MMT, 2013).

7.4.2 *Coastal Geology and Geomorphology*

The geomorphology of the Northumberland coast is strongly influenced by the underlying geology which is formed in general of two distinct geological series: the harder carboniferous limestone and millstone grits, of the Lower and Upper Carboniferous periods respectively, which dominate the northern section of the coast from the Scottish border to Alnmouth; and the less resistant coal measures of the Middle, Upper Carboniferous, which includes the Cambois Beach North Landfall and extends down to the River Tyne (Royal Haskoning, 2009).

The geology has been reworked during various incursions of ice with a general movement to the southeast. This has resulted in a more exposed north section of the coast characterised by cliffs, and a wider glacial deposited lower land in the south. The present coastline comprises well defined and relatively stable bays, typically backed by dunes or slowly eroding glacial deposits, held by harder headlands or areas of rock exposed over the foreshore (Royal Haskoning, 2009).

Cambois Beach North Landfall

The surveyed area extends approximately 220m from the base of the cliffs to mean low water springs (MLWS). The area of the beach above high water is composed of a gravelly sand and cobble shelf, approximately 5m in width. This shelf then drops down to the wide expanse of the beach which is almost entirely sandy with occasional gravel and cobbles. There are accumulations of fine carbonaceous debris (poor coal and carbonaceous mudstone) across the whole beach, probably due to wind and tidal action.

The ground level gradually slopes down from 3.7m Ordnance Datum (OD) at the top of the beach to -2.1m below the low water mark. Small sand banks are formed by tidal runs in this area.

Cambois North Beach landfall lies approximately 400m to the south of Creswell and Newbiggin Shores Site of Special Scientific Interest (SSSI) which is important for Westphalian and Quaternary studies. It comprises the best exposure in the Northumberland Coalfield of Middle Carboniferous strata belonging to the Upper *similis-pulchra* Biozone. The southern section of the site is also an important Quaternary site for the study of glacial till. It is the longest and best section of Late Devensian till on the coast of Northumberland and shows several characteristic features of lodgement till deposition (English Nature, 1992).

7.4.3 *Seabed Sediments and Shallow Geology*

The offshore sediments of the North Sea are comprised of unconsolidated material deposited since the retreat of glacial ice and the transgression of the sea over the region during the early Holocene. They generally consist of a combination of sands and gravels overlying stiff glacial till (boulder clay) deposited during the last (Devensian) glaciation on top of bedrock. In places mud is present as a result of the reworking of glacial deposits. In addition, colliery waste dumped onto the beaches around Lynemouth and Cambois now forms a component of the offshore sediments; see Section 18.4.2 for further details (Royal Haskoning, 2009).

The seabed across the majority of the proposed marine cable route comprises Holocene unconsolidated sediments, with thicknesses ranging from 0.5 to 10m. These typically overlie Pleistocene stiff till (boulder clay) which in turn overlies basement rock, although in places a thin veneer of Holocene sediments directly overlies basement rock.

The bedrock below consists of Precambrian, Palaeozoic and Mesozoic rocks. Most of the solid geology is concealed by seabed sediments although Carboniferous strata crop out at the seabed in a belt that extends approximately parallel with the coast (Barne *et al*., 1995).

Cambois North Landfall Approach (KP714 – KP699)

The Cambois Beach North Slipway landfall route corridor passes through an area dominated by silt and fine sediments typically less than 2m in thickness overlying firm to stiff clay (for approximately 15km). There are also some areas or patches of coarser sediments comprised of sand and gravel. An area of outcropping bedrock occurs at the seabed surface approximately 4km from the landfall to the north of the proposed cable route corridor, and sandy areas in this region have a rippled surface. Close to the shore the route passes through an area of coarse sediment and sand with a rippled surface (KP708 – 710).

Offshore Cable Route (KP699 – KP368)

The geological sequences found within the main marine cable route corridor have been significantly affected by the last glaciation. Varying thicknesses of glacigenic and reworked glacigenic deposits are found over sedimentary basement for approximately the first 97km of the route. Seabed sediments for the first 42km of the route (KP699- KP657) consist of very soft to soft clay. Initially along this stretch of the route they represent basin deposits and are up to 10m thick. Further to the north-east they occur as a thin cover of clay (<2m thick) over sedimentary basement.

For the next 57km (KP657 – KP603) moving further northeast along the proposed marine cable route corridor, basement rock remains close to the seabed surface with a thin (<2m thick) cover of overlying seabed sediments. Travelling northeast these consist of: silt and sand; clay containing coarse sediment; sand and sand and gravel; and an alternation between sand, sand and gravel, and silt and fine sands. Patches of gravel are also present associated with low to high frequency boulder fields.

The remaining 235km (KP603 - KP368) of the proposed marine cable route corridor is characterised by channels, inter-channels and basins in a variety of dimensions and shapes. In general they have a repeated pattern in sedimentary and geotechnical style. The seabed is typically covered by loose to dense sand often with gravel sized shell fragments. Thicknesses range from 2m to 10m in the channels and basins and 0.5m to 3m in the inter-channels. These surficial sediments often overlie laminated soft clay followed by firm to stiff clay or till, although the surface sediments may directly overlie firm to stiff clay or till in places.

7.4.4 Seabed Features

Along the survey corridor, seabed features encountered include outcropping bedrock, gravel patches associated with boulder fields, sand waves, and sand with a rippled surface and pockmarks.

Outcropping bedrock

The proposed marine cable route has been micro-routed slightly to the south to avoid outcrops of exposed bedrock before terminating at the Cambois North Beach landfall. The proposed marine cable route is closest to outcropping bedrock at KP705.9, where bedrock is 6m from the route.

Boulder fields

Fifteen SSS targets along the Cambois Beach North landfall approach have been interpreted as boulders >2m in size. Additionally, patches of gravel associated with boulder fields of varying frequencies are present from approximately KP604 to KP544. The frequency of the boulder fields range from 4 to 20 boulders per 0.01km^2 to >40 boulders per 0.01km^2.

Sand waves and ripples

Sand waves and seabed with a rippled surface are present for approximately the first 128km of the cable route i.e., KP714 to KP586 and 27 km between KP544 – KP571, and are indicative of intensive bottom currents and / or wave activity and potentially mobile sediments. The orientation of the sand waves are predominantly north although may also be northwest or west.

Features associated with gas seepage

The geology over a section of the survey corridor (approximately between KP571 to KP372) may have been influenced by gas seepage from lower formations. This is detected from sub-bottom profiles, but there are also features present at the surface, which may be caused by seepage and associated carbonate cementation. Examples of features which may be present are pockmarks (typically 5m – 10m in diameter and <1m in depth), cemented hardground present at or very close to the seabed surface, carbonate chimneys rising from the seabed, and carbonate aggregations of gravel to stone size. Cobble to boulder size concretions were identified between KP369 – KP484, and the area is considered by MMT as potential for carbonate hard ground generation and pockmarks. Pockmarks alone are not considered to conform to any of the Annex I habitats, but the potentially important Methane Derived Authigenic Carbonates (MDAC) listed in Annex I are often associated with gas seeps and pockmarks.

The presence of features with specific shapes and appearances, together with ‘blanking’ in the acoustic data, has led MMT (2013b) to interpret these features as potentially resulting from gas seepage. However, none of the visual inspections and geotechnical survey results have verified the presence of pockmarks concretions, gas cemented hard-ground, or the presence of bacterial mats.

Similar seabed features have been identified within adjacent Starling field exploration surveys. The features here also indicate the absence of protected habitat and show pockmarks with heavy trawling activity with many trawling scars passing through them (Shell, 2008).

7.4.5 Metocean Conditions

Hydrodynamic (Tidal) Regime

Data from oceanographic surveys carried out by Partrac Ltd (Natural Power Consultants, 2012) for the Blyth Offshore Wind Demonstration Project between January and August 2011 provide a good indication of the hydrodynamic regime in the nearshore region of the proposed marine cable route. These survey data are confirmed by comparison with public domain data such as those presented in Admiralty Tide Tables (UK Hydrographic Office, 2013).

The Blyth survey measured an astronomical tidal range of 5.71m. This agrees with published data for the nearby standard port of River Tyne (UK Hydrographic Office, 2013), which gives an astronomical tidal range of 5.7m, a mean spring tidal range of 4.3m, and a mean neap tidal range of 2.1m.

Current velocities in the nearshore area are generally homogenous, with peak currents on a mean spring tide of 0.51m/s to 0.55m/s (Natural Power Consultants, 2012). Corresponding neap currents are less than 0.22m/s. Modelling and measured results for this area show a strong bi-directionality of flow with a principle axis of N/S to NNW/SSE. This tendency for bi-directionality is modified moving nearer to the shore with flows adapting to the geometry of the coastline. In the lee of headlands, re-circulation is observed.

All locations monitored and modelled indicate that flood (southwards) flowing currents are always stronger than ebb (northwards) currents. This asymmetry can drive a residual sediment transport in the flood direction for both bed load and suspended sediments, although this process has been observed to reverse under southerly wave conditions. The residual currents responsible for the net southerly drift are, however, in the order of 0.02m/s to 0.04m/s. While not capable of entraining bottom sediments, they may be important for the transport of very fine sediment in suspension (Natural Power Consultants, 2012).

For the offshore portion of the proposed marine cable route, the mean spring tidal range decreases steadily from the coast towards the median line, dropping from over 4m near the landfall to about 1m near the median line. The peak current on a mean spring tide similarly decreases with distance from the coast, with depth-averaged speeds dropping from about 0.55m/s near the shore end to less than 0.35m/s near the median line. Equivalent near-bed current speeds vary from about 0.4m/s near the coast to 0.2m/s near the median line (Intertek, 2013). The tidal ellipse is generally bi-directional, but the principal axis swings round from NNW/SSE close to the coast, through N/S, to NNE/SSW near the median line.

Wave Regime

Measured wave data, collected within the Blyth Offshore Wind Demonstration Project area between January and August 2011, indicate the offshore wave climate has a strong N-NNE tendency relating to dominant waves arriving from the North Sea and swell-like conditions running down from the Norwegian Sea. A secondary wave climate exists from the NE to SE relating to locally-generated waves within the southern and mid North Sea basin. Moving inshore, the wave climate is influenced by seabed conditions with the direction of the N-NNE wave energy gradually turning to NNE-ENE, due to wave refraction (Natural Power Consultants, 2012).

Average annual significant wave height varies from 0.8m close to the coast to 2.1m near the median line, the increase being fairly steady with distance offshore (Intertek, 2013). The lowest monthly average significant wave heights occur in summer, ranging from 0.6m near the coast to 1.3m near the median line. The highest monthly average significant wave heights occur in winter, ranging from 1.1m near the coast to 2.9m near the median line. The 1-year extreme significant wave height is 5.2m near the coast rising to 9.5m near the median line (Intertek, 2013).

Seabed Temperatures

Mean seabed temperatures in the region of the proposed marine cable route range from 7° to 9°C with temperatures generally decreasing with water depth (Defra, 2010).

7.4.6 Sediment Transport

The sedimentary regime defines the key characteristics of sediment erosion, transport and deposition and how these vary spatially and temporally within any given system. There are three dominant types of sedimentary regime: erosion-dominated; transport-dominated; and deposition-dominated. The type of regime in a given area is typically driven by a range of external parameters such as wind, wave and tidal variability, sediment supply, mean grain size and human-induced factors. Changes to the sedimentary regime may result from a change to one or a combination of these factors (Environment Agency, 2013).

The sedimentary regime within the area of the proposed marine cable route and the surrounding North Sea has been evaluated giving consideration to the following:

- the morphology of the seabed along the proposed marine cable route and surrounding North Sea;
- the composition and distribution of sediments on the seabed within the proposed marine cable route corridor;
- an understanding of baseline sediment mobilisation and transport pathways.

The overall modern topography of the North Sea seabed has been largely influenced by deep geological structural processes of basin subsidence and uplift. The smaller scale seabed landscape is a relic of several glacial periods when large volumes of material were eroded from the adjacent mainland and from the continental shelf itself. The modern sedimentary environment of offshore areas of the North Sea continental shelf is now dominated by very low sediment input and the reworking of the seabed by near-bottom currents (Natural Power Consultants, 2012).

The presence of bedforms on the seabed can provide indications as to the prevalence of sediment transport in the area, and also provides clues as to the predominant transport direction. Interpretation of the geophysical data, in particular the SSS data along the proposed marine cable route, shows that sand waves and seabed with a rippled surface are present for approximately the first 170km (between KP544 – KP714). They are indicative of intensive bottom currents and/or wave activity and potentially mobile sediments. The orientation of the sand waves is predominantly north although may also be northwest or west (Natural Power Consultants, 2012). Sediment transportation along the route is net movement north to south driven by wave action rather than currents.

An overview of the coastal processes in the area is provided in the Northumberland and North Tyneside Shoreline Management Plan 2 (Royal Haskoning, 2009). The Northumberland coastline is dominated by wave action that controls the erosion, transport and deposition of beach sediments. The inshore tidal currents are weak and only have a secondary effect on the movement of sediment. The predominant wave direction is from the northeast along this coastline causing a net movement of material from north to south (Natural Power Consultants, 2012).

Seabed sediments can be re-suspended by tidal currents when the frictional drag exerted by the currents exceeds the submerged weight of particles which act to retain the particles on the seabed. If tidally-driven sediment suspension does occur, variability in concentration that follows the neap-spring tides is expected. Data collected for the Blyth Offshore Wind Demonstration Project indicated that in this region there is a very weak tidal signal and associated changes in suspended sediment concentration are typically 5mg/l, i.e. tidal re-suspension is only barely discernible (Natural Power Consultants, 2012).

Even though the coast is exposed to high wave energies the rate of longshore transport of sediment is relatively low (Natural Power Consultants, 2012; Royal Haskoning, 2009). Sediment movement is limited to individual bays because rock platforms and headlands provide natural barriers to the southerly movement of sediment.

Large bays formed by the relatively harder headlands punctuate the low lying coast in the southern section of the Northumberland coastline. Along some of the more resilient sections of coast, such as Newbiggin to the north of Cambois Beach, the best estimates of erosion are less than 0.1m per year. The effect of this quite resilient geological structure to the coast has allowed many of the bays to reach a good degree of stability. Erosion rates, even to many of the soft embayed frontages, is therefore similarly low, ranging at present from an assessed erosion rate of 0.1m per year to maximum average rates of 0.5m (Royal Haskoning, 2009).

7.4.7 *Sea Level Rise*

Significant changes to coastal erosion may result from sea level rise, in effect submerging key rock outcrops, such as the rocks fronting Creswell. It has been estimated that as a result of sea level rise, erosion rates on the more directly exposed sections of coast, such as the headlands, may increase by a factor between 1.4 and 1.7 times historical rates. In areas of relatively stable backshore such as Cambois Beach, erosion purely due to a rolling back of the shore could be as much as 50m, though more typically 10m to 20m, over the next 100 years, depending on shoreline slope (Royal Haskoning, 2009). Net Sediment Transport Direction is north to south driven by wave action rather than currents.

The potential for sea level rise has indicated that HDD at the cable landfall site may be unsuitable

7.5 Potential Effects on the Physical Environment

7.5.1 *Installation*

Changes to seabed bathymetry, seabed bedforms and seabed sediments

This section considers the wider seabed bathymetry, any specific features or bedforms (such as sand waves) that may be found on the seabed, and the sediment composition of the seabed (e.g. particle size distribution).

Along the majority of the proposed marine cable route, the cable will be buried. Marine cable installation is likely to create a trench up to 0.75m wide and between 1-2m deep. Installation tools may have a footprint up to 10m wide. The predicted total footprint covered by the cable burial will be 6.8km^2. Where possible, the cables would be laid and buried at the same time to avoid the risks associated with cable lengths lying exposed on the seabed.

For the majority of the proposed marine cable route, where adequate burial is expected, cable installation will result in a temporary disturbance to the seabed within the cable trench and installation tool footprint. Features and bedforms entirely within the trench footprint will be destroyed, while those within the installation tool footprint may suffer disturbance ranging from none to total destruction (depending on the feature type). However, the installation footprint is narrow, so only a small part of a specific feature area (for example, an area of ripples) would be affected. Furthermore, cable burial activities will disturb sediment and redeposit it locally (either through deliberate backfill in the intertidal area, or through the settling of disturbed sediment), so there will be no net change in the near-surface sediment composition. As such, it is likely that any effects of trenching and backfill will be short term with the seabed returning to pre-installation conditions under natural processes.

There are a number of locations along the route where cable burial is not possible due to the presence of cable or pipeline crossings or hard ground with insufficient sediment cover. At these locations, cable protection will be required using rock placement and/or concrete mattress installation. At each of these locations the seabed profile will be raised, for at least the life of the cables, by the layer of rock or mattresses. Use of these hard materials, in the region of third party crossings, in what is generally a soft sediment environment, also has the potential to lead to some scour effects. Scour as a result of rock/mattress placement will only occur in areas of sediment where bottom currents either already exceed the critical bedload parting velocity, or where the rock placement results in an increase in current velocity to above the critical bedload parting velocity. However, given that currents in the area are relatively low, scour is unlikely to be a significant issue, and good practice will be used to minimise scour around areas of cable protection.

The predicted total footprint that will be covered by cable protection measures (rock placement and/or concrete mattresses) is 0.14km^2. In areas of hard ground with minimum sediment cover, the potential for seabed damage, or for subsequent sediment scour, will be low.

During installation, it is anticipated that installation vessels will primarily use dynamic positioning to hold station. Dynamically positioned vessels do not disturb sediments unless used in shallow waters less than 20m deep. There will therefore be no disturbance of the seabed by anchors for the majority of the route. An exception might be close in to the shore end where anchors may be deployed in place of dynamic positioning. However, the area that these would cover is small in relation to the total footprint of installation (trenching) tools.

The sensitivity of the physical environment to changes to seabed conditions is considered to be medium. It is anticipated that any effects will be transient and the affected areas will quickly return to pre-installation conditions under natural processes. The magnitude of the impact is assessed as low, indicating the significance is **Minor**.

Changes to geological features of conservation interest

The most sensitive geological feature in the vicinity of the proposed cable route is the Creswell and Newbiggin Shores SSSI as discussed in Section 9. The only significant effect of the cable installation on this site would be from trenching through the geological interest features of the SSSI. However, given that the site is 400m to the north of the proposed marine cable route at closest approach, no impacts are anticipated to the geological feature of conservation interest and the significance of the effect is considered to be **None**.

Changes to the metocean regime

Installation activities, and the presence of vessels and other equipment, will be relatively small-scale and transient. These activities will have no substantive effect on the metocean regime such as currents and waves. The significance of the impact is considered to be **None.**

Changes to the sediment regime and coastal processes

The assessment considered the wider sediment transport regime, including regional sediment transport pathways, sediment budgets, and the associated effects on coastal processes such as beach replenishment and coastal erosion.

Installation activities are, by their nature, transient, therefore sensitivity to cable installation activities is considered low. Changes to the broader sediment transport regime and coastal processes would require longer-term effects due to the cable presence. It is anticipated that installation activities will cause no long-term change to either the seabed sediment composition or to metocean processes, indicating that magnitude is negligible. As the installation trench will be backfilled after installation, restoring the beach profile, there are no long-term changes to sediment transport pathways or coastal processes (e.g. through changes to the long shore sediment flux) anticipated. The impact significance is considered to be **None**.

7.5.2 *Operation*

Changes to seabed bathymetry, seabed bedforms and seabed sediments

For the majority of the cable route, the cables will be buried and will have no long-term impacts on the seabed profile and sediment features. The exception to this will be where rock cable protection measures are required at cable and pipeline crossings and areas where sufficient burial cannot be achieved.

Throughout the operational lifespan of the cable, there may be the requirement for maintenance and the restructuring of the rock/mattress protection. Additions or adjustments to structures on the seabed have the potential to change the seabed topography, bedforms and sediments. Sensitivity to changes to the seabed from cable operation are considered to be medium. Maintenance and modifications to the cable once initially installed are anticipated to be minimal, infrequent and localised. Any effects will be the same as those described for installation but on a smaller scale. Therefore the magnitude of the impact is considered to be low. The significance of the impact is **Minor**.

Changes to geological features of conservation interest

The Creswell and Newbiggin Shores SSSI is 400m to the north of the proposed marine cable route at closest approach. It is not anticipated that the operational phase of the cables will have any impact on this designated site. The significance of the impact is **None**.

Changes to the metocean regime

Those parts of the cable which are buried will cause no changes to the metocean regime, such as waves and currents, throughout the lifespan of the cables. Where rock placement or mattressing is used, there may be very localised changes to tidal or wave-induced currents, for example associated with localised scour around the protection. Any such local changes will be immeasurable in the wider environment, and the presence of the cable protection will cause no changes to the wider metocean regime. The significance of the impact is considered to be **None**.

Changes to seabed temperature

When the Norway – UK Interconnector is in operation there will be a localised heating of the environment surrounding the cables (i.e. heating of the sediment where the cables are buried, heating of the rock berms/concrete mattresses where cable protection is employed, or heating of water in the interstitial spaces). The sensitivity of seabed conditions and processes to small temperature changes is low. The magnitude of this effect will be low as it is localised and will cause no wider change in sea water or sediment temperatures. The significance of the impact is considered to be **None**.

Sea level rise and climate change

Sea level rise has the potential to cause greater erosion in the Cambois Bay area which in turn could increase the risk of cable exposure. The impacts of cable maintenance and operation to sea level rise and climate change are considered to be medium. Any potential impacts resulting from remedial works required to protect and/or rebury the cable after a significant change in beach profile, will be on a much smaller scale than potential impacts which may arise during installation. The magnitude is considered to be low due to the localised and short term nature of maintenance works, and it is not anticipated that such impacts would affect the integrity of the Northumberland Shore SSSI. The impact significance is considered to be **Minor**.

7.6 Mitigation

Changes to the sedimentary and metocean environments will be minimised by careful route selection and the use of appropriate burial/rock-dumping techniques.

Changes to seabed bathymetry, seabed bedforms and seabed sediments

Rock placement will only be used where cable burial is not possible, and the profile of rock berms will be designed to minimise the potential for scour to occur.

Sea level rise and climate change

Restoration of the intertidal area after installation and/or maintenance by backfilling will restore the beach profile to the existing baseline condition.

7.7 Residual Impact

No residual impacts are anticipated

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8 WATER AND SEDIMENT QUALITY

8.1 Introduction

This Section provides an overview of the water and sediment quality likely to be present along and adjacent to the proposed marine cable route corridor. This assessment considers the potential impacts that the marine cable installation and operation may have on water and sediment quality and the mitigation measures to be implemented to avoid, reduce, and offset any potential impacts.

8.2 Data Sources

Baseline conditions have been established by undertaking a desktop study of published information and through consultation with relevant bodies.

The primary data sources used in the assessment of effects on water and sediment quality are:

- MMT (2012) Environmental Survey Report North Sea Network
- UKMMAS (2010) Charting Progress 2
- JNCC Website
- Environment Agency Website
- NAREC (2012)
- JNCC (1995) Coasts and Seas of the United Kingdom, Region 5 North-east England

8.3 Methods

8.3.1 *Assessment Guidelines*

The potential impacts of the installation and operation of the proposed marine cables on water and sediment quality have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

The geographic scope of the appraisal includes the area along and adjacent to the proposed marine cable route corridor as illustrated in Figure 1-1 (Appendix 1).

8.3.2 *Magnitude of Impact*

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential effect and takes into account the likelihood of an effect occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the effect prior to recovery. Criteria for describing the magnitude of effect are described in Table 8.1.

Table 8-1: Magnitude Criteria

Magnitude	Description
High	A long-term effect which has implications for water or sediment quality conditions such as sediment transport or changes to coastal processes which extend beyond the vicinity of the marine cables route.
Medium	A medium or long-term change to the water or sediment quality conditions of the local environment, a permanent change to the local seabed topography which does not have any impact on regional sediment processes, or sediment re-suspension and deposition at significantly greater levels than those expected from natural processes.
Low	A temporary, small-scale change to water or sediment quality conditions lasting for the duration of installation works, such as creating the cable installation trench, or sediment re-suspension and deposition within comparable levels to those expected from natural processes.
Negligible	No measurable change to the water or sediment quality conditions.

8.3.3 *Sensitivity or Importance of Receptor*

The sensitivity of the baseline conditions has been assessed according to the relative importance of the water and sediment quality present in the vicinity of the proposed marine cable route corridor .

The sensitivity of water and sediment quality has been assessed in accordance with the criteria outlined in Table 8.2

Table 8-2: Sensitivity Criteria

Sensitivity	Description
Very High	Feature is of very high environmental value, quality or rarity on a national scale and/or has little or no ability to absorb change without fundamentally altering its character.
High	Feature is of very high environmental value, quality or rarity on a national scale and/or has little or no ability to absorb change without fundamentally altering its character.
Medium	Feature is of medium environmental value, quality or rarity on a local scale and/or has a moderate capacity to absorb change without significantly altering its character.
Low	Feature is of low environmental value, quality or rarity on a site scale and is tolerant to change without detriment to its character.
Negligible	Feature is of low or no environmental value, quality or rarity on a

Sensitivity	Description
	local scale and is resistant to change.

8.3.4 *Significance of Impacts*

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the magnitude of a potential impact and the sensitivity or importance of the receptor. Impacts are identified as Beneficial and Adverse and their significance as Major, Moderate, Minor or None. The term ‘None’ denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account any mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts identified as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. The full results of the assessment of impact significance are presented in Appendix 2.3.

8.3.5 *Regulator Background*

Water and sediment quality are monitored and regulated in the UK under a number of EU Directives. The most relevant to the Norway – UK Interconnector project are:

- Water Framework Directive (WFD) (EU, 2000; JNCC, 2013a)
- Dangerous Substances Directive (DSD) (EU ,1976a)
- Bathing Waters Directives (BWDs) (EU, 1976b, EU, 2006a)
- Shellfish Waters Directive (SFWD) (EU, 2006b) and
- Marine Strategy Framework Directive (MSFD) (EU, 2008)

The BWDs and the SFWD are only applicable at designated bathing waters and shellfisheries, respectively. Both the WFD and MSFD seek to ensure Good Environmental Status (GES) within designated water bodies. The WFD covers surface and ground waters to 1 nautical mile out to sea, while the MSFD covers the coastal zone out to the extent of the Exclusive Economic Zone. In coastal waters, the MSFD is only intended to apply to those aspects of GES which are not already covered by the WFD. In coastal waters measures taken under the WFD should be sufficient to achieve the GES targets for pressures such as contaminants under the MSFD.

The Dangerous Substances Directive had the objective of regulating potential aquatic pollution by thousands of chemicals. The purpose of the Directive is to eliminate pollution from highly toxic substances (list I) and to reduce pollution from less toxic subtances (list II). The Directive was repealed and its role subsumed into the Water Framework Directive in 2013. The directive sets Environmental Quality Standards (EQS's) that are used to assess the risk of chemical pollutant effects on water quality to the health of aquatic plants and animals. EQSs are set for freshwater, estuarine and coastal waters. The EQSs for substances pertinent to this study are provided in Table 8.4.

Table 8-3: Environmental Water Quality Standards

Determinand	Coastal and Estuarine EQS (ug/l)	Method	List
Mercury (dissolved)	0.3	Annual average	1
Cadmium (dissolved)	2.5	Annual average	1
Arsenic (dissolved)	25	Annual average	2
Chromium (dissolved)	15	Annual average	2
Copper (dissolved)	5	Annual average	2
Iron (dissolved)	1000	Annual average	2
Lead (dissolved)	25	Annual average	2
Nickel (dissolved)	30	Annual average	2
Vanadium (dissolved)	100	Annual average	2
Zinc (total)	40	Annual average	2

Source: EU (2000); JNCC, (2013a)

8.4 Existing Conditions

Water and sediment quality at any particular location in the North Sea is the result of a combination of source, transport and removal mechanisms for the individual chemical species under consideration.

The coastal section of the proposed cable route corridor has been heavily influenced by human activity, particularly since the industrial revolution, with ongoing contamination from industrial activity continuing to the present. In particular mineral particles arising from mining and metallurgical industries and organics from sewage outfalls may be present within the water column and as components of sediments (Intertek, 2012). In addition the offshore section of the route close to the Norway/UK median line is influenced by oil and gas exploration, and contaminants associated with this industry are likely to be within sediments immediately surrounding such infrastructure.

Transport mechanisms are important in determining the distribution of contaminants. The majority of contaminants which enter the marine environment in association with water (either river or sewage) tend to either be trapped in the estuarine and near coastal zone (as components of the sediment) or, if soluble in seawater, are rapidly diluted. Contaminants which enter the marine environment as a result of direct local inputs, such as those deriving from offshore oil and gas extraction, may be elevated in the immediate vicinity of the source, but tend to decrease rapidly with distance from the input site.

Removal of contaminants is largely dependent on advection and dispersion within the water column and changes in solubility, with an ultimate sink in sediments. For many water transported contaminants changes from fresh to seawater conditions (particularly increasing pH) result in rapid removal in the estuarine and immediate coastal zone, leading to contamination of near shore sediments.

8.4.1 *Water Quality*

The concentrations of contaminants in the water column are not routinely measured under the existing monitoring programmes, with the significant exception of artificial radionuclides, and are not available from the route survey. However, data relating to suspended particulate matter (SPM), from the Land Ocean Interaction Study (LOIS) has been included in this study. This section, with the exception of SPM, represents a general discussion of water quality in the North Sea.

Turbidity

Turbidity provides a measure of Suspended Particulate Matter (SPM), both mineral and organic, in the water column. Turbidity generally increases on approach to the shoreline as a result of terrestrial inputs (which are likely to include particles and nutrients, the latter contributing to SPM through increased productivity) and shallower waters (which allow greater re-mobilisation of sediments by waves and tidal currents). In offshore continental shelf waters the upper water column turbidity tends to be relatively high as a result of biological activity, with a near bottom increase as a result of sediment re-suspension. An important component of turbidity is very fine (colloidal) material comprised of clay minerals, organic macro-molecules and products of reactions within the water column, particularly in estuaries.

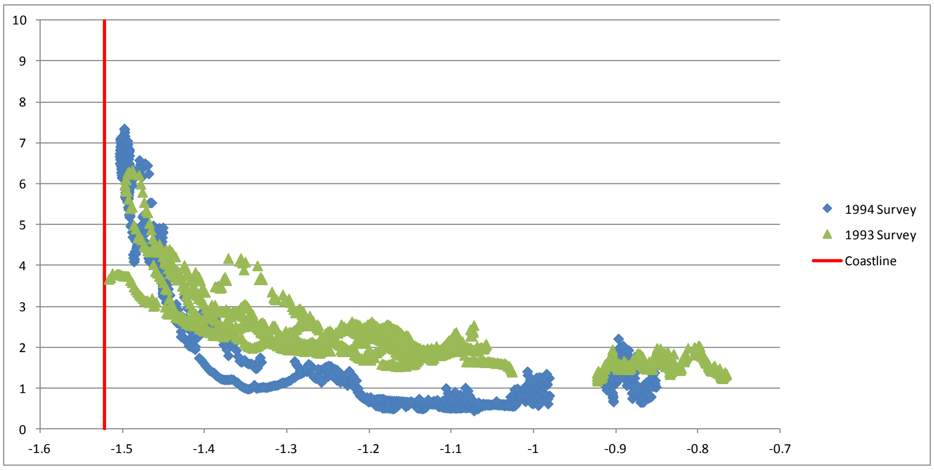
There is a strong temporal component to turbidity in the North Sea, on time scales ranging from seconds (wave action), through hours and days (tidal, including spring-neap cycles), to years (productivity cycles), and decades (climatological factors). Superimposed on these cyclical variations are impacts of events such as storms (influencing sediment re-suspension through wave action and particle and nutrient inputs through increased river flow) which themselves have seasonal and long term components.

Some components of turbidity may act as a source of contaminants, particularly where they are undergoing rapid changes in environmental conditions, e.g. increases in salinity while passing through an estuary. However, many components, and particularly clay minerals, act to remove contaminants such as metals and hydrocarbons from the water column.

The northern North Sea, with weaker tidal currents and deeper water, has lower SPM concentrations than the southern North Sea (UKMMAS, 2010).

Data for SPM from the LOIS study (1993 to 1994) indicates that, in the period of that study, average SPM concentrations close to the shore are of the order of 4.5 mg/l, while offshore concentrations averaged around 1.25 mg/l. Figure 8.1 shows measured SPM concentrations plotted against longitude with landfall occurring at a longitude of around -1.52°.

Figure 8-1: Measured SMP Concentrations Offshore Cambois 1993 and 1994



Source: Royal Haskoning (2009)

Organic contaminants

The majority of organic compounds present in the environment are either readily biodegradable or of low water solubility and hence of limited significance in terms of water contamination. However some organic compounds have been the subjects of concern. Prominent among the compounds that can reach toxic concentrations in the dissolved phase, and/or bioaccumulate from the dissolved phase to toxic levels are the organo-metallic compounds of lead, tin and mercury. Use of organo-tin compounds (as marine anti-foulants) and tetra ethyl lead (as a petrol additive) have been subject to stringent controls and concentrations in the marine environment and are subsequently decreasing. Organo-mercury is produced both as a result of natural processes in marine waters and sediments and as an industrial waste. Discharges of the latter and of inorganic mercury are being increasingly controlled; however, a major pathway for mercury to the marine environment is through discharges to the atmosphere, particularly from coal fired power stations.

River quality

The River Blyth, the Sleekburn and the Wansbeck all discharge to the coast within 1km of the landfall position. In 2009, as part of the River Basin Management Plan (EA, 2009), the ecological quality in all these rivers was designated as ‘Poor’.

Bathing waters

Bathing water quality is typically at risk from pathogenic organisms arising from local terrestrial sources. Cambois Beach is not an EU designated bathing water and has not been tested. The closest designated bathing waters to the landfall are Blyth South Beach, Newbiggin South and Newbiggin North. Newbiggin

South bathing water is around 3.3km from the landfall. Bathing water quality is very good at this beach and it has achieved the higher water quality classification since 2009. Newbiggin North bathing water is some 500m further distant from the landfall and water quality similarly achieves the higher water quality classification. Bathing water quality at Blyth South Beach is not always of a similar quality, although the higher classification has been achieved for the last 2 years. This variability in bathing water quality is believed to be the result of an outfall in the centre of the bathing beach through which the Newsham South Burn and an unnamed burn in South Newsham housing estate discharge.

Shellfish waters

There are no designated shellfish waters close to the landfall.

Heavy Metals

Dissolved metal concentrations are normally higher in coastal waters than in the open ocean (Chester, 1990), with a generally inverse relationship to salinity.

Available evidence (reported in UKMMAS, 2010) suggests that, while there is some evidence of anthropogenic perturbation close to industrial sites there are no significant concerns over water quality over the cable route. However there are known to be historic potentially contaminated sites within 1 km of the coastline. These sites have been identified north and south of the Wansbeck coastline, commencing with Lynemouth power station, and associated foundries stretching down to Cambois and Blyth Harbour (Royal Haskoning, 2009).

Artificial Radionuclides

The dominant source of artificial radionuclides to the North Sea is from Dounreay, and concentrations are correspondingly very low. While artificial radionuclides are detectable in waters throughout the North Sea, any exposure to radiation from this source is insignificant in comparison with the natural background radiation.

8.4.2 *Sediment Quality*

Sediment in the near-shore section of the proposed marine cable route is likely to be affected by recent human activity. Mining was active at Cambois and colliery waste was tipped onto the foreshore from 1920 until 1968 when the colliery was closed. Since then the colliery waste has been subject to erosion throughout the bay. It rapidly breaks down into clay, silts and fine sand particles that are easily removed by wave action. The eroded material can now be seen in the offshore sea bed sediments (Royal Haskoning, 2009).

The offshore section of the route within English waters is largely undisturbed by industrial activity. As a result, contamination of sediments is likely to decrease rapidly away from the shoreline except in the vicinity of specific sources. The proposed cable route corridor passes through the northern tip of an open spoil ground for 3.5km and is approximately 0.8km north of a closed disposal site

(Tyne Industrial), both of which run parallel to the coast between 5 and 10km offshore. The active spoil ground now only receives dredge material although it formerly received dredgings from Blyth Harbour, Fly Ash from Blyth Power Station and colliery waste (Eagle *et al*., 1979). Typically the material deposited is likely to have been contaminated with heavy metals and persistent organic pollutants. However, evidence (Bolam *et al.*, 2011) for the current status of the North Tyne disposal site (12.55km distant) suggests that impacts of spoil disposal are likely to be restricted to the area receiving the spoil.

The offshore section of the route in Scottish waters has been heavily exploited for oil and gas resources and therefore concentrations of contaminants associated with drilling may be relatively high. As with the other sections of the route contaminants will be largely associated with fine material in the sediments. The main contaminants likely to be encountered are hydrocarbons, either originating in reservoir fluids or used as components of drilling muds (Intertek, 2012). As a result of regulatory controls the volume of oil discharged in produced water from offshore oil and gas installations fell by about 50% over the period 2002 – 2008. The volume of oil accidentally spilled varies from year to year but generally spills are small and of relatively minor significance (UKMMAS, 2010).

Physical Characteristics

The physical characteristics of the proposed marine cable route are thoroughly considered in Section 7 Physical Environment .

Chemical Characteristics

The analytical data for metals and organic contaminants have been reported in the cable route survey (Intertek, 2012). Total organic carbon was found to be always less than 0.74% of the total mass. The metals concentrations have been compared to the Cefas Action Levels in Dredged Materials (Cefas, 2014)). Cefas have set Action Level 1 and Action Level 2 concentrations to provide standards to assess whether dredged material is suitable for disposal at sea. Concentrations below Action Level 1 are of no concern, concentrations above Action Level 2 is generally considered unsuitable for sea disposal, while contaminant levels between Action Levels 1 and 2 require further consideration and testing before a decision can be made. The Action Levels for the surveyed metals are provided in Table 8-5, together with the number of samples which were found to be above each action level.

Table 8-4: Cefas Action Levels

Parameters	Action Level 1	Number above	Action Level 2	Number above
Arsenic	20	5	100	0
Mercury	0.3	0	3	0
Cadmium	0.4	0	5	0
Chromium	40	0	400	0
Copper	40	0	400	0
Nickel	20	0	200	0
Lead	50	0	500	0
Zinc	130	0	800	0

Source: Cefas (2014)

This indicated that overall there was little evidence of metals contamination. Only arsenic concentrations were found to be above Action Level 1 and all of the samples were found to be below Action Level 2.

Arsenic levels were elevated at a number of sites between KP 604.6 and KP 701.7. With the exception of KP 701.7, these elevated values are not associated with any other evidence of contamination, and are therefore likely to be natural in origin. KP701.7 is close to the closed Tyne Industrial disposal site.

There was some evidence of elevated barium levels between the median line and KP 432.3, probably reflecting drilling activity in the area. Barium (in the form of barium sulphate) is functionally inert and is not considered toxic in the marine environment. Metal concentration generally increases slightly on approach to the shoreline. There is no evidence for significant contamination with organic compounds. and no other evidence for contamination in this area.

Disturbance of Munitions

Vast amounts of munitions were dumped at designated sites off the UK coast (e.g. Beaufort’s Dyke, NW Scotland) or randomly jettisoned into the sea after the First and Second World Wars. These included conventional munitions such as bomb, grenades, torpedoes, mines, incendiary devices and chemical munitions. During a programme to establish the extent of munitions dumping, OSPAR has revealed that munitions were dumped in 148 sites and 1879 encounters with munitions have occurred since 2004.

Munitions contain unstable compounds which can leach from the ordinance in to surrounding sediments and potentially present a contamination risk if disturbed during cable installation, in addition to being a significant threat to human safety. OSPAR records and a site specific Explosive Ordnance Threat Assessment (Bactec, 2013) indicate that there are no official munitions dumping grounds within the cable route area. However, records show that with proximity to the Northumberland coast, the risk of encountering UXO increases. Sources of such munitions are likely to be remenants of the East Coast Mine Barrage which was laid within the cable route area between approximately KP636 and KP677, unexploded torpedoes and U-Boat 105mm HE projectiles from World war one, and remenants from German bombing raids to Blyth during world war two. A modern firing practice area is located between approximately KP592 and KP686 and a submarine exercise area is also recorded. There is possibility to encounter UXO in such areas.

8.5 Potential Impacts

8.5.1 *Installation*

Sediment disturbance

During marine cable installation some seabed sediment will be re-suspended into the water column causing three related effects:

- a small localised and temporary increase in turbidity, with subsequent re-deposition on the seabed.
- a localised and temporary increase in the concentration of sediment contaminants in the water column.
- a localised and temporary increase in the concentration of contaminants from the cuttings piles resulting from drilling activity in the area between the median line and KP 432.3.

The baseline conditions along the route identify two areas of potential concern for suspension of contaminated sediments: the open disposal site offshore Blyth and the oil and gas region within Scottish waters. The former has the potential to impact coastal surface waters (WFD) and wider marine environment (MSFD); whilst the latter may impact marine waters only (MSFD).

Quantities of sediment ejected from the trench can be estimated, based on the following parameters:

Table 8-5: Seabed Trench Parameters

Trench width	0.75m
Trench depth	1-2m
Proportion of sediment falling directly back into trench (plough)	95%
Proportion sediment falling directly back into trench (trenching – jetting or mechanical)	80%
Installation speed	300m/hr

Installation methods will not be finalised until an appropriate contactor is appointed therefore ploughing, jetting and trenching have been considered. Based on these values the rate of sediment ejected from the trench will be 0.75 – 1.5 m^3/minute for trenching, and 0.2 – 0.4 m^3/minute for ploughing. The coarser fractions of the sediment, up to and including fine sand, ejected from the trench will be raised a few metres from the seafloor, and will re-deposit within 60m or less of the cable trench. The remaining finer silt and clay fractions will remain in suspension for longer before being deposited over a wide area. Based on the spring tide current velocities, silt which comprises between 3% and 12% of the sediment could be transported up to 5.6km. Clays which comprise less than 1% of the sediment could be transported further. The particle size distribution within this remobilised sediment varies along the route with more fine sediments being found in deep water highly dispersive areas than closer to the shore. Fine material which could stay in the water column for longer will be rapidly diluted and dispersed in this water. Thus, the deposition footprint will be limited.

There is a potential temporary effect associated with remobilisation of sediment contaminants during cable installation operations, and it was noted in the SEA (Cefas, 2005) that: “Anthropogenic activities involving sediment disturbance such as trawling, installation of wind turbines and oil/gas pipelines are likely to increase re-dissolution from the reservoir of contaminated sediment residing on the seabed.” Sediment contaminants held in pore water will be released to the water column during cable installation. Survey data (Intertek, 2012) show that, with a few exceptions, contaminant concentrations in sediment are low. Arsenic can be considered the most critical sediment contaminant taking into account its sediment concentration, partition between sediment and water and its annual average dissolved EQS (25 µg/l). Calculations based on the most contaminated sample provided in Table 8-6 indicate that a maximum rate of 620mg/s (or 2 mg/s/metre of trench) of dissolved arsenic may be released around KP 696.5. The depth at this location is around 57 metres and current speeds average 0.25m/s, which affords considerable dilution and dispersion. Conservative dilution calculations have been carried out using tidal current data obtained from Intertek’s in-house North Sea hydrodynamic model. These calculations show that, assuming the pore water is spread only over the first metre of water column above the bed (a conservative assumption), the average arsenic concentration at the point of discharge is predicted to be less than 24µg/l. The arsenic concentration of the sample taken at the site closest to the active disposal site (KP 701.6) was 60% of concentration of the sample at KP 696.5. Conservative dilution calculations were also carried for this sample and an average predicted dissolved water column concentration of around 15µg/l was found. Contaminants are expected to be rapidly further diluted and dispersed after this initial dilution phase.

There is also a potential temporary effect from the area of drilling activity in the oil and gas region within Scottish waters. The most significant component of cuttings piles is the base oil employed to make up the drilling mud (Neff, 2005, Neff, 2010). The main environmental impact of this is a result of short term de-oxygenation of the cuttings piles and surrounding sediment, rather than any longer term toxicological effect.

The receiving environment along the proposed marine cable route corridor is expected to have moderate to good tolerance to changes to water and sediment quality and sensitivity has therefore been assessed as low.

Any changes will be temporary and localised and the magnitude of the impact on water or sediment quality is therefore low and the significance is assessed as **None**.

For sections of the cable where rock placement is required, a long term (placement lifetime) change in sediment properties from the baseline will occur. The extent of such changes will be small, however the magnitude in these areas is assessed as medium. The significance of sediment disturbance in these areas is considered to be **Minor.**

Sediment deposition

In order to give a better understanding of the scale of the sedimentation effect from cable installation (trenching / jetting), calculations have been made using current velocities along the discharge route. The initial conditions for these calculations are presented in Table 8-7.

Table 8-6 Sedimentation Dispersion Depth Calculations

Trench volume - trench width (0.75m) x trench depth (2m) x section length (1m)	1.5m^3
Volume ejected from trenching (20 % of trench volume)	0.3m^3 per m
Volume ejected from a ploughed trench (5 % of trench volume)	0.075m^3 per m
Height above the bed that sediment is released.	2 m

The average predicted maximum depth of deposition at 10 KP points are presented in Table 8-8, for all sediment fractions and for the gravel and clay fractions.

Table 8-7: Sedimentation Dispersion Depth Calculations

KP Point	Estimate Average Depth (mm)			
	Trenching		Plough Trenching	
	All fractions	Gravel and clay	All fractions	Gravel and clay
KP 364.8	31.6	7.8	7.9	1.9
KP 415.6	44.9	11.1	11.2	2.8
KP 476.4	39.7	9.8	9.9	2.4
KP 528	40.9	8.5	10.2	2.1
KP 576.4	31.9	6.6	8.0	1.7
KP 626.8	26.2	5.4	6.5	1.4
KP 655.4	25.0	5.2	6.2	1.3
KP 691.0	40.7	21.6	10.2	5.4
KP 701.2	44.0	23.4	11.0	5.8
KP 711.2	52.6	28.0	13.2	7.0

For plough trenching all sediment depths are predicted to be below 15mm. For trenching, predicted sediment depths taking into account all fractions exceed 20mm at all KPs, with a sediment of over 50mm predicted close to the shore. However, in most cases the deposited sediment will be rapidly re-suspended in periods when current speeds exceed the critical speed for erosion for each fraction of the sediment.

Current speeds near the bed derive from two sources:

- Tidal current speeds which vary from maximum to minimum twice over an approximate 12.5 hour period and vary in overall magnitude over a spring neap cycle (14 days).
- Wave action which converts energy to current speed.

Conservative re-suspension calculations have been carried out using tidal current data obtained from Intertek's in-house North Sea hydrodynamic model. These calculations do not take into account increases in current speed resulting from wave action and therefore can be considered conservative. The percentage of time for which each sediment fraction is erodible for each KP point is presented in Table 8-9. This analysis shows that gravel and clay are never predicted to be eroded, while sands and silt are more readily erodible. Overall, sands and silts make up over 97% of the bed material. The results of this analysis show that bed erosion is predicted to increase in a shoreward direction as water depths decrease. Close to the shore bed erosion decreases again as current speeds decrease.

Table 8-8: Sediment Deposition – Percentage of Time Erodible

KP Point	Very fine gravel	Coarse sand	Medium sand	Fine sand	Silt	Clay	Overall
364.8	0%	0%	1%	5%	2%	0%	4%
415.6	0%	0%	1%	6%	3%	0%	5%
476.4	0%	0%	3%	12%	6%	0%	10%
KP 528	0%	1%	6%	17%	11%	0%	12%
576.4	0%	3%	14%	26%	20%	0%	20%
626.8	0%	8%	23%	34%	29%	0%	28%
655.4	0%	1%	12%	27%	40%	40%	33%
691.0	0%	12%	27%	39%	32%	0%	31%
701.2	0%	13%	28%	39%	33%	0%	31%
711.2	0%	2%	14%	27%	21%	0%	20%
Overall	0%	4%	13%	23%	20%	4%	19%

The trenching process is localised and temporary. Close to the, shore (KP 711.2 to KP 691.0) where predicted deposition depths are greatest; the re-deposited bed substrate will be rapidly re-suspended. In this near-shore zone, the bed substrate is naturally continually re-suspended and deposited. Both tidal current and wave action contribute to this sediment re-suspension. This near-shore area is expected to have moderate to good tolerance to this level of sediment deposition.

Further offshore and in slightly deeper water (KP 655.4 to KP 476.4) predicted total deposition is up to 40mm for trenching. However, for the sand and silt fractions re-suspension is rapid in this zone and only the gravel and clay fractions will remain for any appreciable period. Predicted depths of gravel and clay are less than 10mm. This more offshore area is expected to have moderate to good tolerance to this level of sediment deposition.

In deeper water (KP 415.6 to KP 364.8) predicted total deposition is around 40mm for trenching and re-suspension is relatively slow at around 5% of the time. A band of gravels around 0.8m wide will remain after other fractions have been re-suspended at a depth of around 10mm. This offshore section of the route in Scottish waters has previously been heavily exploited for oil and gas resources. Therefore this area is expected to have moderate to good tolerance to this very localised and low level of sediment deposition.

The receiving environment is expected to have moderate to good tolerance to the level of sediment deposition expected from marine cable installation and sensitivity has therefore been assessed as low to medium. Sediment deposition will be localised and temporary and the magnitude of the potential effect is assessed as low. The overall impact significance is assessed as **Minor**.

Contamination from vessel discharges

Quantities of any discharges of dissolved contaminants from vessels engaged in installation activities will be small, particularly relative to the other direct inputs to the water column (e.g. rivers, airborne contaminants). No discharges are permitted within 12nm of the coast, therefore no impacts to bathing waters are anticipated. Impacts of discharges offshore will be temporary and localised. Moreover, vessels engaged in cable laying operations will be equipped with waste disposal facilities (sewage treatment or waste storage) to IMO MARPOL standard. The magnitude of any associated changes in water quality is estimated as negligible.

The sensitivity of the marine environment to pollution from vessels has been assessed as low due to its ability to absorb contaminants in small quantities and the provision of waste disposal facilities. Due to the small quantities of discharges which will be released from installation vessels the magnitude of this potential effect is low. Therefore the overall impact significance is assessed as **None.**

Introduction of non native species from the disposal of ballast waters

Since the introduction of steel hulled vessels around 120 years ago, water has been used to stabilise vessels at sea. Ballast water is pumped in to a vessel to maintain safe operating conditions throughout a voyage (IMO, 2011). The multitude of marine species carried in ships' ballast water may pose ecological problems as transferred species may survive a voyage and be discharged at a destination. Here they may establish a reproductive population in the host environment, becoming invasive and out-competing native species.

Water and sediment quality is of medium sensitivity to the introduction of non-native species as they can result in fundamental changes to food web dynamics and water quality. The magnitude of this effect has been assessed as low due to the temporary presence of cable installation vessels in what is already a busy shipping region and the likelihood that ballast water will be discharged away from the project area. The overall impact significance to water and sediment quality is assessed as **Minor.**

Accidental hydrocarbon or chemical spill

The presence of installation vessels will marginally increase the risk of a pollution incident. The running aground of a vessel or a collision could lead to a fuel spill. In addition, cleaning fluids, oils and hydraulic fluids used onboard cable laying vessels and during ROV operation could be spilled overboard or accidentally discharged. The marine environment is highly sensitive to hydrocarbon and chemical spills which can have major ecological effects. The magnitude of the potential effect is low to high and is dependent on the nature and size of a spill. Mitigation measures are therefore required to remove the risk of accidental hydrocarbon or chemical spill. The overall impact significance is assessed as **None.**

Disturbance of Munitions

Munitions, if disturbed, represent a significant potential risk, both to the installation vessel and personnel as well as other sea users and water and sediment contamination. The sensitivity to water and sediment quality has therefore been assessed as high.

The risk of encountering munitions along the cable route has been assessed (Bactec, 2013) as low to medium offshore (median line to KP592) increasing to medium or high in the nearshore zone which was subjected to wartime activity. The magnitude of the risk has therefore been assessed as medium. The overall impact significance is assessed as **Moderate.** Mitigation measures are therefore required to remove the risk of encountering munitions.

8.5.2 *Operation*

Potential effects during operation would occur only during survey activity or repairs to the installed marine cables. These effects would be the same as described for the main installation activities but on a much smaller scale. Quantities of any operational discharges of dissolved contaminants will be small relative to the other direct inputs to the water column.

8.6 Mitigation

8.6.1 *Installation*

Sediment disturbance

- Micro-routing to avoid disposal sites and drill cuttings piles.

Contamination from vessel discharges

- All vessels associated with cable installation will comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations.

Introduction of non native species from the disposal of ballast waters.

- Installation vessels will follow IMO ballast water management guidelines and/or European interim strategies (prior to the entry into force of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (EMSA, 2008)), developed to reduce the risk of the introduction of non-native species into the marine environment.

Accidental hydrocarbon or chemical spill

- All installation vessels will be compliant with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations. These regulations cover the prevention of pollution from accidents and routine operations.
- Mitigation measures will be taken to minimise the risk of collision between installation vessels and other vessels. All vessels will have shipboard oil pollution emergency plans (SOPEP) in operation.

Disturbance of Munitions

- Pre-installation ROV survey will be used to identify any obstructions to the route immediately prior to installation.
- Detailed routing will avoid any contacts identified as unexploded ordnance.
- Awareness training will be given to all personnel working on the site, and the survey and installation contractors will be required to have procedures in place for dealing with any munitions that are encountered during their operations.
- A registered explosives and ordnance disposal specialist will be available during the installation works to identify any suspicious items and provide advice on the appropriate remediation.

8.6.2 *Operation*

The operation of the marine cables will have little or no effect on water or sediment quality. Mitigation measures required during cable maintenance or repair activities are the same as those for installation.

8.7 Residual Impacts

Sediment disturbance

There are two key areas of concern:

- Avoidance of the Tyne Industrial disposal, which will be considered for micro-routing;
- Potential for re-suspension of drill cuttings. A literature review has been carried out, which established that there will be no significant toxicological effects.

Therefore it is not anticipated that the Norway-UK Interconnector project will have any significant impacts on the objectives of the WFD and MSFD.

Vessel emissions, introduction of non native species from the disposal of ballast waters, accidental spillage and disturbance of munitions.

With mitigation measures in place, no significant residual impacts are anticipated.

8.8 References

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9 PROTECTED SITES & SPECIES

9.1 Introduction

This Section identifies and assesses the potential installation and operational impacts on protected sites and species and identifies appropriate mitigation measures to remove, reduce or offset any predicted adverse impacts.

Receptors considered in this Section include the species and habitats protected under European Directives or National legislation.

The potential impacts on protected sites and species are inter-related with impacts upon benthic and intertidal communities, fish and shellfish, marine birds, and marine mammals. Species are considered thoroughly in their relevant sections (Sections 10, 11, 12, and 13). This Section considers the protected sites and designations.

9.2 Data Sources

Data sources used to inform this Section include but are not limited to the following:

- Constraints Study (Intertek Metoc, 2010).
- Data published on the JNCC, SNH, Marine Scotland and Natural England websites
- Environmental Survey Report (MMT, 2012; MMT, 2013)
- Intertidal Habitat survey (CMACS, 2012)
- Net Gain Project (2011)

9.3 Methods

9.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on protected sites and species have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

9.3.2 Magnitude of Impact

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential impact and takes into account the duration of an impact for example whether it is temporary or permanent and direct or indirect. Criteria for describing the magnitude of impact are described in Table 9-1.

Table 9-1: Magnitude Criteria

Magnitude	Description
High	Long-term (greater than 1 year) damage or loss to the structure/integrity of the total habitat and/or associated species of existing designated sites or potential Annex I Habitat (PAIH) sites. In the case of PAIH the impact could result in its failure to qualify as a potential Annex I Habitat under EC definitions.
Medium	Medium term (less than 1 year) damage or loss to the structure/integrity of the total habitat and/or associated species of existing national / international designated sites or PAIH sites.
Low	Small scale or short-term damage or loss to the structure/integrity of existing national / international designated sites or PAIH sites, and no long-term noticeable impacts above the levels of natural variation experienced in the area.
Negligible	No measurable direct or indirect impacts that would compromise the integrity of designated site.

9.3.3 *Sensitivity or Importance of Receptor*

The sensitivity of the baseline conditions has been assessed according to the relative importance of the protected sites and species present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance) and the capacity to absorb change.

The sensitivity of protected species and habitats has been assessed in accordance with the criteria outlined in Table 9-2.

Table 9-2: Sensitivity Criteria

Sensitivity	Description
Very High	The receptor has little or no capacity to absorb change without fundamentally altering its present character, is of very high environmental value, and/or is subject to one of the following levels of designation: An internationally designated site or candidate site (SPA, pSPA, SAC, SCI, cSAC, pSAC, dSAC, and/or Ramsar site). A viable area of a habitat listed in Annex I of the Habitats Directive or smaller areas of such habitat that is essential to maintain the viability of a larger whole (PAIH). A regularly occurring, nationally significant population/number of any internationally important species. Regularly occurring, globally threatened species (i.e. IUCN Red listed) or species listed on Annex 1 of the Berne Convention. Regularly occurring populations of internationally important species that are rare or threatened in the UK or of uncertain conservation status.
High	The receptor has low capacity to absorb change without fundamentally altering its present character, is of high environmental value and/or is designated as a Natura 2000 site or a Ramsar Site or is a designating feature of conservation interest.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has environmental

Sensitivity	Description
	value, and/or is a designating feature or feature of conservation interest of national importance e.g. SSSI pMPA, pMCZ.
Low	The receptor is tolerant of change without detriment to its character, and/or is of local importance e.g. impacts on species and habitats not protected by international legislation, and has moderate to high recoverability.
Negligible	The receptor is resistant to change irrespective of designation status.

9.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6.4 and also using professional judgement. The significance of a given impact is based on a combination of the magnitude of a potential impact and the sensitivity or importance of the receptor. Impacts are identified as Beneficial or Adverse and their significance as Major, Moderate, Minor or None. The term 'None' denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account any mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts identified as Minor or Negligible are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. The full results of the assessment of impact significance are presented in Appendix 2.3.

9.4 Existing Conditions

Sites of nature conservation interest are designated to protect them from development and other activities that may affect their biodiversity interest. There are a wide range of national and international statutory designations within the project area that vary in their level of importance and protection.

The designated areas which include habitats and species which could potentially be impacted by the Project are shown in Figure 9.1 and 9.2 (Appendix 1) and are described below:

9.4.1 Existing Protected Areas

Site of Special Scientific Interest (SSSI)

A SSSI is an area of land or water notified under the UK Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000). SSSIs provide legal protection for areas of special interest by reason of their flora, fauna, or geological features. All SSSIs noted for their important bird assemblages are also designated as Ramsar sites in England.

The proposed marine cable route corridor passes through the Northumberland Shore SSSI for a distance of approximately 156m, on the approach to the cable landing at Cambois Beach North. This protected area includes most of the coastline between the Scottish border and the Tyne Estuary and consists largely of sandy bays separated by rocky headlands (NCC, 2010). The section of the SSSI intersected by the proposed cable route consists of littoral sediment habitat important to wading birds (NE, 2013). This site provides wintering grounds for shore birds and is of international or national importance for six species: purple sandpiper (*Calidris maritima*); turnstone *(Arenaria interpres*); sanderling (*Calidris alba*); golden plover (*Pluvialis apricaria*); ringed plover (*Charadrius hiaticula*); and redshank (*Tringa totanus*). The Northumberland Shore SSSI also supports other shorebirds in winter including curlew (*Numenius arquata*), oystercatcher (*Haematopus ostralegus*), dunlin (*Calidris alpina*), knot (*Calidris canuta*), bar-tailed godwit (*Limosa lapponica*) and lapwing (*Vanellus vanellus*). In summer Arctic and little terns breed on the shores, and the inter-tidal zone is favoured throughout the year as feeding grounds for eiders, which are present along the coast in nationally important numbers.

Creswell and Newbiggin Shore SSSI is approximately 400m north of the proposed cable landfall at Cambois Beach North, and has been designated as an area of national importance for its geological exposures of Northumberland Coalfield of middle Carboniferous strata. Due to its geological status this protected area has been considered fully in Section 7.

Further details of the SSSI sites are provided in Table 9-4.

Ramsar Sites
Ramsar sites are wetlands of international importance, designated under the Ramsar Convention of Wetlands, and protected as European sites (as set out in The Conservation of Habitats and Species Regulations 2010). The vast majority are also classified as Special Protection Areas (SPAs) and all Ramsar sites in England are also notified as sections of SSSIs. The proposed cable landing at Cambois Beach North, passes approximately 1.3km to the north of

the Northumbria Coast Ramsar site. The site is notable for the occurrence of six bird species and populations at levels of international importance as outlined below in Table 9-4.

Special Protection Areas (SPA)

A SPA is a strictly protected site of international conservation importance for rare and vulnerable birds as listed on Annex I of the EC Directive 2009/147/EC (Birds Directive) on the conservation of wild birds (codified version), and for regularly occurring migratory species. The Directive provides a framework for the conservation and management of, and human interactions with wild birds in Europe, protecting birds through the establishment of a network of SPAs comprising all the most suitable territories for these species.

In the UK, the provisions of the Birds Directive are implemented through the Wildlife & Countryside Act 1981 (as amended), the Conservation (Natural Habitats, & c.) Regulations 2010 (as amended); the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) as well as other legislation related to the uses of land and sea.

As birds are also mobile species, those birds protected by SPA designation are not only protected at the site itself, but also afforded protection away from the SPA throughout their range. For this reason, SPAs in close proximity to the proposed project, and those SPAs designated for target species, whose foraging ranges overlap with the site have been included (see Table 9.4).

The proposed marine cable route corridor passes in close proximity (approximately 1.3km) to the Northumbria Coast SPA and Ramsar Site (see Figure 9.1; Appendix 1). This SPA includes much of the coastline between the Tweed and Tees Estuaries in north-east England. In summer, the site supports important numbers of breeding little tern (*Sterna albifrons*), whilst in winter the mixture of rocky and sandy shore supports large numbers of turnstone (*Arenaria interpres*) and purple sandpiper (*Calidris maritime*). These species may be present in the coastal area of the proposed marine cable route corridor. The potential impacts of the Project specifically to birds are considered in more detail in Section 12 – Ornithology.

Special Areas of Conservation (SAC)

SACs are areas of land or water of international conservation importance designated under the EC Habitats Directive (92/43/EEC) and relate to habitat or species types which are listed for protection under Annexes I and II of the Directive. Designations under The Habitats Directive aim to maintain or restore natural habitats and wild species listed on the Annexes to the Directive at a favourable conservation status. In order to achieve this, the Directive requires member states to set up a network of protected sites to protect and restore habitats and species as listed on the Annexes.

The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) and The Conservation of Habitats and Species Regulations 2010 transpose the Habitats Directive into UK national law.

The Berwickshire and North Northumberland Coast SAC is the closest SAC, approximately 24km north of the proposed marine cable route. This site encompasses the Farne Islands (approximately 51km north of the proposed marine cable route corridor), which is an important area for both bird and marine mammal species. The islands provide extensive haul out areas for the Annex II listed grey seal (*Halichoerus grypus)* which is also primary reason for selecting the area as a SAC. The area comprises a number of Annex I habitats, which are a primary reason for designation. Further details of this site are provided in Table 9.4.

Together SACs and SPAs make up the Natura 2000 ecological network. If an activity has the potential to have a significant adverse impact on the conservation features for which a Natura site is designated, and that activity is not directly connected with the management of the site for nature conservation, then the proposal will be subject to an 'Appropriate Assessment'. This applies to the qualifying interests and conservation objectives of the Natura site, no matter how far away from that site the impact originates. A competent authority must not authorise a plan or project unless, by means of the appropriate assessment, they can ascertain that it will not adversely affect the integrity of a Natura site.

Marine Conservation Zones (MCZ)

Marine Conservation Zones are designated under the Marine and Coastal Access Act, 2009 to protect areas that are important to conserve the diversity of nationally rare or threatened and representative habitats and support functioning communities of species. An aim of MCZs is to complement existing marine protected areas such as SACs and SPAs. Social and economic factors are also taken in to account when identifying and designating possible sites. The JNCC and Natural England, as the Government's advisers on the natural environment, have reviewed 127 rMCZs, and designated 27 sites to date. Natural England has a statutory responsibility to provide conservation advice that sets out each MCZ conservation objectives and the operations that may impact on the features of the site.

Table 9-3: Summary of Existing Protected Areas

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
SSSI	Northumberland Shore	The Northumberland shore consists largely of sandy bays separated by rocky headlands with wave-cut platforms, backed by dunes or soft and hard cliffs. Discrete areas of estuarine intertidal mudflats and saltmarsh are also included. Supports two species of shorebirds that occur in internationally important numbers: Turnstone (*Arenaria interpres*)	Intersected by the cable route corridor

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
		Purple Sandpiper (*Calidris maritima*). Species occur in nationally important numbers: Sanderling (*Calidris alba*) Golden Plover (*Pluvialis apricaria*) Ringed Plover (*Charadrius hiaticula*) Redshank (*Tringa totanus*).	
SSSI	Creswell and Newbiggin Shore	Consists of the best exposure in the Northumberland Coalfield of Middle Carboniferous strata belonging to the Upper similis-pulchra Biozone. It includes a thick sequence from the High Main Seam to the Vanderbeckei Marine Band, and is the highest part of this coalfield to be well exposed.	400m north of the cable corridor
Ramsar Site	Northumbria Coast	Species regularly supported during the breeding season: Little Tern (*Sterna albifrons*) Species with peak counts in winter: Purple Sandpiper (*Calidris maritima*) Ruddy Turnstone (*Arenaria interpres*)	1.3km north of the cable corridor & 2.3km south of the cable corridor
SPA	Northumbria Coast	Supports Populations of European Importance: Annex I Species, during the breeding season: Little Tern (*Sterna albifrons*) Annex I Species, over winter: Turnstone (*Arenaria interpres*) Purple Sandpiper (*Calidris maritima*)	1.3km north of cable corridor 2.3km south of cable corridor
SPA	Coquet Island	Supports Populations of European Importance: Annex I Species, during the breeding season:	19.3km north of the cable route corridor

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
		Arctic Tern (*Sterna paradisaea*) Common Tern (Sterna hirundo) Roseate Tern (*Sterna dougallii*) Sandwich Tern (*Sterna sandvicensis*) Supporting populations of European importance of the following migratory species: During the breeding season: Puffin (*Fratercula arctica*) Internationally important assemblage of birds. During the breeding season, the area regularly supports 33,448 individual seabirds.	
SAC	Berwickshire and North Northumberland Coast	Features of European Importance: Annex I habitats: Mudflats and sandflats not covered by seawater at low tide Large shallow inlets and bays Reefs Submerged or partially submerged seacaves Annex II species: Grey Seal (*Halichoerus grypus*) This SAC is representative of grey seal Halichoerus grypus breeding colonies in the south-east of its breeding range in the UK. It is the most south-easterly site selected for this species, and supports around 2.5% of annual UK pup production (JNCC, 2013a).	24km north of the cable route corridor
SPA	Teesmouth and Cleeveland	Supports Populations of European	49km south of the cable

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
	Coast	Importance: Annex I Species during the breeding season: Little Tern (*Sterna albifrons*) Annex I species on passage: Sandwich Tern (*Sterna sandvicensis*) Supporting populations of European importance of the following passage species: Ringed Plover (*Charadrius hiaticula*) Supporting populations of European importance of the following migratory species: Knot (*Calidris canutus*) Redshank (*Tringa totanus*) Designated a wetland of international importance by regularly supporting at least 20,000 waterfowl. During migration it is possible that some passage birds from this SPA may be observed in the inshore area of the proposed marine cable route corridor on passage to overwintering or breeding areas. These include sandwich tern and ringed plover (Birdlife International, 2013).	corridor
SPA	Farne Islands	Supports Populations of European Importance: Annex I Species, during the breeding season:	51.5km north of the cable corridor

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
		Arctic Tern (*Sterna paradisaea*) Common Tern (*Sterna hirundo*) Roseate Tern (*Sterna dougallii*) Sandwich Tern (*Sterna sandvicensis*) Supporting populations of European importance of the following migratory species: During the breeding season: Guillemot (*Uria aalge*) Puffin (*Fratercula arctica*) Designated a seabird assemblage of international importance The Farne Islands are a group of low-lying islands 2-6km off the coast of the Northumberland. The islands are important as breeding areas, especially for terns, gulls and auks. The seabirds feed outside the SPA in the nearby waters, as well as more distantly in the North Sea (JNCC, 2013b). There is potential that arctic tern, kittiwake and guillemot is able to forage from this SPA in the vicinity of the proposed marine cable route corridor. Puffin can also travel up to 100km but are more likely to be fishing within 10km of their colony depending upon food availability (Birdlife International, 2013).	
SPA	Lindisfarne	Supports Populations of European Importance: Annex I Species, during the breeding	52km north of the cable corridor

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
		season: Little Tern (*Sterna albifrons*) Annex I Species, over winter: Bar-tailed Godwit (*Limosa lapponica*) Golden plover (*Pluvialis apricaria*) Whooper Swan (*Cygnus cygnus*) Supporting populations of European importance of the following migratory species: On Passage: Ringed Plover (*Charadrius hiaticula*) Over Winter: Grey Plover (*Pluvialis squatarola*) Greylag Goose (*Anser anser*) Knot (*Calidris canutus*) Light-bellied Brent Goose (*Branta bernicla hrota)* Wigeon (*Anas penelope*) Encompasses the island of Lindisfarne (Holy Island) and extensive mud flats south of the island at Budle Bay. The island incorporates a range of coastal habitats and is an important food source for wintering birds. It is possible that tern species could be foraging from their breeding colonies on Holy Island to the shallow waters in the vicinity of the proposed marine cable route corridor (Birdlife International,	

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
		2013).	
SPA	Forth Islands SPA	Supports Populations of European Importance: Annex I Species, during the breeding season: Arctic Tern (*Sterna paradisaea*) Common Tern (*Sterna hirundo*) Roseate Tern (*Sterna dougallii*) Sandwich Tern (*Sterna sandvicensis*) Supporting populations of European importance of the following migratory species: During the breeding season: Gannet (*Morus bassanus*) Lesser Black–backed Gull (*Larus fuscus*) Puffin (*Fratercula arctica*) Shag (*Phalacrocorax aristotelis*) Designated a seabird assemblage of international importance. Assemblage bird species which may be present, foraging from this SPA in the vicinity of the proposed cable route corridor are fulmar and gannet (Birdlife International, 2013).	127km north of the cable corridor
SPA	Flamborough Head and Bempton Cliffs	Supporting populations of European importance of the following migratory species:	135km south of the cable corridor

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
		During the breeding season: Kittiwake (*Rissa tridactyla*) Designated a seabird assemblage of international importance by regularly supporting at least 20,000 seabirds. The site supports large numbers of breeding seabirds including the only mainland-breeding colony of Gannet (Morus bassanus) in the UK. The seabirds feed and raft in the waters around the cliffs, outside the SPA, as well as feeding more distantly in the North Sea (JNCC, 2013b). Assemblage bird species which may be present, foraging from this SPA in the vicinity of the proposed cable route corridor are gannet (Birdlife International, 2013).	
MCZ	Swallow Sand NG 16	Broad scale habitats: Subtidal coarse sediment Subtidal sand Habitats of conservation importance: Subtidal sands and gravels Subtidal coarse sediments typically include communities of anemones, polychaete worms (e.g. Pisione remota, Glycera lapidum), bivalve molluscs (e.g., Spisula elliptica), sea urchins (e.g., Echinocyamus pusillus) and both mobile and sessile epifauna. Subtidal sands were identified during the environmental survey of the proposed cable route through this	Intersected by the cable route corridor

Designation	Site Name	Description/Qualifying Interest	Distance from proposed cable route corridor
		MCZ.	
MCZ	North East of Farne Deep (previously Rock Unique) NG 15	Broad scale habitats: Low energy circalittoral rock Subtidal coarse sediment Subtidal sand Feature of conservation importance: Subtidal sands and gravelsNG15 supports a unique animal community of sea squirts (Ciona intestinalis, Ascidia mentula), dead man's fingers (Alcyonium digitatum), plumose anemones (Metridium senile), peacock worms (Sabella pavonina), bristleworms (Polychaeta), squat lobsters (Galathea squamifera), hermit crabs (Paguroidea) and a number of species of urchin (Echinoderm).	1.25 km north west of cable route
MCZ	Aln Estuary NG 13a	Broad scale habitats: Intertidal mud Coastal salt marshes and saline reed beds High energy infralittoral rock Feature of conservation importance: Estuarine rocky habitat Sheltered muddy gravels Subtidal sands and gravels This MCZ is an inshore site of approximately 0.4km2.	25km north of the cable route

9.4.2 *Possible Protected Areas*

Protected sites which have been proposed, but are not yet officially designated, have been considered in the assessment as if they were fully designated.

Many of the priority habitats and species identified in the UK Biodiversity Action Plan (BAP) have recently been taken forward as part of the 'UK Post 2010 Biodiversity Framework' (JNCC 2013c) and used to search for suitable marine areas for protection, such as the UK waters Marine Conservation Zones (MCZs) and Scottish Marine Protected Areas (MPAs). The proposed protected areas are shown in Figure 9.1 (Appendix 1) and described below.

Recommended Marine Conservation Zones (rMCZ)

As discussed above, Marine Conservation Zones are designated under the Marine and Coastal Access Act, 2009 to protect areas that are important to conserve the diversity of nationally rare or threatened and representative habitats and support functioning communities of species. The JNCC and Natural England, as the Government's advisers on the natural environment, have reviewed 127 rMCZs, and designated 27 sites to date. The rMCZs that are located in the vicinity of the proposed marine cable route have been considered as if they are designated.

Possible Marine Protected Area (pMPAs) – Scotland

pMPAs are areas designated under the Marine (Scotland) Act 2010 within Scottish Territorial Waters (12nm). Outside 12nm Scottish pMPAs are designated under the Marine and Coastal Access Act, 2009. These areas have been identified in recognition of features of national importance, and to meet international commitments for developing a network of MPAs. The Marine (Scotland) Act 2010 will protect areas that are important to conserve the diversity of nationally rare or threatened habitats and/or species, to complement existing Marine Protected Areas such as SACs and SPAs. The act allows for nature conservation areas, demonstration and research, and historical areas to be protected. Thirty three nature conservation pMPAs have been consulted upon (up to13th November 2013). A further four MPA search locations remain to be fully assessed. The outcome of the consultation is not currently known and are therefore considered for assessment purposes as designated.

Table 9-4: Summary of Proposed Protected Areas

Designation	Site Name (and code)	Description / Qualifying Interest	Distance from proposed cable route corridor
pMPA	East of Gannet & Montrose Fields (EGM)	Proposed protected features: Ocean quahog (*Arctica islandica*) aggregations (including sands and gravels as their supporting habitat) Offshore deep sea muds The aim is to conserve (*feature condition uncertain*)	Intersected by the cable route corridor

Designation	Site Name (and code)	Description / Qualifying Interest	Distance from proposed cable route corridor
		the proposed protected features within the possible MPA. Deep sea muds were identified which are considered suitable for supporting the colonisation of ocean quahog, however no Annex I habitats or aggregations of ocean quahog were identified during the benthic survey of the proposed cable route (MMT, 2012).	
rMCZ	Coquet to St Mary's NG 13	Broadscale habitats: High energy infralittoral rock Moderate energy infralittoral rock Moderate energy circalittoral rock Also identified for intertidal and subtidal mixed sediments and a diverse under-boulder community. Coquet Island - internationally important breeding seabirds. There were no features of conservation importance identified during the environmental survey of the proposed cable route through the rMCZ.	Intersected by the cable route corridor
rMCZ	Farnes East NG 14	Broad scale habitats: Moderate energy circalittoral rock Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediment Feature of conservation importance: Peat and clay exposures	27km north of the cable route
rMCZ	Fulmar NG 17	Broad scale habitats: Subtidal coarse sediment	45km south east of cable

Designation	Site Name (and code)	Description / Qualifying Interest	Distance from proposed cable route corridor
		Subtidal sand Feature of conservation importance: Subtidal sands and gravels Ocean quahog (Arctica islandica)	corridor

Potential Annex I Habitat (PAIH)

There are four marine habitats present in UK waters away from the coast for which the European Commission has stated that additional SACs must be designated. Habitat types listed on Annex I to the Habitats Directive include:

- Sandbanks which are slightly covered by seawater all the time;
- Reefs;
- Submarine structures made by leaking gases;
- Submerged or partially submerged sea caves.

JNCC and the Statutory Nature Conservation Bodies (SNCBs) are currently working to identify areas which may contain these habitat types, to put forward for designation. Possible areas have been mapped as Potential Annex I Habitat (PAIH). Areas identified as PAIH do not necessarily comprise Annex I habitats, and require verification via survey to confirm the presence and quality of PAIH.

An almost continuous 320km stretch of the coastline from North Berwick in south-east Scotland to Easington in north-east England has been identified by JNCC as being PAIH reef occurring within the designated Berwickshire and North Northumberland Coast European Marine Site. The PAIH are areas where available evidence suggests that Annex I reef may be present. The Northumberland rocky reefs PAIH are an important component of this European Marine Site and are widely occurring. The Annex I habitat, bedrock and stony reef, occurs where bedrock, boulders and cobbles arise from the surrounding seabed. This habitat has strong vertical zonation and can support a variety of benthic communities including corals, sponges and sea squirts as well as fish and crustaceans such as crabs and lobsters (JNCC 2012d).

Areas identified as potentially containing the Annex I habitat 'submarine structures made by leaking gases' were identified during the geophysical survey between KP 344 – KP 484, KP 384 – KP 544 and KP 368 – KP 484. The habitat is defined as rocks, pavements and pillars composed of carbonate cement that is produced by microbial oxidation of gases (mostly methane) that bubbles up from below the seabed. Methane derived authigenic carbonate (MDAC) is often found in association with pockmarks (shallow seabed depressions) that are generally formed in soft, fine grained sediments (Judd, 2001). Like reefs, the MDAC structures provide shelter for many species such as crabs, conger eels and wolfish but they also support a unique community of chemosynthetic organisms that are able to survive on the methane and hydrogen sulphide gases (JNCC, 2014).

JNCC and the Statutory Nature Conservation Bodies (SNCBs) are currently working to identify areas which may contain these habitat types, to put forward for designation. There was no indication from the survey data that the MDAC identified was 'spectacular' or currently active.

9.4.3 Protected Species

Certain species present in the vicinity of the proposed marine cable route corridor are afforded protection under either the Habitats Directive (Council Directive 92/43/EEC), UK Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000), the Wildlife & Countryside Act 1981 (as amended), and/or the Conservation (Natural Habitats, & c.) Regulations 2010 (as amended). These species are considered and assessed in the relevant Sections of the Environmental Statement (Section 11 - Fish and Shellfish, Section 12 - Marine Mammals and Section 13 - Ornithology). A summary of the protected species likely to be present in the vicinity of the proposed marine cable route corridor and their associated protection measures is provided in Table 9-6.

Table 9-5: Summary of Species Protection Measures

Legislation	Protected species likely to be in the project vicinity
Habitats Directive - Annex II Species whose conservation requires designation of SAC. The proposed marine cable route corridor does not pass through a SAC, however the installation and operation of the marine cable may impact on interest features from a SAC within the species range.	Grey seal *(Halichoerus grypus),* common seal (*Phoca vitulina*), harbour porpoise *(Phocoena phocoena)*, bottlenose dolphin *(Tursiops truncatus)*, river lamprey (*Lampetra fluviatilis*) sea lamprey (*Petromyzon marinus*), Allis shad (*Alosa alosa*) and Atlantic salmon (*Salmo salar*). (see Sections 11, 12 and 13)
Habitats Directive - Annex IV Annex IV of the Habitats Directive lists species in need of special protection measures. Any Annex IV species occurring within UK waters are known as European Protected Species (EPS). In UK waters, all cetaceans, turtles and the Atlantic sturgeon are considered EPS. It is an offence under the Offshore Marine Conservation (Natural Habitats & c) Regulations 2007 (as amended) to deliberately capture, injure, kill or disturb any wild animal of an EPS.	Bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhynchus albirostris*), harbour porpoise (*Phocoena phocoena*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), killer whale (*Orcinus orca*) and minke whale (*Balaenoptera acutorostrata*). (see Section 13)
Habitats Directive - Annex V Species of community interest, whose taking in the wild and exploitation may be the subject of management measures.	River lamprey (*Lampetra fluviatilis*), Allis shad (*Alosa alosa*), Atlantic salmon (*Salmo salar*), grey seal *(Halichoerus grypus)* and common seal (*Phoca vitulina*). (see Sections 11 and 13)

Legislation	Protected species likely to be in the project vicinity
The Birds Directive Provides protection of habitats for endangered as well as migratory species, especially through the establishment of a coherent network of SPAs.	Arctic tern (*Sterna paradisaea*), common tern (*Sterna hirundo*), roseate tern (*Sterna dougallii*), sandwich tern (*Sterna sandvicensis),* ringed plover (Charadrius hiaticula), knot (*Calidris canutus*), redshank (*Tringa totanus*), turnstone (*Arenaria interpres*), purple sandpiper (*Calidris maritime*),bar-tailed godwit (*Limosa lapponica*), golden plover (*Pluvialis apricaria*), whooper swan (*Cygnus cygnus*), ringed plover (*Charadrius hiaticula*), grey plover (*Pluvialis squatarola*), greylag goose (*Anser anser*), light-bellied Brent goose (*Branta bernicla hrota*), wigeon (*Anas penelope*), gannet (*Morus bassanus*), guillemot (*Uria aalge*), puffin (*Fratercula arctica*), lesser black–backed gull (*Larus fuscus*), shag (*Phalacrocorax aristotelis*), kittiwake (*Rissa tridactyla*)
UK Biodiversity Action Plan (BAP) Species are identified as being the most threatened and requiring conservation action under the UK BAP.	Cod (*Gadus morhua*), plaice (*Pleuronectes platessa*), sea trout (*Salmo trutta*), basking shark (*Cetorhinus maximus*), tope (*Galeorhinus galeus*), porbeagle (*Lamna Ditropis*), lesser sandeel (*Ammodytes marinus*), common seal (*Phoca vitulina*), harbour porpoise (*Phocoena phocoena*), mackerel (*Scromber scrombus*), bottlenose dolphin (*Tursiops truncates*), white-beaked dolphin (*Lagenorhynchus albirostris*), minke whale (*Balaenoptera acutorostrata*), herring (*Clupea harengus*).
OSPAR OSPAR has established a list of threatened and/or declining species and habitats in the North-East Atlantic. Based on a defined criteria (of decline, in terms of population, distribution and condition of species, and distribution, extent and condition of habitats), there are currently 42 marine species listed.	Cod (*Gadus morhua*), salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), and Ocean quahog (*Arctica islandica*).

Legislation	Protected species likely to be in the project vicinity
The Wildlife and Countryside Act 1981 (as amended) This act makes it an offence (subject to exceptions) to intentionally kill, injure, take, possess, or trade in certain species within English and Welsh waters. In Scottish waters under the Nature Conservation (Scotland) Act 2004, the measures have been extended to include any 'reckless' acts. The Act provides for the notification and confirmation of SSSIs.	Wild bird species, angel shark (*Squatina squatina*), basking shark (*Cetorhinus maximus*), sturgeon (*Acipenser sturio*), Allis shad (*Alosa alosa*) and Twaite shad (*Alosa fallax*).
IUCN Red List of Threatened and Endangered Species The IUCN Red List asses the conservation status of species, subspecies, varieties, and even selected subpopulations on a global scale in order to highlight taxa threatened with extinction, and therefore promote their conservation.	European eel *(Anguilla anguilla*), river lamprey (*Lampetra fluviatilis*), sea lamprey (*Petromyzon marinus*), Atlantic sturgeon *(Acipenser sturio*), Twaite shad *(Alosa fallax*), angel shark *(Squatina squatina)*, basking shark (*Cetorhinus maximus*), spurdog *(Squalus acanthias),* Porbeagle *(Lamna nasus),* common skate (*Dipturus batis*), spotted ray (*Raja montagui*), thornback ray (*Raja clavata*) and white skate (*Raja alba*).

9.5 Potential Impacts

Potential impacts have been identified for protected fish, bird, seal and cetacean species. These impacts are discussed in detail in the corresponding sections (Sections 11 - Fish and Shellfish, Section 12 - Ornithology and Section 13 - Marine mammals) and are summarised in Appendix 2.6. The impacts discussed in this section focus on the integrity of the designated sites.

9.5.1 Installation

Direct disturbance/removal of intertidal protected habitat (trenching/jetting)

SSSI & Coquet to St Mary's rMCZ

Cable burial within the intertidal area is to be achieved by trenching. The cable trench is expected to be 1-2 m wide and approximately 1.5-2m deep. This will transect approximately 270m of the Northumberland Shore SSSI (footprint of 0.001km^2). Sediments within the SSSI at Cambois Beach North consist of predominantly medium sand with some coarse sand (CMACS, 2012). A high proportion of benthic invertebrates within the installation footprint such as amphipods, isopods, polychaetes and bivalve molluscs are likely to be lost through mortality or displacement. However these species are regularly disturbed by tidal and wave action and can recover quickly from any physical disturbance by being highly mobile and tend to be short-lived, fast maturing and fecund (this includes intertidal bivalves). Therefore re-colonisation of habitat is expected relatively quickly (CMACS, 2012).

The sensitivity of the Northumberland Shore SSSI and Coquet to St Mary's rMCZ to habitat removal is assessed as having a medium sensitivity due to the absence of PAIH and broadscale habitats of conservation importance within the footprint of the cable installation. The loss of prey items for protected species feeding within the SSSI/rMCZ will be extremely localised, occur for a short period of time, and result in a low level of change to the integrity of the protected sites. Therefore the magnitude of the impact is expected to be low. The overall significance of the impact is assessed as **Minor.**

Direct disturbance/removal of sub tidal protected habitat (jetting)

The preferred burial option in the subtidal area is jetting. Cable installation by jetting will cause direct disturbance and removal of sublittoral habitats within the footprint of the installation tool. This is calculated to be approximately 6.8km^2 across the entire UK route. During jetting soft sediments are fluidised and disturbed fauna and flora directly in the cable route are likely to be displaced or destroyed and there is potential for an installation scar to be formed. However, approximately 80% of the disturbed sediment is expected to fall directly back in to the trench naturally backfilling after the cable has been installed. Soft seabed sediments such as those in the North Sea have the capacity to recover quickly from disturbance. Species are likely to re-colonise the area relatively quickly after installation.

The impacts of habitat removal have been assessed separately for each protected area.

Coquet to St Mary's rMCZ

Coquet to St Marys rMCZ has been identified for subtidal rock and sediment features which support intertidal under boulder communities and estuarine rocky habitats of conservation importance. During the intertidal survey, no evidence of intertidal under-boulder communities or other UKBAP habitat features of conservation interest have been identified within the footprint of the proposed cable route corridor. A review of the benthic survey data (MMT, 2012; 2013) identified areas of low grade PAIH rocky reef, which have subsequently been avoided with careful cable routing. Therefore due to the absence of protected features of conservation interest the sensitivity of the protected site to habitat removal is low within the footprint of the proposed cable route corridor. The loss of habitat will be extremely localised, and result in a low level of change to the integrity of the protected site. Species are expected to re-colonise the area relatively quickly. Therefore the magnitude of the impact has been assessed as low and the significance of the impact is **None**.

Swallow Sand MCZ

The proposed marine cable route enters the corner of the MCZ Swallow Sand for approximately 1.3km (footprint of approximately 0.026km^2). During the intertidal survey, within the MCZ, subtidal coarse sediment - sands and gravels were identified within the footprint of the proposed cable corridor. Broadscale habitats, for which this MCZ is designated, will be disturbed during the installation of the marine cable. Therefore the sensitivity of this has been assessed as high.

The MCZ is approximately 4,746km^2 in size. The cable footprint within the MCZ is < 0.001% of the total area of the MCZ. The cable was initially routed around the MCZ to avoid the protected area. However since finalising the boundaries of the MCZ areas in conjunction with establishment of the North East Marine Plan Area, the MCZ boundary has shifted so that the proposed marine cable is now just within the MCZ boundary. The small spatial extent of the disturbance, the absence of species of conservation interest identified during the environmental survey, and the high recoverability of soft sediments, suggests that the magnitude of the disturbance will be negligible. Therefore the significance of the impact to the integrity of the Swallow Sands MCZ is considered to be **Minor**.

Possible East of Gannet and Montrose Fields pMPA

The proposed marine cable route corridor intersects the East of Gannet and Montrose (EGM) pMPA for approximately 15km. This area is designated due to the ocean quahog (*Arctica islandica*) aggregations and presence of offshore deep sea muds (shelf). In addition it also contains offshore subtidal sand and gravel habitat, considered suitable for ocean quahog colonisation and may promote distribution of the species in the future.

The OSPAR and BAP listed habitat ‘Sea-pens and burrowing mega fauna in circalittoral fine mud’ were found to dominate the proposed cable route corridor through the pMPA, interspersed with deep circalittoral mixed sediments. Species identified in this habitat include sea-pen (*Virgularia mirabilis*), the lesser cylinder-anemone (*Cerianthus lloydii*), hermit crabs (*Pagurus bernhardus*) and sea stars, (*Asteroidea*). Due to the presence of the UKBAP habitat ‘offshore deep sea muds’ within the cable footprint, the sensitivity of the EGM pMPA proposal has been assessed as high. However mud habitats in deep water are the most common and abundant deep sea habitats in the UK offshore marine environment (JNCC, 2013e).

When the proposed cable route was surveyed, the pMPA was considered a search area, and the lack of ocean quahog aggregations in this sector of the pMPA indicated that it may be less likely to be designated. However during the finalisation of this report, the boundaries of the pMPAs have been set and the proposed route now intersects the pMPA.

The pMPA is 1,838km^2 in size. The size of the cable corridor installation footprint is approximately 0.3km^2 equivalent to 0.016% of the total area of the pMPA. Due to the small spatial extent of the removal, the absence of ocean quahog aggregations and their supporting habitat and the high recoverability of soft sediments, the magnitude of the disturbance has been assessed as negligible. Therefore the significance of the impact to the integrity of the EGM MPA proposal is considered to be **Minor**.

Disturbance of protected habitat (anchor placement)

The cable route passes through EGM pMPA and Swallow Sands MCZ offshore. A dynamically positioned (DP) installation vessel will be used offshore, therefore no impact from anchor placement are expected within these protected areas.

In the nearshore area, the route passes through Northumberland Shore SSSI and Coquet – St Mary's rMCZ in the approach to the landfall. Anchors may be required in shallow waters to maintain vessel position and/or to position the cable lay barge while the cables are pulled to shore. No Annex I habitat or species of conservation importance were identified within the footprint of the cable route corridor, therefore no impacts are expected. Anchor impact is not expected to be greater than existing vessel anchor disturbance in the region. Therefore the sensitivity of protected sites and species to disturbance by anchor has been assessed as low. The magnitude is assessed as low. The significance of the impact has been assessed as **None**.

Change of habitat due to cable protection

The installation of external cable protection (rock berms or concrete mattressing) will introduce new hard substrate for colonisation. This has the potential to change local habitat characteristics especially in areas of soft/sandy sediments. The hard substrate may act as an artificial reef, supporting a new range of benthic epifauna that prefer harder substrates, with a resulting community feeding on them. The sensitivity of protected areas to the presence of installed cable protection has been assessed as high as the substrate change will result in a fundamental change to the character of the localised habitat.

Rock placement will only be used where burial of the cables is not possible (at crossings) or where the target burial depths are not achievable. Rock placement will smother and destroy sessile organisms that are unable to move away from the operation. The level of habitat change is dependent on existing sediment characteristics. Rock placement requirements have been calculated to be approximately 9.6km or approximately 2.8% of the total length of the route in UK waters. There are no crossings with other cables or pipelines within protected areas along the UK section of the proposed cable route corridor. However there are sections of the cable route within the Swallow Sands MCZ and EGM pMPA which may require additional cable burial due to the presence of shallow sediments and where fishing activity (trawling) requires rock placement to provide adequate cable protection for cable and fishing vessel safety. The areas where rock placement is predicted to be required within protected areas is outlined in Table 9.7 below.

Table 9-6: Habitat change by rock placement

Protected Area	Habitat impacted	Length of Estimated rock placement	Estimated Area of rock protection (km^2 per cable)	Protected Area (km^2)	% of protected area impacted per cable
Swallow Sands MCZ	Subtidal gravel or sand and gravel	743m	0.0052	4,746	0.0001%
EGM pMPA	Offshore deep sea muds	735m	0.0051	1,838	0.0003%

As both these protected areas have broad-scale habitats (for which they were identified) within the footprint of the cable route corridor, the sensitivity of the protected areas to rock dumping has been assessed as high.

Within Swallow Sands, rock placement will have a low level of change to subtidal gravel or sand and gravel. In addition the proposed cable route corridor represents a very small proportion of the overall protected area (0.0001% per cable) and total available habitat. Therefore the magnitude of the impact of rock placement to Swallow Sands MCZ has been assessed as negligible and the significance of the impact is **Minor**.

Within the EGM pMPA, the sediments consist of finer mud and the level of change to sediments from rock placement will be high. However no aggregations of ocean quahog were observed during the environmental survey of the proposed route. The route corridor represents a very small proportion of the total pMPA (0.0003% per cable). The small extent of the habitat change is not expected to have an impact to the overall integrity of the protected area. In addition this is a site of active deposition of fine sediments and the rock placement may eventually become buried, re-forming the natural habitat.

Therefore the magnitude of the impact to the EGM pMPA is assessed as negligible and the significance is **Minor**.

Increase in deposition from suspended sediments

Sediment dispersion varies depending on specific conditions e.g., sediment particle size distribution, current speeds etc. Sea bed current speeds across the cable route are generally low and tidally driven, indicating that dispersion of sediments will be limited to the immediate vicinity of the cable route corridor. Approximately 80% of sediment is expected to fall directly back in to the trench after jetting. The particle size distribution within remobilised sediment varies along the route, with more fine sediments being found in deep water. Fine material which could stay in the water column for longer comprises between 3 and 12%. This will be rapidly diluted and dispersed in the water column. Therefore, the deposition footprint will be limited.

Low energy deeper environments are less likely to experience sediment suspension and deposition from natural causes. Deposition will result mainly from anthropogenic sources, such as the use of trawling gear and oil and gas exploration. The presence of offshore deep sea muds habitats within the EGM pMPA indicate the possibility of the presence of ocean quahog, although surveys suggest that the aggregations occur in the north and west of the pMPA (Heriot-Watt, 2011) rather than close to the proposed cable route corridor. The distance from the known quahog aggregations and low current speeds in the area indicate that suspended sediments created by trenching are likely to be rapidly deposited close to the corridor and will not reach the species of conservation interest. Therefore species of conservation interest are unlikely to be impacted by an increase in deposition from suspended sediments.

In shallower higher energy environments elevated concentrations of suspended sediment are a normal feature and the habitat and associated species are therefore likely to be tolerant to increases in sediment deposition. The absence of broadscale habitats of conservation importance, BAP habitats and Annex I Habitats within rMCZ Coquet to St Mary's, indicates that a temporary increase in deposition from suspended sediments are unlikely to impact protected habitats in the near shore.

The sensitivity of protected areas to increased sediment deposition has been assessed as medium. All impacts of an increase in deposition will be very localised and temporary and therefore the magnitude of the impact is considered to be low. The significance of the impact to protected areas has therefore been assessed as **Minor**.

Introduction of non-native species from installation vessel ballast waters

Protected areas are considered to have a high sensitivity to the introduction of non-native species. Vessels commissioned to undertake the installation are likely to have only been operating in northern European continental shelf waters, and are unlikely to introduce invasive species from distinctly different biological areas. Therefore the possibility of invasive species being introduced is limited, and the magnitude of the impact has been assessed as negligible. The overall significance is considered to be **Minor.**

Accidental hydrocarbon or chemical release from installation vessel

Any release of surface pollutants, such as mineral oils and chemicals from vessels associated with the marine cables installation operations, have the potential to impact protected sites which encounter the pollutant at the surface or on the sea bed. However the key receptor for a chemical or hydrocarbon release are bird and marine mammal species within protected sites or foraging from them. The sensitivity for protected areas has been assessed as high as there is likelihood for protected species to be within the installation area.

Data showing the probability of a hydrocarbon or chemical release from installation vessels is not available. However, analysis of data from the Advisory Committee on Protection of the Sea (ACOPS) Annual Survey of Reported

Discharges shows that during the period 2002-2011 there was an average of 447 oil or chemical releases from vessels per year in the NSN region of the North Sea (ACOPS, 2002-2011). Of these incidents the majority occurred in the UKCS related to oil and gas activities; incidents within the north east England region were within ports and harbours. During 2011 there were no reported discharges from offshore support vessels. The magnitude has therefore been assessed as low, with an overall significance assessed as **Moderate**.

Pollution from discharge of grey water from installation vessel

Protected areas may be sensitive to the impacts of enrichment from the discharge of grey water. Vessels will not discharge grey water within 12nm of the coast. Discharges will be made in offshore waters where dilution and dispersion will be small quantities into a very large volume of water, during the installation period. While they may result in localised decreases in dissolved oxygen levels in surface waters, these will be extremely localised and temporary in nature.

The amount of grey water discharged is a marginal increase against background levels. Given the short timescale of the project, and the relatively small cumulative volume of food, water and sewage discharges, it is considered that the marine environment will be able to rapidly assimilate the discharges and deal with them through bacterial action. Neither organic enrichment nor oxygen depletion is therefore likely and the magnitude of the impact has been assessed negligible, with an overall significance of **minor**.

9.5.2 Operation

The proposed marine cable will be buried, where possible, beneath the seabed, and therefore no impacts to designated or potentially designated sites are anticipated during operation of the marine cables. The sensitivity of protected areas is considered to be low.

Potential impacts to protected species related to EMF and heating impacts are discussed in Section 11 (Fish and Shellfish), Section 12 (Ornithology) and Section 13 (Marine Mammals), where it is concluded that impacts on marine fauna will not be significant.

The marine cables have a design life of 40 years, however, during this period there may be a need for maintenance or repairs to be undertaken. Such impacts are likely to be highly localised in nature (i.e. confined to the section of the cable being repaired) and similar in nature to those described for marine cable installation.

9.6 Mitigation

9.6.1 Installation

Direct disturbance/removal of intertidal protected habitat (trenching/jetting and anchor placement)

- As agreed with Natural England, within the Northumberland Shore SSSI, installation activities will be undertaken outside of the period October - March, to avoid overwintering birds using the area.
- Restoration of intertidal habitat by backfilling will occur after construction.
- Construction works in the intertidal area will be restricted to a designated working area within which all construction activity and plant/vehicle movement will take place.

Introduction of non-native species from installation vessel ballast waters

- Installation vessels will follow IMO ballast water management guidelines and/or European interim strategies (prior to the entry into force of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (EMSA 2008)), developed to reduce the risk of the introduction of non-native species into the marine environment.

Accidental hydrocarbon or chemical release from installation vessel

- All vessels associated with cable installation will comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations.

9.7 Residual Impact

9.7.1 Installation

Direct disturbance/removal of intertidal protected habitat (trenching/jetting and anchor placement)

SSSI & Coquet to St Mary's rMCZ

Due to mitigation by design (avoidance of PAIH and broadscale habitats), the potential for removal of the intertidal protected habitat has been assessed as of minor significance. Restoration of habitats by back filling with the same sediment after the cable is positioned in the intertidal zone will help to restore habitat and enable rapid recolonisation and subsequent feeding habitat for foraging species. Benthic organisms within intertidal sediments are likely to be habituated to disturbance and are therefore likely to recover quickly. The magnitude of the impact is therefore reduced to negligible, and there is no impact to the integrity of the protected sites or features within the intertidal zone. The residual impact is **Not Significant.**

Direct disturbance/removal of sub tidal protected habitat

There are no mitigation measures in place to reduce the minor impact further. Soft sediments (such as those encountered across the proposed cable route) have high recoverability, and re-colonisation of the habitat is expected to occur quickly after installation. The impact remains as minor. Minor impacts are **Not Significant.**

Change of habitat

Rock placement within the protected areas is considered to be a very small footprint of the total protected areas. No mitigation measures are available to minimise the impact of habitat change due to the presence of the installed cable protection. Therefore the residual impact remains as minor and **Not Significant.** It should be noted however, that whilst not significant, the impact could be considered to be beneficial. Rather than changing the baseline by attracting new species to the area, it is more likely that existing species in the area will be using the new stable habitat and feeding on newly colonising fauna.

Increase in deposition from suspended sediments

There are no mitigation measures to reduce the impact of suspended sediment deposition from installation by jetting. The residual impact is minor and the level of deposition from suspended sediment is **Not Significant**

Introduction of non-native species from installation vessel ballast waters

With the implementation IMO ballast water management guidelines, the likelihood of the impact occurring has been reduced to ALARP and as such it has been assessed as having a minor residual impact. Minor impacts are assessed as **Not Significant.**

Accidental hydrocarbon or chemical release from installation vessel

With mitigation in place, the impacts to protected areas are minimised. The likelihood of pollution from project vessels is very low, the magnitude of the impact is reduced to negligible; therefore the residual impact has been assessed as minor. Minor impacts are **Not Significant.**

Pollution from discharge of grey water from installation vessel

Complying with MAPOL regulations will minimise the likelihood of release from installation vessels. With this mitigation in place, the impacts to protected areas are minimised. The likelihood of pollution from project vessels is very low; therefore the residual impact has been assessed as minor. Minor impacts are **Not Significant.**

9.8 References

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10 BENTHIC AND INTERTIDAL ECOLOGY

10.1 Introduction

This Section provides an overview of the existing benthic and intertidal ecology along and adjacent to the proposed marine cable route corridor. The assessment considers the potential impacts that the marine cable installation and operation may have on benthic and intertidal ecology and identifies appropriate mitigation measures to be implemented to avoid, reduce and offset potential adverse impacts.

10.2 Data Sources

Baseline conditions have been established by undertaking a desktop review of published information, undertaking environmental surveys and through consultation with relevant bodies. Data sources used in this assessment include but are not limited to the following:

- MMT Environmental Survey Report (May-June 2012 and May-June 2013) NSN, (MMT, 2013)
- Centre for Marine and Coastal Studies Ltd (CMACS) NSN Cable Landfall Intertidal Survey Report (CMACS, 2012)
- National Renewable Energy Centre (NAREC) Blyth Offshore Demonstration Project Environmental Statement, (2012) (NAREC, 2012)
- Strategic Environmental Assessment (SEA) reports for SEA 2 and SEA 3 (DTI, 2001; DTI, 2002)
- Department for Environment Food and Rural Affairs (Defra) (2013). Charting Progress 2, Benthic Habitats.

10.3 Methods

10.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on intertidal and benthic ecology have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

Methods used by the Marine Life Information Network for Britain and Ireland (MarLIN) have been used as the basis for the assessment of species and habitat sensitivity; guided by completed Biology and Sensitivity Key Information Reviews available on the MarLIN website (www.marlin.ac.uk).

10.3.2 Magnitude of Impact

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential impact and takes into account the likelihood of the impact occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of an impact are described in Table 10-1.

Table 10-1: Magnitude Criteria

Magnitude	Description
High	Major alteration to population levels (including through habitat availability or prey/predator levels) and/or impacts long-term (e.g. > 5 years) and/or irreversible.
Medium	Appreciable alteration to population levels and/or impacts medium-term (e.g. 1-5 years) and/or irreversible.
Low	Minor alteration to population levels and/or impacts short-term (up to 1 year) and/or reversible.
Negligible	No measurable alteration to population levels and/or impacts short-term and/or reversible.

10.3.3 Sensitivity or Importance of Receptor

The sensitivity of the baseline conditions has been assessed according to the recoverability of the receptor and the relative importance of the habitat and species present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance) and capacity to absorb change.

The criteria provided in Table 10-2 provide a general definition for determining the sensitivity of intertidal and benthic communities.

Table 10-2: Sensitivity Criteria

Sensitivity	Description
Very High	Rare of very restricted in distribution / in decline or has been in decline / high proportion of world extent.
High	High environmental value, quality or rarity on a regional scale / keystone in a biotope by providing a habitat for other species.
Medium	Species or biotopes of local importance but not recognised as rare / protected or nationally important examples / species whose loss or depletion would cause disruption of the local food web.
Low	Common species or biotopes which are well represented on a site scale and tolerant of change.

Sensitivity	Description
Negligible	Common species or biotopes which are well represented locally and resistant to change.

10.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the magnitude of a potential impact and the sensitivity or importance of the receptor. Impacts are identified as Beneficial and Adverse and their significance as Major, Moderate, Minor or None. The term 'None' denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account any mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts assessed as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. The full results of the assessment of impact significance are presented in Appendix 2.3.

10.4 Approach to Appraisal

10.4.1 Intertidal Ecology

The Centre of Marine and Coastal Studies (CMACS) was commissioned to conduct an intertidal survey at the Cambois Beach North landfall. The survey covered a 250m wide corridor (125m either side of the centre line of the proposed cable route corridor). Habitat type and the presence of visible fauna were recorded from the top of the shore to the limit of the tidal retreat.

Survey points were plotted from the upper shore to the lowest astronomical tide (LAT) level in order to ensure maximum coverage of the intertidal area. It was recognised, however, that as actual tides rarely reached LAT it was likely that many points would be underwater at the time of low tide during the survey and therefore would not be visited. A hand-held geographic positioning system (GPS) was used to navigate between target survey points. At survey points, predominant habitat and any obvious fauna were noted, supported, where appropriate, by hand-searching with trowel and hand-held sieve. Biotopes were identified (where possible) with the JNCC version 04.05 biotope manual.

In addition, to hand searching and to support the classification of biotopes, in situ faunal analysis was undertaken of approximately 0.02m^2 of sediment. The sediment was then sieved and all invertebrates were identified to the lowest possible taxonomic level. To support post survey interpretation, photos were taken of the shore as a visual reference to the target notes. Other features of interest, including anthropogenic influences, were also noted and photographic records taken.

10.4.2 Benthic Ecology

MMT were commissioned to undertake a detailed environmental and habitat baseline survey of the proposed marine cable route corridor. The objectives of the survey were to ground truth the seabed, classify habitat, and identify areas of conservation interest. This survey was required to satisfy the European Commission (EC) Habitats Directive (Council Directive 92/43/EEC), implemented in UK offshore waters in 2000, which requires the surveillance of habitats from which potential Special Areas of Conservation (SAC) maybe selected. In addition, survey results were also interpreted in accordance with the UK Biodiversity Action Plan (UKBAP) and the Oslo and Paris Conventions for the protection of the marine environment of the North-East Atlantic (OSPAR).

This environmental baseline survey was required to provide data relating to the physiochemical and macrofaunal environment along the proposed cable route corridor. Geophysical data was used to assist with the environmental survey strategy and subsequent data interpretation. Sampling stations were chosen with emphasis on variations in the seabed characteristics, along with areas of notable interest, such as areas of potential conservation importance. Offshore (Area 5 and 6) and nearshore (Area 7) survey work was undertaken between April and October 2012 and then again in Area 7 during May and June 2013. This additional nearshore work was required to get full data coverage of the Cambois Beach North proposed cable route corridor.

The environmental and habitat survey utilised a drop down video camera and a still camera system. In addition to seabed photography, sediment sampling for the environmental baseline was undertaken by retrieving a grab sample. Each sampling location was photographed prior to retrieval of the grab sample to ensure that the sample site was not in an area of sensitive habitat (i.e. those listed in EC Habitat Directive Annex I). A total of 76 environmental benthic sampling sites were investigated. Grab sampling was conducted using a Day grab which samples an area of $0.1m^2$, two grab samples were taken at each site, one for benthic infaunal analysis and the other for physiochemical analysis. For the purposes of habitat assessment, all in-situ still photographs of the grab samples were used to aid interpretation.

Information from sediment sampling and visible fauna in photographs and video footage was used to classify habitats/biotopes present at each sample location and to produce biotopes maps. Biotopes were based on the European Union Nature Identification System (EUNIS); developed between 1996 and 2001 by the European Environment Agency (EEA) in collaboration with European experts (JNCC, 2013a) and based on biotic and abiotic features of the seabed.

Macrofaunal data was derived from the taxonomic analysis of the samples collected from each of the 76 sampling stations. Abundances of each sample were expressed as abundance per square meter.

Multivariate analysis was undertaken using the Plymouth Routines in Multivariate Ecological Research (PRIMER) v6.0 statistical package (Clark and Gorley, 2006).

Several survey areas along the route were identified to contain habitats classified as the EC Habitat Directive Annex I ‘reef’ habitat, including both stony and biogenic reef. An assessment of these areas was conducted using the Joint Nature Conservation Committee (JNCC) guideline criteria for the determination of 'reefiness' (Irving, 2009).

10.5 Existing Conditions

10.5.1 General overview

Benthic ecology describes the assemblages of organisms living in (infauna) or on (epifauna), the seabed, their diversity, abundance and function. Benthic communities include those found on the sea floor from the intertidal zone to the deepest parts of the marine environment. The structure of benthic communities varies temporally and spatially depending on a wide range of physical factors of which water depth, sediment type, particle size, and supply of organic matter are key variables. The proposed cable route corridor is located within the central North Sea (CNS) and passes through the strategic environmental assessment zones (SEA) 2 and 3.

Sediments in the CNS generally consist of muddy/sandy sediments and are regarded as uniform in their biology. In terms of spatial coverage, the most comprehensive survey of the CNS indicate that, on intermediate and muddy sands, the major infauna typified were polychaetes (marine worms), amphipod crustaceans and bivalve molluscs (Basford *et al.,* 1990). Within this area of the North Sea four main communities have been observed.

- Fine sand in 50-70m water: Fauna is generally typified by the polychaetes *Ophelia borealis* and *Nephtys longosetosa*
- Muddy find sands in a water depth of 30-50m with the bivalve *Nucula nitidosa*, the shrimp *Callianassa subterranea* and the cumacean crustacean *Eudorella truncatula*.
- Coarse sediments in mainly less than 30m water depth with the polychaete *Nephtys cirrosa*, the sea urchin *Echinocardium cordatum* and the amphipod crustacean *Phoxocephalus holbolli*.
- Coarse sediments in mainly less than 30m water depth with polychaetes *Aoindes paucibranchiata* and *Pisione remota* and the amphipod crustacean *Phoxocephalus holbolli* (Kunitzer, 1992; DTI, 2001)

With the exception of the large bivalve mollusc *Arctica islandica* and the cold water coral *Lophelia pertusa*, the fauna of the CNS areas does not contain any very long lived species. *A. islandica* is widely distributed in the North Sea, mostly reported in offshore areas, with high numbers recoded in the Fladen Ground. *L. pertusa* has small colonies reported in the northern North Sea, generally in deeper waters (DTI, 2001). Both species are listed on OSPAR list of threatened and/or declining species and habitats.

The horse mussel, *Modiolus modiolus* and Ross worm, *Sabellaria spinulosa* are both widely distributed species within the North Sea and in suitable conditions can develop into dense and persistent beds, providing consolidated habitat for epibenthic species. These beds can influence the seabed topography and, depending on the size, can be considered as biogenic reefs. These species themselves are not afforded any protection, however biogenic reef habitats are on the OSPAR list of threatened and/or declining species, on the UKBAP and could come under Annex I of the EC Habitat Directive definition of ‘reefs’.

The EC Habitat Directive definition ‘reefs’ also covers rocky reefs, which are widespread in the more nearshore areas of the North Sea. Bedrock and stony reefs are both types of rocky reef. These occur where the bedrock or stable boulders and cobbles arise from the surrounding seabed creating a habitat that is colonised by many different marine animals and plants (Irving, 2009).

Methane derived authigenic carbonates (MDAC) and sand banks are also a widespread features of the CNS, which can be classified as Annex I Habitat ‘submarine structures made by leaking gases’ and ‘sandbanks which are slightly covered by sea water all the time’, respectively (DTI, 2002).

The nearshore areas of the CNS hosts a range of nearshore benthic habitats including: sand plains; mudflats and salt marsh systems; coastal lagoons; rocky shores; rocky outcrops and reefs; and deep water muds and gravels, each with a characteristic species assemblage.

10.5.2 Intertidal Ecology

The shores at the Cambois Beach North landfall consist predominantly of coarse and medium sand with relatively shallow slope angles. The sediment has been landscaped into low banks and troughs by tidal action and with occasional pools of water retained on the upper site of the banks. Fauna recorded in the samples was typical of this type of shore and included the amphipods *Haustorius arenarius*, *Bathyporeia* spp. and *Pontocrates altamarinus*, the isopod *Eurydice pulchra*, the polychaetes *Paraonis fulgens, Scolelepis* sp. and *Nephtys* sp. as well as a single individual of the bivalve mollusc *Angulus tenuis* on the lower shore of Cambois Slipway.

There is a small area of barren sand on the upper shore at the northern end where the sand is well drained. The predominance of amphipods with some isopods on the mid shore led to the biotope classification LS.LSa.MoSa.AmSco ‘amphipods and *Scolelepis* spp. in littoral medium-fine sand’. On the lower shore the decreased abundance of amphipods as well as the presence of *Nephrops* sp. and *Angulus tenuis* suggested that the biotope was LS.LSa.FiSa.Po ‘polychaetes in littoral fine sand’; insufficient invertebrates were recovered in the samples to take the classification any further.

The organisms that inhabit sandy shores, such as those described above for Cambois Beach North, are regularly disturbed by tidal and wave action and can recover quickly from any physical disturbance. They do this through two means:

1. They are highly mobile (excepting bivalves) and can therefore avoid disturbance.
2. They tend to be short-lived, fast maturing and fecund (produce a lot of offspring; this includes intertidal bivalves) and are therefore able to replace any individuals lost to anthropogenic mortality relatively quickly.

No rare or protected species or habitats of conservation importance were observed during the intertidal survey at Cambois Beach North landfall (CMACS, 2012).

10.5.3 UK nearshore waters

The western nearshore area (Area 7) of the proposed marine cable route corridor runs from just within the 12nm limit (KP 692) to KP 793 (see Figure10-1; Appendix 1) to the Cambois Beach North landfall. The bathymetry of the nearshore area of the proposed marine cable route corridor is varied, with a flat to irregular seabed. The depth of this area ranges from 81-23m. Sediments get progressively coarser in a landward direction; ranging from silty fine sediment in the east, through silty sand in the central sector, to sandy sediments at the landward (western) end.

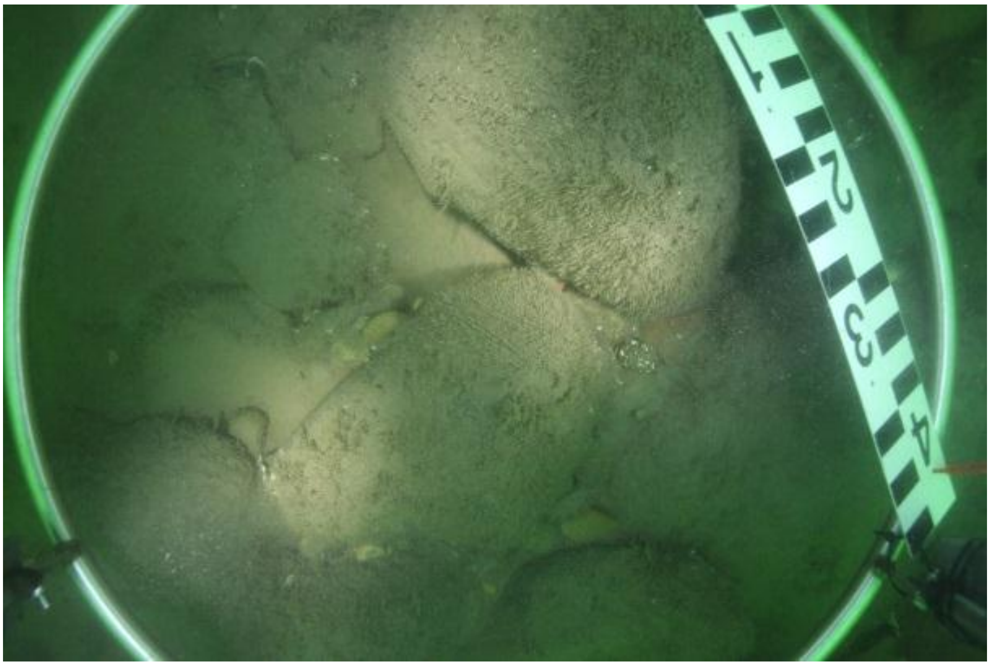
The section of the route corridor from KP 692 – KP 707 is dominated by circalittoral muddy sand (Figure 10-2; Appendix 1, Figure 10-3 below) with small scattered areas of circalittoral mixed sediment. From KP 706 – KP 712 the dominant habitat is circalittoral sandy mud (Figure 10.2; Appendix 1). This habitat is discontinued in the centre by an area of bedrock and boulders. Survey transects in this area revealed several areas of EC Habitats Directive Annex I habitat – stony 'reef', stretching across the survey area from approximately KP 708 – KP 710 (Figure 10.2; Appendix 1). These reef habitats are classed as low grade stony reef (see Table 10-3). Habitats in this area of stony reef included Atlantic and Mediterranean moderate energy circalittoral rock and circalittoral mixed sediment.

Figure 10-3: EUNIS Habitats UK nearshore waters

Left caption = circalittoral muddy sand, right caption = deep sandy mud

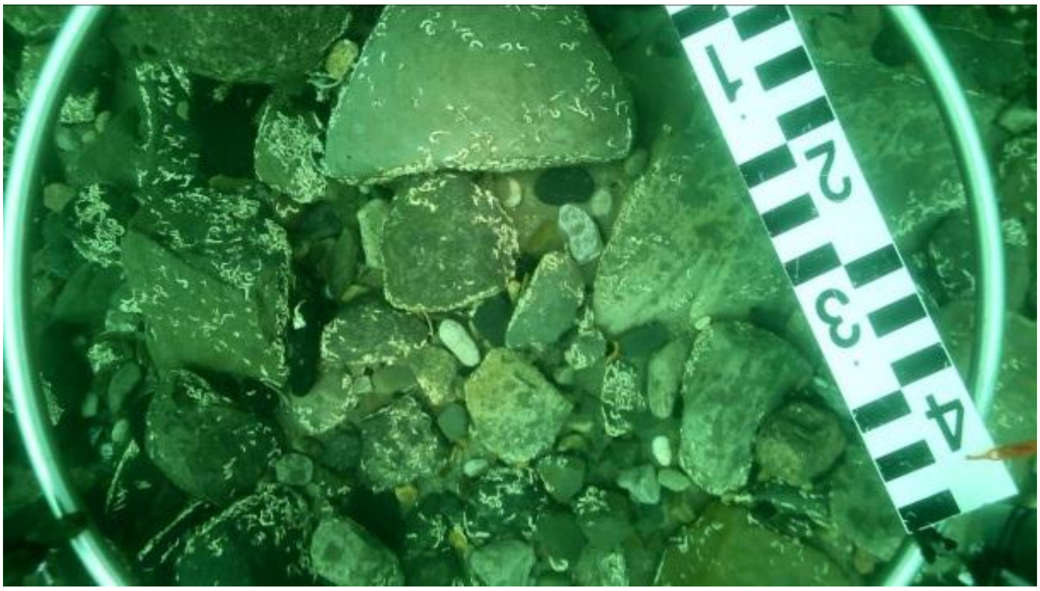
From KP 710.5 – KP 712, in the shallower more landward section of the route, the habitat is dominated by *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand. Within this habitat patches of Atlantic and Mediterranean moderate energy infralittoral rock were observed, on which, at about KP 713 an area of large boulders has been classified as medium grade stony reef (see Table 10-3, Figure 10.2; Appendix 1 and Figure 10.4 below).

Figure 10-4: Medium grade stony reef at KP 713



From KP 712 – KP 715, the shallowest section of the route corridor is dominated by infralittoral fine sand. South of the proposed route at approximately KP 714 an area of low grade stony reef was located (Table 10-3). To the north of the proposed route, from approximately KP 712 – KP 714, a small area of Atlantic and Mediterranean moderate energy infralittoral rock was observed. This bedrock has also been classified as medium grade stony reef (Figure 10-5). Moving landward this boulder area ends and is followed by sand with ripples.

Figure 10-5: Medium grade stony reef at KP 714



Boulders and areas of bedrock along the route are dominated by dead man's fingers (*Alcyonium digitatum*), echinoderm and hydrozoa. Soft corals are also seen attached on the boulders.

Silty sandy sediments along the route are dominated by polychaetes *Lumbrineris* spp. and polychaetes of the family Polynoidae, and the bristleworm *Scoloplos armiger*. Arthropods are quite common with the crustacean *Leucon* sp. being the most dominant species from this phylum. Other species observed included species such as hermit crabs (Paguridae), echinoderms and large sea snails (Buccinidae). Holes from burrowing megafauna are also present in the finer sediments.

The cable route was optimised to avoid all known areas of stony reef habitat; this can be seen in side scan sonar imagery in Figures 10-6, 10-7 and 10-8 (Appendix 1). However, small areas of boulders and bedrock maybe observed along the route.

Table 10-3: EUNIS habitats found in nearshore waters along the proposed marine cable route corridor.

EUNIS habitat classification	EUNIS Habitat Description	Location along route
Circalittoral muddy sand	Circalittoral non-cohesive muddy sands with the silt content of the substratum typically ranging from 5% to 20%. This habitat is generally found in water depths of over 15-20m and supports animal-dominated communities characterised by a wide variety of polychaetes, bivalves such as *Abra alba* and *Nucula nitidosa*, and echinoderms such as *Amphiura* spp. and *Ophiura* spp., and *Astropecten irregularis*. These circalittoral habitats tend to be more stable than their infralittoral counterparts and as such support a richer infaunal community.	KP 692 – KP 706
Circalittoral mixed sediment	Heterogeneous sediment in the circalittoral zone including well mixed muddy gravelly sands or very poorly sorted mosaics of shells, cobbles and pebbles in or on mud, sand or gravel. A wide range of infaunal species inhabits the sediment and epifauna, like hydroids, may dwell on larger shells or stones.	Small intermittent areas along the route
Circalittoral sandy mud	Circalittoral, cohesive sandy mud, typically with over 20% silt/clay, generally in water depths of over 10m, with weak or very weak tidal streams. Sea pens such as *Virgularia mirabilis* and brittlestars such as *Amphiura* spp. are particularly characteristic of this habitat whilst infaunal species include the tube building polychaetes *Lagis koreni* and *Owenia fusiformis*, and deposit feeding bivalves such as *Mysella bidentata* and *Abra* spp.	KP 706 – KP 712

EUNIS habitat classification	EUNIS Habitat Description	Location along route
Atlantic and Mediterranean moderate energy infralittoral rock	Predominantly moderately wave-exposed bedrock and boulders, subject to moderately strong to weak tidal streams. On the bedrock and stable boulders there is typically a narrow band of kelp *Laminaria digitata* in the sublittoral fringe which lies above a *Laminaria hyperborea* forest and park. Associated with the kelp are communities of seaweeds, predominantly reds and including a greater variety of more delicate filamentous types than found on more exposed coasts (cf. A3.11).	Small intermittent areas along the route.
Fabulina fabula and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	In stable, fine, compacted sands and slightly muddy sands in the infralittoral and littoral fringe, communities occur that are dominated by venerid bivalves such as *Chamelea gallina*. This biotope may be characterised by a prevalence of *Fabulina fabula* and *Magelona mirabilis* or other species of *Magelona* (e.g. *M. filiformis*). Other taxa, including the amphipod *Bathyporeia* spp. and polychaetes such as *Chaetozone setosa*, *Spiophanes bombyx* and *Nephtys spp*. are also commonly recorded. In some areas the bivalve *Spisula elliptica* may also occur in this biotope in low numbers. The community is relatively stable in its species composition, however, numbers of *Magelona* and *F. Fabulina* tend to fluctuate.	KP 710.5 – KP 712
Infralittoral fine sand	Clean sands which occur in shallow water, either on the open coast or in tide-swept channels of marine inlets. The habitat typically lacks a significant seaweed component and is characterised by robust fauna, particularly amphipods (*Bathyporeia*) and robust polychaetes including *Nephtys cirrosa* and *Lanice conchilega*.	KP 712 – KP 714
Atlantic and Mediterranean moderate energy circalittoral rock	Tide-swept circalittoral coarse sands, gravel and shingle generally in depths of over 15-20m. This habitat may be found in tidal channels of marine inlets, along exposed coasts and offshore. This habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Certain species of sea cucumber (e.g. *Neopentadactyla*) may also be prevalent in these areas along with the lancelet *Branchiostoma lanceolatum*.	Small areas between KP 712 – KP 714

Habitat and species of conservation interest

Side scan sonar and seabed photography data of rocky reef areas identified above and in Table 10-4, were assessed using the JNCC reefiness (Irving, 2009) criteria outlined in Table 10-5***.*** This scoring system is used to determine the value of a reef and therefore provides an indication of whether it may be considered eligible for protection under Annex I of the EC Habitats Directive. Stony habitat is considered a reef if: it is elevated off the seabed by at least 0.064 metres; has a composition of at least 10% stones; covers an area of at least $25m^2$; and is associated with a community of largely epifaunal species.

Numerous areas of potential Annex I stony reef were identified within the survey area, corresponding to areas delineated as rock outcrop, and boulder fields. The areas of highest reefiness were located more nearshore at KP 712.9 and KP 713.9, both classified as medium grade stony reef. This scoring was due to a high coverage of boulders and diverse epifauna.

Table 10-4: Areas of reef identified in the nearshore waters

Location	Grade of Annex I Habitat	Elevation (cm)	Composition (%)	Habitat name	Habitat description
KP 708.2	low grade stony reef	10-20	25	Circalittoral coarse sediment	Hard surfaces from boulders and cobbles being scattered on the sea floor. Different kind of fauna was connected to the stones, mainly dead man´s finger and Hydrozoa. Soft corals and sea stars were also seen on and around the boulders
KP 708.4	low grade stony reef	10-30	30-60	Circalittoral coarse sediment	Boulders and cobbles covered with a thin layer of mud. The fauna in the boulder field was mainly *Urticina fellina* and *Munida sp.*
KP 708.4	low grade stony reef	10-30	30-50	Circalittoral coarse sediment	Cobbles and boulders were present at the sediment. In some areas covering up to 50% but generally more scattered. Different soft corals and starfishes were present on the hard surfaces.
KP 708.7	low grade stony reef	10-30	70	Circalittoral mixed sediments	The sediment composition was a mix of boulders on muddy sands. Fauna found in the boulder field was mainly *Alcyonium*

Location	Grade of Annex I Habitat	Elevation (cm)	Composition (%)	Habitat name	Habitat description
					digitatum, *Flustra foliacea* and *Echinus esculentus*.
KP 708.9	low grade stony reef	10-50	25	Circalittoral coarse sediment	In this patch, dead man´s finger was attached to the hard surface and soft corals were frequently seen. The stones in the habitat were distributed in a patchy manner.
KP 709.5	low grade stony reef	10-50	80	Circalittoral mixed sediments	The sediment composition was a mix of boulders on muddy sand. Fauna found in the boulder field was mainly *Alcyonium digitatum* and *Echinus esculentus*.
KP712	low grade stony reef	10-20	20-35	Atlantic and Mediterranean moderate energy infralittoral rock	Large boulders with smaller boulders and cobbles in between. The fauna in the boulder field was mainly *Alcyonium digitatum* and *Echinus esculentus*.
KP 712.9	medium grade stony reef	10-50	90	Atlantic and Mediterranean moderate energy infralittoral rock	The sediment composition was a mix of large boulders, cobbles. Dominated by species like dead man´s fingers and starfishes.
KP 713.9	medium grade stony reef	10-40	80	Atlantic and Mediterranean moderate energy infralittoral rock	Boulders on sand. Fauna sparse. Boulders mostly covered with *Spirobranchus triqueter*.

Table 10-5: Measures of reefiness of potential stony reef habitat (Irving 2009).

Characteristic	Not a reef	Low	Medium	High
Composition (cobbles and boulders)	<10%	10-40%	>40-95%	>95%
Elevation above seabed	Flat seabed	<64mm	64mm – 5m	>5 m
Cover of visible epifauna	Predominantly infaunal species			>80% of species present composed of epifaunal species.
Extent	<25m^2	>25m^2		

10.5.4 UK Offshore Waters

The offshore area (Area 5 and 6) of the proposed marine cable route corridor from the UK/Norway medium line (KP 368) to just within the 12nm limit (KP 692) (see Figure 10-1; Appendix 1) is varied in bathymetry, sediment and habitat composition. The general bathymetry presents a flat to irregular seabed with small depth variations over a depth range of 63-105m. The seabed along the route is heterogeneous consisting of fine sediments such as clay, silt and sand, with occasional areas consisting of coarser sediments such as gravel and boulders. The only noticeable feature along the offshore route was a ridge located at KP 508.18, where, over a distance of 500m, the seabed drops from 86m down to 96m.

The habitats in the offshore route section were similar in composition. According to the EUNIS habitat classification system, principle areas along the offshore route largely consisted of the habitat ‘sea pens and burrowing megafauna in circalittoral fine mud’ followed by the habitat ‘deep circalittoral sand’ (Figure 10.9). A total of six EUNIS habitats were identified along the offshore route (see Table 10-6).

Figure 10-9: EUNIS Habitats UK offshore waters

Left caption = sea pens and burrowing megafauna in circalittoral fine mud, right caption = deep circalittoral sand

The eastern most part of the cable route from the UK/Norway median line (KP 368) to KP 392 consists of a mixture of 'deep circalittoral sand', 'deep circalittoral mixed sediments' and 'deep circalittoral mud'. The infaunal community in this area is dominated by annelids and juvenile echinoderms. Holes in sediment from burrowing mega fauna are common and the epifaunal community is dominated by echinoderms with the occasional sea pen.

Sections of the route from the KP 392 – KP 545 and from KP 578 – KP 604 consist mostly of the EUNIS habitat "sea pens and burrowing megafauna in circalittoral fine mud", with small areas of 'deep circalittoral sand' and deep circalittoral mixed sediments'. "Sea pens and burrowing megafauna in circalittoral fine mud" is OSPAR listed and is a UKBAP habitat (see Figure 10-9; figure 10-10 Appendix 1 and Table 10-6). Species found at this habitat included the phosphorescent sea-pen *Pennatula phosphorea*, the slender sea-pen *Virgularia mirabilis*, the lesser cylinder-anemone *Cerianthus lloydii*, Portunidae (swimming crabs), hermit crabs *Pagurus* sp. and sea stars, Asteroidea. Tubes from polychaetes, possibly *Chaetopterus variopedatus* and/or other burrowing infauna are also present.

From approximately KP 606 – KP 640 'deep circalittoral coarse sediment' dominates the seabed, containing a mixture of coarser sediments such as gravel and sediments' boulders. This area also contains small areas of 'deep circalittoral sand' and 'deep circalittoral mixed (Figure 10-11; Appendix 1). The EUNIS habitats identified in the offshore section of the route along with their location are listed in Table 10-6.

From KP 545 – KP 578 and from KP 640 – KP 692 (see Figure 10-12 and Figure 10-13; Appendix 1) habitats largely consisted of the EUNIS habitat 'deep circalittoral sand' with small intermittent areas of 'deep circalittoral mixed sediments' and 'sea pens and burrowing megafauna in circalittoral fine mud'. From KP 572 – KP 575 the seabed consists of an area of '*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand'. Species found in this habitat included *Owenia fusiformis*, *Amphiura filiformis*, *Chaetozone setosa*, *Spiophanes kroyeri*, *Thyasira flexuosa*, *Timoclea ovata* and *Labidoplax buski*.

Fauna along the offshore section of the proposed marine cable route corridor is dominated by annelids followed by echinoderms, arthropoda, mollusc and cnidaria. Holes from burrowing megafauna are present in the finer sediments, suggesting the presence of species such as *Nephrops* sp. Infauna along the route is dominated by annelids and echinoderms (majority being juvenile) and epifauna along the route is generally dominated by echinoderms with the occasional sea pen; epifauna is generally quite sparse.

Table 10-6: EUNIS habitats found in offshore waters along the proposed marine cable route corridor

EUNIS habitat classification	EUNIS Habitat Description	Location along route
‘ deep circalittoral sand’	Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms.	KP 367 – KP 383 KP 390 – KP392 KP 545 – KP 571 KP 640 – KP 643 KP 647 – KP 692 Other small intermittent areas along the route.
‘circalittoral mixed sediments’	Heterogeneous sediment in the circalittoral zone including well mixed muddy gravelly sands or very poorly sorted mosaics of shells, cobbles and pebbles in or on mud, sand or gravel. A wide range of infaunal species inhabits the sediment and epifauna, like hydroids, may dwell on larger shells or stones.	Small intermittent areas along the route
‘deep circalittoral mud’	Mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70m. May hold a variety of faunal communities depending on the composition of the sediment. Polychaetes, echinoderms and bivalves typically dominate the communities.	KP 383 – KP 390
A5.361 ‘sea-pens and burrowing megafauna in circalittoral fine mud’	Plains of fine mud at depths greater than about 15m. The sediment may be heavily bioturbated by burrowing megafauna like *Nephrops norvegicus* and different kinds of seapens and echinoderms. The sediment may hold significant populations of different kinds of polychaetes like *Pholoe* spp., *Glycera* spp., *Nephtys* spp. and spionids.	KP 392 – KP 545 KP 578 – KP 604 KP 643 – KP 647
‘*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand’	Areas of slightly muddy sand in offshore waters. The habitat may be characterised by high numbers of the tube building polychaete *Owenia fusiformis* often with the brittlestar *Amphiura filiformis*. Other species found in this community are different kinds of polychaetes (i.e. *Goniada maculata*, *Pholoe*	KP 571 – KP 577

EUNIS habitat classification	EUNIS Habitat Description	Location along route
	inornata, Diplocirrus glaucus, Chaetozone setosa and Spiophanes kroyeri).The sea cucumber *Labidoplax buski* and the cumacean *Eudorella truncatula* are commonly found in this biotope.	
'deep circalittoral coarse sediment'	Offshore (deep) circalittoral habitats with coarse sands and gravel or shell. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore mixed sediments and in some areas settlement of *Modiolus modiolus* larvae may occur and consequently these habitats may occasionally have large numbers of juvenile *M. modiolus.* Generally poorly described due to lack of quantitative data.	KP 604 – KP 640

Habitats and species of conservation interest

The horse mussel *Modiolus modiolus* was found at approximately KP 374. However, individual numbers found were too low to indicate the presence of any EC Habitats Directive Annex I habitat 'reef', in the form of mussel beds. In order to create a biogenic reef, *M. modiolus* would have to be in significant numbers in order to clump together to create reef structures.

Five UKBAP priority fish species were observed from photo stills in the offshore area of the proposed cable route corridor; the European hake (*Merluccius merluccius),* the lesser sand eel *(Ammodytes marinus),* the angler fish (*Lophius piscatorius),* ling *(Molva molva) and* European plaice *(Pleuronectes platessa).*

The OSPAR listed bivalve mollusc *Arctica islandica (*Icelandic ocean quahog) was found at three grab sample locations at KP 573.85, KP 645.48 and KP 667.27. Although widespread in the North Sea, according to the OSPAR Commission this species has been in decline over the last 50 years, predominantly in the shallower parts (< 50m) of the North Sea. The proposed marine cable route passes through the proposed East of Gannet and Montrose Field Marine Protected Area (MPA) which is designated for aggregations of this species.

None of the habitats identified during surveys qualifies as an EC Habitats Directive Annex I habitat. The habitat 'sea-pens and burrowing megafauna in circalittoral fine mud' is on the OSPAR List of threatened and/or declining species and habitats. The deep water mud on which this habitat is found is a UKBAP Priority Habitat and is listed in Annex I of the EC Habitats Directive under Large shallow inlets and bays (JNCC, 2013b).

10.6 Potential Impacts

The potential impacts to benthic communities from installation and operation of the marine cables is provided below. The full results of the assessment of impact significance are presented in Appendix 2.3.

10.6.1 Installation

Loss or disturbance of intertidal species and habitat

Intertidal species in the vicinity of the cable trench may suffer direct mortality during cable burial operations. No rare or protected species were encountered during the intertidal survey and therefore sensitivity has been assessed as low. Sediments will not be altered and species will be able to re-colonise the area swiftly once disturbance ceases. The magnitude of the effect has been assessed as negligible and the impact significance is assessed as **None**.

Direct loss/disturbance of benthic species and habitat

Benthic communities in the vicinity of cable installation operations would be impacted by substratum loss and direct displacement of species located within the installation corridor as a result of cable ploughing/trenching, pre-sweep dredging and through the use of rock placement where burial is not possible. It is likely that a high proportion of the benthic invertebrates within the width of the plough/trench footprint will be susceptible to mortality, injury or displacement as a result of coming into contact with the route clearance grapnel, cable installation machinery or anchors. This is more likely to affect sessile or less mobile species such as sea pens. It is also likely to have a greater effect on populations of longer-lived species (such as some bivalves) rather than shorter-lived species, such as small polychaetes.

The assessment of this impact has been split into three categories: general habitats; OSPAR listed habitats e.g. ‘sea pens and burrowing megafauna in circalittoral fine mud’ and *Arctica islandica*; and rocky reef habitat.

General habitat

The majority of benthic species identified along the proposed marine cable route corridor are expected to be widely occurring and sensitivity has therefore been assessed as low for the general habitats. Polychaetes, such as *Chaetopterus variopedatus,* tend to dominate the species counts. Polychaetes are found in sandy and muddy sediments at a depth of 5-15cm, and are therefore protected from most sources of abrasion and disturbance caused by cable installation. Recoverability, from disturbance and direct removal of species, would be expected to be very high. It is expected that there would be a rapid return to undisturbed conditions, as displaced fauna would re-enter the finer sediment. Component species associated with sandy and muddy sediments, e.g., errant polychaetes and small crustaceans, are highly mobile and tolerant of sediment movement and would accompany the influx/re-settlement of disturbed material (Budd, 2008).

Bivalve molluscs are generally shallow active burrowers and are found within muddy and sandy sediments along the route. Bivalves will be vulnerable to substratum loss during cable installation. However, many bivalves, once removed, can re-locate to suitable habitat or return to location and therefore have a high recoverability. Bivalves which have a weak shell will be prone to abrasion and physical disturbance from trenching equipment. Species such as *Modiolus modiolus* are more vulnerable to cable installation as they have a low sporadic recruitment, meaning it can take 10-20 years for a population to recover. Numbers of *M. modiolus* along the route were low and are not afforded a protection status; as such the magnitude of impact on this species is assessed as low. Other bivalve species, where information was available, have a low sensitivity and high recoverability to physical disturbance and substratum loss.

In muddier sediments larger mobile species like *Nephrops*, are likely to seek refuge within their burrows if disturbed and will therefore be prone to direct removal (Sabatini and Hill 2008). Abrasion and disturbance from trenching equipment is also likely to crush some individuals. However, if they survive intact *Nephrops* are likely to commence burrowing immediately, with burrows being re-established within 2 days providing that the occupant has remained unharmed (Marrs *et al*., 1998).

Some species from the echinoderm family such as sea urchins have a fragile outer shell (test) that is likely to be damaged by an abrasive force increasing vulnerability and likelihood of death. Other species, such as brittlestars (*Ophiura* sp.), can tolerate considerable damage to arms and even the disk without suffering mortality (Budd, 2008). Individuals which are displaced but undamaged will therefore be able to re-establish themselves and due to the highly fecund nature of the majority of species will be able to rapidly re-colonise disturbed habitats.

Recoverability of mud, sand and mixed sediments is likely to be rapid with recruitment from adjacent unaffected areas. The magnitude of effect has been assessed as negligible. The impact significance for general species and habitats is assessed as **None**.

OSPAR listed habitat

A large section of the offshore route consists of the habitat ‘sea pens and burrowing megafauna in circalittoral fine mud’, an OSPAR listed habitat. Disturbance and direct removal of sediment could damage and displace *Virgularia mirabilis* during installation. However, providing that a suitable substratum remains, recoverability is expected to be moderate (Marlin, 2013). This habitat is widespread in this area of the North Sea and the route does not intersect any protected sites designated for this habitat; therefore, sensitivity has been assessed as medium. Given that the impact will be short term and localised, and the seapens within this habitat have a moderate recovery to disturbance, the magnitude of effect has therefore been assessed as low.

The OSPAR listed bivalve *Arctica islandica* was found in the offshore section of the route. This species is found within muddy sediments and therefore direct loss of sediment during installation could remove this species. However, bivalves are active burrowers therefore if this species is displaced it should be able to return to a suitable habitat. The East of Gannet and Montrose Fields pMPA, through which the proposed marine cable route passes, has been designated for aggregations of *Arctica islandica.* However, aggregations of this species are found in the far north-north west of the pMPA (JNCC, 2012), away from the proposed marine cable route corridor. Taking this into account and given that this species is long lived (MarLin, 2013), its sensitivity has been assessed as medium. However, this species is widespread in the North Sea and given that it was only found at three locations along the route, this suggests that the magnitude of effect is low.

The significance of the impact on OSPAR listed habitats is assessed as **Minor**.

Rocky reef habitat

In areas of harder substrate in the more nearshore areas, including potential areas of reef habitat, epifauna, e.g. *Alcyonium digitatum,* echinoderms, calcareous tube worms or encrusting bryozoans, removed from the substratum are likely to be killed. However, displacement of the cobbles, stones or pebbles to which they are attached is far more likely. Some individuals will probably be killed by abrasion in the process of displacement but as long as they are displaced to a similar habitat then the majority would survive (Tyler-Walters, 2008).

The proposed marine cable route has been optimised to avoid known areas of Annex I habitat stony reef habitat. However, small areas of low grade stony reef habitat may be encountered in the nearshore section of the route during installation. The installation contractor will be instructed to avoid these areas as much possible by cable micro-routeing and careful anchor placement. The dominant species present in areas of harder substratum, including *Alcyonium digitatum*, encrusting bryozoans and erect hydroids and bryozoans are rapid colonizers, capable of rapid growth and early reproduction (Tyler-Walters, 2008). The majority of the epifauna is probably subject to severe physical disturbance and scour during winter storms and are likely to develop annually, through re-colonisation from any surviving individuals and from adjacent habitats. Full recoverability of reef habitat of low reefiness is expected to take many months (or years). Reef habitat is of high conservation value and may have potential to be Annex I habitat and therefore sensitivity has been assessed as high. Recoverability of reef habitat is also expected to take longer than for sediments and the magnitude of effect has therefore been assessed as medium. The significance of the impact is **Moderate**.

Smothering from displaced sediment

Effects on the surrounding area could occur due to the displacement and re-distribution of sediment during ploughing or trenching operations. This can affect the surrounding habitat due to the redistribution of a thick layer of sediment over the immediate area physically smothering species present. This effect is only expected to impact the immediate vicinity of the cable trench and will be most applicable to sessile and less mobile fauna.

Suspension and deposition of fine particles may have an effect on low mobility filter feeders, through the blocking of feeding siphons, and may also affect the reproductive processes of some species. The significance of this will relate to the sensitivity of habitat and species in the affected area. Benthic communities in mobile muddy and sandy sediments are generally adapted to high sediment loading and thereby have a high tolerance to smothering; as such recovery is expected to be high. In addition, feeding siphons can reach above the sediment surface to feed and respire and many filter feeders are burrowers and are able to switch from aerobic and anaerobic respiration and are adapted to such conditions. Therefore, sensitivity and magnitude of impact have been assessed as low.

Taxa that are more mobile should be able to relocate away from disturbed areas. Sessile epifauna are vulnerable to smothering as they are unable to move away from the affected area. However, the effect of smothering is likely to be temporary, as material deposited will be re-suspended and dispersed by natural hydrodynamic processes. The benthic species and biotopes that have been identified are expected to be widely occurring and sensitivity has therefore been assessed as low. Recoverability is likely to be rapid and the magnitude of effect has also been assessed as low. The impact significance is assessed as **none**.

Sediment suspension and deposition

During cable installation some seabed sediment will be re-suspended into the water column causing small localised and temporary increases in suspended sediment followed by subsequent re-deposition on the seabed. 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.

The particle size distribution within this remobilised sediment varies along the route mainly as a result of the seabed energy; fine sediments only being found where seabed currents and wave action are minimal. This will tend to limit the deposition footprint, as plumes of fine material, which will remain in suspension for longer than those of coarse material, will only occur in relatively quiescent regions. If fine sediment (e.g. clay from an underlying deposit) is mobilised within a high energy area the plume will be rapidly diluted and dispersed. The settling rates of particles increases rapidly with size. Sand particles (down to 0.06mm diameter) could remain suspended for a few minutes. Larger particles (> 2mm diameter) would only remain suspended for a few seconds.

Estimated sediment deposition depths have been calculated in Section 8. Depending on the specific conditions and sediment particle size distribution the dispersion distance may vary, but it is difficult to refer to a worst case scenario as greater sediment dispersion distance means the sediment will be more thinly dispersed over a wider area, whilst a smaller sediment dispersion distance gives a high deposition depth over a smaller distance.

The average predicted maximum depth of deposition at 10 KP points exceeds 20mm at all points; ranging from 25mm to 53mm (see Section 8, Table 8-8). However, in most cases the deposited sediment will be rapidly re-suspended in periods when current speeds exceed the critical speed for erosion for each fraction of the sediment.

The benthic species and biotopes that have been identified are expected to be widely occurring and sensitivity has therefore been assessed as low. Effects from solids suspension and deposition are not expected to be detectable outside of the range of natural background fluctuations and recovery would be immediate or at most within a few days. The magnitude of the effect has therefore been assessed as negligible. The impact significance for general species and habitats is assessed as **none**.

Smothering from cable protection

In areas of cable or pipeline crossings or where target burial depth cannot be achieved, it will be necessary to deposit rock or mattresses on the seabed to protect the cable. This will result in the smothering and direct mortality of benthic species located beneath the footprint of the protection material and may also lead to long term, but localised changes to habitat characteristics, due to the introduction of a new substrate. The benthic species and biotopes that have been identified are expected to be widely occurring and sensitivity has therefore been assessed as low. In areas where there is rocky reef sensitivity has been assessed as high as this habitat holds higher environmental value. The rocky reef habitat where rock installation is utilised may be locally reduced in extent and magnitude has therefore been assessed as medium. The significance of this impact is assessed as **moderate** in areas of rocky reef and **minor** for all other areas of habitat.

10.6.2 Operation

Substrate change due to presence of installed cable

The vast majority of intertidal and benthic species inhabit the topmost 30cm of sediment. The introduction of a new hard substrate has the potential to change local benthic habitat characteristics especially in areas of soft/sandy sediments. The benthic species and biotopes that have been identified are expected to be widely occurring and sensitivity has therefore been assessed as low. The physical presence of the buried cable will have no effect on benthic species and where rock installation is used this will provide alternative habitat for colonisation. The magnitude of effect has therefore been assessed as low. The significance of this impact is assessed as **none.**

Electromagnetic fields / Induced electric fields

As described in Section 3, during operation HVDC cables, emit electromagnetic fields which will cause a change in the detectable level of these fields in the immediate vicinity of the cable. The effect will be present along the entire cable route.

It is possible that the field will impair the navigation of and/or cause physiological effects upon marine macro-invertebrates in very close proximity to cables (CMACS, 2011a). However, these effects will only be minor in nature. The benthic species and biotopes that have been identified are expected to be widely occurring and sensitivity has therefore been assessed as low. The emission of EMF from the marine cables is not expected to have a detectable effect on the structure and functioning of benthic species and biotopes and magnitude of effect has been assessed as negligible. The significance of this impact is assessed as **none.**

Heating effects

During operation the cable will produce heat, as a consequence of the internal resistance in the conductors. The greatest change in temperature will occur in sediments immediately (tens of cm) around the cable but is not expected to be greater than 2°C in upper sediments less than 20cm deep (OSPAR, 2009). Since the surrounding water column will rapidly dissipate any heat away from the cable the only organisms likely to experience heating are those burrowing into surrounding sediments or dwelling in the interstices of rock armouring.

The deepest burrowing organisms likely to be present are crustaceans (such as *Nephrops norvegicus*), which are expected to burrow to around 0.5m depth and could come within approximately 0.5m of the cable, if it is buried to 1m.

Sensitivity of benthic fauna has been assessed as low as no organisms would be sensitive to such small increases in temperature (CMACS, 2011b). Due to the small scale of any heating effects, magnitude has been assessed as negligible. The significance of this impact is assessed as **none.**

10.7 Mitigation

10.7.1 Installation

Direct loss/disturbance of intertidal species and habitat.

- Any deployment of equipment or vessels onto the seabed (e.g. anchors, intertidal cable-lay vessels) will be kept to a minimum.
- Restoration of intertidal habitat by backfilling will occur after construction.
- Construction works in the intertidal area will be restricted to a designated working area within which all construction activity and plant/vehicle movement will take place.

Direct loss/disturbance of benthic species and habitat

- Any deployment of equipment and vessel anchors onto the seabed will be kept to a minimum.
- The stony reef Annex I habitats will be marked as exclusion areas, and where possible the installation contractor will be required to avoid these in cable installation and anchor deployment.

Sediment dispersion and deposition

- No specific mitigation measures are proposed to reduce potential levels of suspended sediment which will be influenced by seabed sediment type and the choice of trenching equipment

10.7.2 Operation

As the significance of the identified impacts on benthic and intertidal ecology has been assessed as ‘None’, no mitigation measures are proposed.

10.8 Residual Impacts

10.8.1 Installation

Loss or disturbance of intertidal species and habitat

Restoration of habitats by back filling with the same sediment after the cable is positioned in the intertidal zone will help to restore habitat and enable rapid benthic re-colonisation. Communities are therefore likely to recover quickly. The residual impact is therefore **Not Significant.**

Direct loss/disturbance of benthic species and habitat

Direct disturbance to benthic species and habitat will occur over a very localised area. In addition, any deployment of equipment or vessels onto the seabed (e.g. anchors of cable-lay vessels) will be kept to a minimum. Soft sediments (such as those encountered across the majority of the proposed cable route) have high recoverability, and re-colonisation of the habitat is expected to occur quickly after installation. Therefore there is no residual significance and therefore residual impacts are **Not Significant.**

The OSPAR listed habitat sea pens and burrowing megafauna in circalittoral fine mud and listed species *Arctica islandica* are widespread in the North Sea. In addition, *Arctica islandica* and sea pen species were not observed along the route in large numbers. Therefore residual significance is minor and impacts are considered **Not Significant.**

The cable route has been optimised to avoid known areas of Annex I stony reef habitat. During installation the contractor will be instructed to avoid these areas. Therefore, it not anticipated the cable route will cause direct loss of habitat to Annex I rocky reef and therefore impacts are considered **Not Significant.**

Smothering from displaced sediment

Impacts from smothering will be localised and many species which will be smothered will be able to burrow away from the impact area. In addition, the newly distributed sediment will be re-colonised by species migrating from nearby areas. Therefore, impacts from smothering are considered **Not Significant.**

Sediment suspension and deposition

Benthic organisms present along much of the proposed cable route will be well adapted to mobile sediment and rapidly changing suspended sediment levels. Impacts will be localised, temporary and within the range of natural fluctuations and are therefore considered **Not Significant**.

Smothering from cable protection

Rocks or mattresses are likely to be rapidly colonised by sessile epifaunal organisms such as sponges, hydroids, bryozoans and soft corals, along with accompanying motile epifauna such as crustaceans and gastropod molluscs. As such, this will represent an increase in local diversity and abundance, particularly in areas of lower diversity, such as mobile sands. Impacts are considered **Not Significant**.

10.8.2 Operation

Substrate change due to presence of installed cable As the cable will be buried to 1 – 2m, fauna that colonise the top layers of sediment will not be denied suitable habitat as a result of the presence of the cable. Cable protection will introduce new hard substrate for colonisation by epifauna, increasing the diversity of epifauna. As such impacts are considered **Not Significant.**

Electromagnetic fields / Induced electric fields

Marine invertebrate are magnetically sensitive however, there is little and contradictory evidence regarding their interactions with anthropogenic sources of magnetic fields, both between species, and within the same species. Magnetic fields (B fields) expected to be generated by the proposed marine cables will attenuate to below geomagnetic field levels within several metres of the cable cores.

Burial of the cable somewhat protect invertebrates from the strongest B fields, although burrowing species such as polychaetes and bivalve molluscs may encounter stronger fields (CMACS, 2011a). If the marine cables are covered with rocks, invertebrates are likely to colonise any interstitial spaces and may also come into closer or direct contact with the cables. The E fields expected to be induced are of relatively minimal strength and therefore unlikely to caused detrimental effects to these taxa (CMACS, 2011a). Therefore impacts have been assessed as **Not Significant.**

Heating

Heating effects are not expected to result in temperature increase of more than 2°C and an assessment of potential effects on marine fauna has not identified any organisms that would be sensitive to such small increases in temperature (CMACS, 2011b). Therefore impacts have been assessed as **Not Significant.**

10.9 References

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11 FISH & SHELLFISH

11.1 Introduction

This Section provides an overview of fish and shellfish species likely to be present along and adjacent to the proposed marine cable route corridor. The assessment considers the likely impacts that the marine cable installation and operation may have on fish and shellfish species and the mitigation measures to be implemented to avoid, reduce, and offset any potential impacts. Impacts on commercial fisheries are considered separately in Section 15.

11.2 Data Sources

Baseline conditions have been established by undertaking a desktop study of published information and through consultation with relevant bodies.

The primary data sources used in the assessment of impacts on fish and shellfish are as follows:

- Desk based fishing report (Network Services, 2011)
- Environmental Survey Reports (MMT, 2012; 2013)
- Fisheries sensitivity maps for UK waters (Coull et al., 1998)
- Spawning and Nursery Grounds of Selected Fish Species in UK Waters (Ellis et al., 2012)
- Coastal Directories Region 5 (JNCC, 1995)

11.3 Methods

11.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on fish and shellfish have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential effect incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor.

11.3.2 Magnitude of Impact

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential effect and takes into account the likelihood of an effect occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the effect prior to recovery. Criteria for describing the magnitude of effect are described in Table 11-1.

Table 11-1: Magnitude Criteria

Magnitude	Description
High	Major alteration to population levels (including through habitat availability or prey/predator levels) and/or impacts long-term (e.g. > 5 years) and/or irreversible
Medium	Appreciable alteration to population levels and/or impacts medium-term (e.g. 1-5 years) and/or irreversible
Low	Minor alteration to population levels and/or impacts short-term (up to 1 year) and/or reversible
Negligible	No measurable alteration to population levels and/or impacts short-term and/or reversible

11.3.3 *Sensitivity or Importance of Receptor*

The sensitivity of the baseline conditions has been assessed according to the relative importance of the fish and shellfish habitat and species present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance) and capacity to absorb change.

The criteria provided in Table 11-2 provide a general definition for determining the sensitivity of fish and shellfish habitat and species.

Table 11-2: Sensitivity Criteria

Sensitivity	Description
Very High	Feature is of very high environmental value, quality or rarity on a national scale and/or has little or no ability to absorb change without fundamentally altering its character.
High	Feature is of very high environmental value, quality or rarity on a national scale and/or has little or no ability to absorb change without fundamentally altering its character.
Medium	Feature is of medium environmental value, quality or rarity on a local scale and/or has a moderate capacity to absorb change without significantly altering its character.
Low	Feature is of low environmental value, quality or rarity on a site scale and is tolerant to change without detriment to its character.
Negligible	Feature is of low or no environmental value, quality or rarity on a local scale and is resistant to change.

11.3.4 *Significance of Impacts*

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6.4 and also using professional judgement. The significance of a given impact is based on a combination of the sensitivity or importance of the receptor and the magnitude of a potential effect. The impact significance is assessed as Major, Moderate, Minor or None. The term 'None' denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account the mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

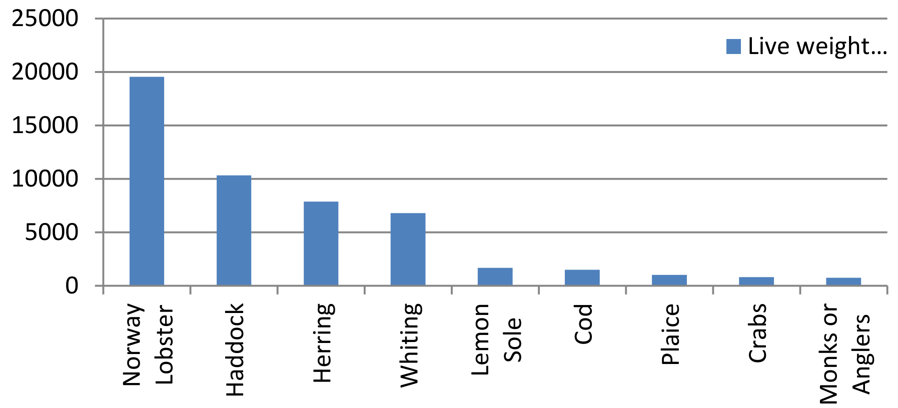
Residual impacts identified as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. The full results of the assessment of impact significance are presented in Appendix 2.3.

11.4 Existing Conditions

Approximately 230 species of fish are known to inhabit the North Sea (OSPAR, 2013). Analysis of fisheries statistics from the Marine Management Organisation (MMO) provides a useful indication of the type of species classified as pelagic (free swimming) or demersal (bottom dwelling), present in the vicinity of the proposed marine cable route corridor. It should be noted that this does not provide a definitive guide to the fish and shellfish in the area and the levels of catch do not correspond to community structure. However as many of the species found in the North Sea are commercially exploitable it does serve as a useful indicator.

The MMO fisheries data collected for the period 2002 - 2012 from the closest International Council for Exploration of the Sea (ICES) rectangles show that 102 species were landed from waters in close proximity to the proposed marine cable route. The species with the highest landing weight over the nine year period are presented in Figure 11.1. This however does not show recent trends in fishing activity and availability. Fish landings data from the most recent years has seen a switch from traditional fisheries of herring, cod and haddock to the Norway lobster fishery. This may indicate that stocks of traditional fish are no longer always a viable option for fishing vessels or may be a result of the enforcement of the cod recovery programme.

Figure 11-1: Species with the highest landing weight (2002-2011)



Source: MMO (2012)

11.4.1 *Spawning and Nursery Grounds*

Fisheries sensitivity maps (Coull *et al*. 1998: Ellis *et al.* 2012) provide information on spawning (the location where eggs are laid) and nursery areas (the location where juveniles are common) for fish-stocks in the region. In general, the spawning and nursery grounds of individual species cover large areas of the North Sea.

This data indicates that the proposed marine cable route passes within or close to the spawning grounds for 10 commercially important fish species. The waters of the area also act as a nursery for 8 commercially important fish species (see Table 11.4 and Figure 11.2; Appendix 1).

Of these species, high intensity nursery areas for herring (*Clupea harengus*), cod (*Gadus morhua*) and whiting (*Micromesistius poutassou*) are found at the inshore areas of the Northumberland coast in the vicinity of the proposed Cambois Beach North landing route (Ellis *et al*. 2012).

Table 11-3: Summary of spawning and nursery areas for the main commercial species

Species	Spawning Period	Nursery Period	Preferred habitat
Cod	January-April	N/A	Demersal
Lemon sole	March-May	March-July	Demersal
Herring	March-April	March - June	Pelagic
Nephrops	All year	All year	Demersal
Plaice	January- March	January-May	Demersal
Sprat	May- August	N/A	Pelagic
Whiting	February-June	February-August	Demersal
Norway Pout	Jan- April	Jan - June	Demersal
Mackerel	May - July	May - September	Pelagic
Sandeel	November- February	November - April	Demersal

Source: Coull et al. (1998), Ellis et al. (2012)

The species most likely to be affected by installation activities are those in their early life stages, either egg laying or larval or juvenile ages. In particular, demersal spawning species which lay their eggs on specific seabed types, such as herring, cod and those species which live in contact with the seabed such as Norway Lobster (Nephrops*)* and sandeel. Sandeel are of particular importance in the North Sea as they are an important component to food webs in the wider region and are protected under the UK Biodiversity Action Plan (UKBAP). Pelagic spawners such as plaice, whiting and sprat release their eggs into the water column. Sediment distribution maps are a good indication of habitat type, and can help to predict potential spawning and nursery areas.

The inshore area (within 11km of the coast) has been identified as consisting of harder sediments (predominantly clay with a shallow surface layer of sand) than offshore sediments (predominantly sand). Sand content of the sediment increases with proximity to the shore (MMT, 2012) and this area is indicated to be a high intensity nursery ground for herring, cod and whiting (Ellis *et al.* 2012).

Offshore, the spawning and nursery areas through which the proposed marine cable route corridor passes are extensive, covering a wide area of the North Sea. Tidal currents also carry fertilised eggs and tiny juvenile fish species within the plankton to nursery areas (areas which provide plentiful food and shelter for young fish species). Once grown most fish leave their nursery grounds.

Some species do not migrate from their nursery grounds e.g. Nephrops which do not move far from their burrows and spend their life in the area in which they settle as larvae (DTI, 2001). The low residual current flow in the location where Nephrops are known to spawn means that this species is concentrated in high numbers in certain areas within the North Sea. The distribution of spawning grounds is best illustrated by the distribution of landings (see Section 15) which indicates that Nephrops appear to be most concentrated within the area of The Farne Deep (Network Services, 2011).

11.4.2 Elasmobranchs

The term elasmobranch encompasses sharks, rays and skates. Most elasmobranchs are characterised by slow growth, late maturity, low fecundity and productivity, and therefore have a limited capacity to recover from population declines (IUCN, 1997). There are 15 species of elasmobranch listed on the UKBAP list, of these, the basking shark (*Cetorhinus maximus*) the largest fish found in UK waters, tope (*Galeorhinus galeus*) and porbeagle (*Lamna Ditropis*) are likely to occur seasonally in small numbers throughout the North Sea (DTI, 2001). Few sightings of these species have been recorded in the vicinity of the proposed marine cable route corridor to date, with only one sighting of basking shark during September 2012 close to the Farne Islands (Northumberland Wildlife Trust, 2012).

Elasmobranch species are sensitive to electric fields, and rely on their keen electric sense in detecting enemy and prey, orientating to ocean currents, and sensing their magnetic compass headings. Their electro-sensory organs known as the ampullae of Lorenzini, can result in increased electric sensitivity 1,000 to 10,000 times greater than other marine fish.

11.4.3 Shellfish

Consultation with fishermen's organisations has identified a number of commercially important shell fisheries along the proposed marine cable route. Common lobster (*Homarus gammarus*), Norway lobster (*Nephrops norvegicus*) and ocean quahog (*Arctica islandica*) are regularly fished in the vicinity of the proposed marine cable route corridor.

Common lobster is found on rocky areas, living in holes and excavated tunnels from the lower shore to approximately 60m depth. Lobster can grow up to 1m in length, but 50cm is more common (Marlin, 2013). In the vicinity of the proposed marine cable route corridor, lobster fisheries are concentrated on harder near shore grounds with rocky outcrops out to approximately 2-3nm from the shore (Network Services, 2011).

Nephrops is a small lobster, which grows to a maximum length of 25cm (including the tail and clawed legs), although individuals are normally between 18-20cm. Nephrops are found sublittorally in soft sediments, commonly at depths greater than 200m, although considerable populations exist at depths less than this. They live in shallow burrows and are common on fine cohesive mud sediments as these are stable enough to support their burrows (Marlin, 2013). The Environmental Survey of the proposed route (MMT, 2012) identified the UKBAP 'Deep Sea mud habitat' to be a dominant habitat type along the proposed marine cable route and this is characterised by burrowing mega fauna such as Norway lobster. Abundant Nephrops fisheries are also located in the vicinity of the proposed marine cable route in the area of the Farne Deeps and The Holes, although the proposed marine cable route has been designed to avoid the most intensively fished grounds.

Ocean quahog is a large cockle shaped bivalve which can grow up to 13cm across. The quahog is a long lived animal, which grows very slowly, and can take up to 50 years to reach market size. They are at particular risk from bottom fishing gear, and, like other slow-growing animals, once their numbers have been reduced the populations can take a long time to recover. Ocean quahog is not characteristic of any particular habitat and is known to occur in a range of sediments from coarse clean sand to muddy sand and over a wide depth range up to 400m. Particularly high densities have been reported within Scottish offshore waters in the Fladden Grounds (SNH, 2013). The proposed marine cable route corridor passes through the southern section of the Fladden Grounds. Although found extensively throughout the North Sea, the quahog is on the OSPAR list of threatened and/or declining species and habitats.

11.4.4 Migratory Fish Species

Migratory fish species are present in the vicinity of the proposed marine cable route corridor. Some species require both the sea and freshwater systems to complete their life cycle. They make extensive migrations to and from spawning grounds with time to maturity often taking several years.

Anadromous Species

Anadromous species such as salmon (*Salmo salar)*, sea lampreys (*Petromyzon marinus*) and sea trout (*Salmo trutta*) spawn in freshwater river systems before migrating out through estuaries and into the open sea environment to mature. The River Coquet and Coquet Valley Woodlands SSSI (approximately 21km from the cable landfall at Cambois Beach) has been recognised for salmon and sea trout. Other rivers in the vicinity of the proposed marine cable route which have been noted for salmon species are the rivers Aln, Tyne, Wear, Tees, Esk, Yorkshire Ouse, Humber and Trent (DTI, 2001). Salmon is an EC Habitats Directive Annex II species and both salmon and sea trout are UKBAP species.

Catadromous Species

Catadromous species spawn in the sea and migrate to fresh water systems where they spend most of their life cycle. European eels (*Anguilla anguilla*), spawn in a specific area of the Atlantic (Sargasso Sea) from where ocean currents transport the young eels back to European coasts. The young eels (elvers) enter freshwater systems to grow and mature. Some may remain in estuarine and coastal areas, rather than move upstream (Cefas, 2013). Adults pass through the estuaries in September–December, and elvers ascend in spring and early summer. This species has undergone persistent decline in recent years and, as such, has recently been adopted as a UKBAP priority species.

There is potential for both these types of migratory species to be present in the vicinity of the proposed marine cable route and the Cambois Beach landfall site on the Northumberland coast.

11.4.5 Species of Conservation Importance

The following species may be present in vicinity of the proposed marine cable route and are identified on OSPAR's list of Threatened and/or Declining Species and Habitats (OSPAR, 2008):

- Cod (Gadus morhua)
- Salmon (Salmo salar)
- Sea lamprey (Petromyzon marinus)
- Ocean Quahog (Arctica islandica)

The following species may be present in the vicinity of the proposed marine cable route and have been identified on the UK BAP as species of priority for conservation action:

- Cod (Gadus morhua)
- Plaice (Pleuronectes platessa)
- Sea trout (Salmo trutta)
- lesser sandeel (Ammodytes marinus)
- Mackerel (Scromber scrombus)
- Herring (Clupea harengus)

The European sturgeon (*Acipenser sturio*) may also be present within the vicinity of the proposed marine cable route. Although on the geographical limit of its range, it has been identified as Critically Endangered on the IUCN Red List (Gesner *et al*, 2010).

11.4.6 Sensitivity to Noise Levels

Some marine fish can produce and detect noise, and while not fully understood, this is thought to be associated with alarm calls and social behaviour, and studies have found that general noise such as is generated by shipping activity can cause an avoidance or attraction reaction in fish (Thomsen, 2006).

Sound pressure is only detected by those fish species with swim bladders. Hearing specialist species such as herring are able to detect relatively high frequency sounds (to over 3 kHz) with optimum sensitivity occurring between 300Hz and 1kHz. However, most fish have optimum sensitivity between 100Hz and 400Hz, and can only detect noise up to 1kHZ.

Other marine groups present within the North Sea, for example cephalopods and prawns, are considered to be no more sensitive to anthropogenic noise than marine mammals or fish (CMACS, 2011b).

11.4.7 Sensitivity to Electromagnetic Fields

During operation HVDC cables such as the proposed marine cables emit small electromagnetic fields which will cause a change in the detectable level of these fields in the immediate vicinity of the cable. The effect will be present along the entire proposed marine cable route.

Magnetic Fields

Marine organisms can detect magnetic fields either directly or indirectly through induced electric field detection.

Species able to directly detect magnetic fields are believed to use magnetic particles (magnetite) within their own tissues. Fish and shellfish species include salmon, lobsters, crabs and bivalve molluscs.

Electric Fields

The second group of species able to detect magnetic fields are those that detect it through induced electric fields, the most sensitive species being elasmobranchs (sharks, skates and rays) and holocephalans (e.g. ratfish) and agnathans (e.g. lamprey). These species are able to detect the presence of magnetic fields from the electric field induced by movement of an object or water through the magnetic field. Elasmobranchs are the most sensitive species to electric fields, and are able to detect very weak voltage gradients, as low as 5 to 20nV/m. Teleost species such as salmon and plaice as well as lampreys are also able to detect electric fields, however they are significantly less sensitive than elasmobranchs (CMACS, 2011a).

11.5 Potential Impacts

The potential impacts to fish and shellfish from installation and operation of the marine cables is provided below. The full results of the assessment of impact significance are presented in Appendix 2.3.

11.5.1 Installation

Loss or disturbance of general seabed habitat from cable installation

Loss or disturbance of seabed habitat will occur as a result of jetting, trenching and through the use of rock protection where cable burial is not possible. The footprint of the cable installation machinery could be up 5m wide for jetting. The marine cable will be buried between 1.5 to 2m (see Section 5).

Sea bed sediments in the vicinity of the cable route range from gravelly to muddy sand with areas of clay, which are typical of the widespread sediment character of this part of the North Sea (BGS, 2011). The loss or disturbance of habitat during the installation operation will be localised, representing only a very small footprint of the wider region (approximately 6.8km^2). All mobile species along the proposed marine cable route corridor will be able to relocate to alternative habitat nearby during installation and return once the cable has been buried. Sessile species will be lost buried or displaced.

The sensitivity of fish and shellfish to disturbance or habitat loss has been assessed as medium. The magnitude of this effect is considered to be negligible due to any impacts being localised and temporary to fish and shellfish populations. The significance of the impact on fish and shellfish from loss or disturbance to general seabed habitat is therefore assessed as **Minor**.

Disturbance to spawning and nursery grounds from cable installation

The proposed marine cable route corridor passes through ten spawning and nursery areas for fish species. Of these, seven are for demersal spawning species and three are for UKBAP species. The inshore section of the proposed marine cable route corridor passes through an area identified as a high intensity nursery for herring, cod and whiting (Ellis *et al.* 2012).

The species most likely to be affected by installation activities are those in their early life stages, either egg laying or larval or juvenile ages. In particular, demersal spawning species which lay their eggs on specific seabed types, such as herring, cod and whiting or those species which live in contact with the seabed such as Nephrops and sandeel.

Offshore, each of the spawning/nursery areas through which the proposed marine cable route corridor passes are extensive, covering a wide area of the North Sea. Impacts to adult common lobster and Norway lobster may occur through removal of mature individuals along the cable route within the footprint of the installation tool (up to 5m width).

The sensitivity of fish and shellfish species has therefore been assessed as high due to the conservation value of certain fish species likely to be spawning or using nursery grounds in the vicinity of the proposed marine cable route, and the presence of the high intensity nursery for herring, cod and whiting. The magnitude of this impact has however been assessed as negligible due to the localised and temporary nature of the impact and the ability of mobile species to move away from the operational area. The recoverability of soft sediments is high, therefore re-colonisation is expected to occur rapidly. Therefore the significance of disturbance to spawning and nursing areas is assessed as **Minor**.

Smothering of demersal species from cable protection

In areas of cable or pipeline crossings or where target burial cannot be achieved it will be necessary to deposit rock or mattresses on the seabed to protect the cable.

The primary threat to benthic fish and shellfish communities from the placement of cable protection (rock berms) will be direct smothering from the cable protection, but also potentially, from any displaced or settling suspended sediments which are disturbed when the cable protection is installed. Any sediment suspension and deposition as a result of cable protection activities will be very localised and short-term in duration.

The longer term impacts of rock placement are mortality to sessile species within the footprint of the cable protection. Faster moving mobile species may be able to avoid smothering by moving away from the area. The sensitivity of fish and shellfish species has been assessed as medium with a moderate capacity to absorb change without fundamentally altering the overall character of fish and shellfish populations in the area. The magnitude of this effect has been assessed as low due to the ability of mobile demersal species to move away and the localised nature of the impacts. The significance of this impact is therefore assessed as **Minor**.

Loss or disturbance of spawning and nursery grounds from cable protection

The main threat to benthic fish and shellfish communities from rock placement will be smothering directly from the placement of cable protection (rock berms or concrete mattresses) on the seabed and, potentially, from the plume of fine sediment deposited when the rocks are positioned. Approximately 9.6km ($0.13km^2$) of the proposed marine cable route will be protected using rock placement. This is at the crossing locations with existing cables or pipelines and at discrete areas along the route where rock placement is required to achieve adequate cable burial depth.

Shellfish, eggs and immobile juveniles present on the seabed will be unable to move away from under the footprint of any rock placement and will be smothered. The extent of rock placement within the spawning grounds, and the more extensive nursing grounds which cover relatively large areas of the North Sea is very small. Impacts from rock placement are unlikely to adversely affect the overall population size of fish and shellfish species as their recoverability from disturbance is expected to be good. Deposited rocks may provide a new habitat for colonisation such as a stable reef type substrate on which organisms may attach. Over time this may support a different range of benthic epifauna and result in a different and potentially more diverse fish species. This may have a positive benefit on the localised marine environment.

The sensitivity of spawning and nursery habitat has been assessed as high as any eggs or larvae present on the seabed at the time of cable protection installation would be removed or destroyed. The magnitude of this impact has been assessed as negligible due to the low level of change expected to fish populations and the limited spatial extent of rock placement within spawning and nursing grounds. The significance of disturbance on fish spawning and nursing from rock placement has been assessed as **Minor**.

Suspended sediment dispersion and deposition effects on demersal species

The degree of sediment suspended in the water during cable installation will depend upon two main factors; the seabed type, and the cable burial techniques used.

Estimated sediment deposition levels have been calculated in Section 8. Overall sands and silts make up over 97% of the bed material with gravel and clay making up the remaining 3%. Sands and silts released during cable installations will be temporarily deposited on the seabed but will be rapidly re-suspended, while gravel and clay will remain on the seabed for an appreciable time. Depending on the exact installation tool used, a band of gravels around 0.8m wide will remain after other fractions have been re-suspended at a depth of around 10mm.

While mobile fish and shellfish species can move away from areas of increased sediment loads, suspension-feeding shellfish could be more detrimentally impacted by the re-suspension of sediments from cable installation. An increase in suspended sediments, sediment deposition and remobilisation of any contaminants may directly interfere with the food uptake, potentially affecting growth and condition of these animals (ARC, 2003). However, any impacts will be temporary and limited to a relatively small area.

The sediment type in the vicinity of the proposed marine cable route corridor ranges from gravelly sand, to muddy sand with areas of clay. The predominant sediment type is sand. The majority of the proposed marine cable route therefore passes through soft sediment habitat which naturally experiences a high level of sediment deposition, suggesting that fish and shellfish species within this environment will have a high tolerance to sediment deposition or are mobile enough to avoid any potential impacts. Some species including Nephrops are particularly tolerant of a degree of smothering (OSPAR, 2010).

The sensitivity of fish and shellfish species has been assessed as medium with a moderate capacity to absorb change. The magnitude of the effect has been assessed as low due to the ability of mobile species to move away and due to any effects to filter feeding shellfish to be localised and temporary (one tidal cycle). The significance of this impact is assessed as **Minor**.

Suspended sediment dispersion and deposition effects on spawning and nursery areas

During marine cable installation some seabed sediment will be re-suspended into the water column causing a small localised and temporary increase in turbidity before being re-deposited on the seabed. The sensitivity of spawning and nursing grounds to the effects of suspended sediments will depend on the location along the proposed marine cable route corridor. The potential impact is greater on demersal spawning fish such as cod and whiting which utilise specific seabed areas for spawning. The conditions their eggs and larvae require are more specific and may not be available across the entire survey area. Therefore the sensitivity of fish species to suspended sediments has been assessed as medium with a moderate capacity to absorb change expected.

Juvenile fish species such as cod, sand eel and plaice also utilise the seabed and would also be impacted by the cable installation works; however, juvenile species, are mobile and able to move away from the immediate installation works and will only be temporarily displaced from the proposed marine cable route corridor. The extent of the spawning and nursery areas covers a large area, and the footprint of the installation is very small in comparison. Therefore due to the localised and temporary nature of the re-suspension of sediments, the magnitude of this impact has been assessed overall as low. The significance of this impact is assessed as **Minor**.

Suspended sediments reducing feeding success of visual species

As discussed above, some seabed sediment will be re-suspended into the water column causing a small localised and temporary increase in turbidity before being re-deposited on the seabed. Jetting is the preferred installation method. Installation by jetting fluidises sediment particles, which may increase suspended sediment volumes over a longer duration.

As the sediment is within the water column, light is reduced and there is potential for a temporary and localised reduction in feeding success of species relying on sight to locate their prey. As turbidity increases, the distance at which predator-prey interactions occur decreases (Robertson *et al*, 2006). There is potential for protected species of salmon and cod to be in the vicinity of the installation, however, the sensitivity of fish and shellfish species has been assessed as low as most species would be expected to be tolerant to any changes in turbidity levels or have the ability to move away from the turbid conditions.

Given the relatively low levels of suspended sediment that will be generated during installation, and the temporary and localised nature of this impact (predicted to last for one tidal cycle), the magnitude of the effect has been assessed as low. Therefore the overall impact significance is assessed as **None**.

Disturbance from noise and vibration during installation

Most anthropogenic noise emitted is of relatively low frequency sound below 1kHz. Most noise generated by marine cable installation is expected to be at relatively low frequency levels. Lower frequencies are considered to be less disturbing to marine fauna than higher frequencies as there is a high level of background noise from shipping, dredging and land based sources, contributing to existing low frequency background noise which the marine fauna is habituated to (CMACS, 2011b).

Marine cable installation will generate noise from a variety of sources, including: vessel activity, cable trenching, ploughing and rock protection placement (see Table 11.5). Of these, the highest levels of noise are expected to arise from vessel dynamic positioning systems.

Table 11-4: Noise range of cable installation activities

Cable Installation Activity	Noise range (dB re 1 μPa @ 1m)
Cable trenching, ploughing and cutting	172 - 185
Rock protection placement	120 - 177
Dynamic Positioning Systems	177 - 197
Support Vessels	171 - 181

Source: Richardson et al. (1995)

Fish species with swim bladders are susceptible to the pressure wave produced by subsea noise. Sensitive species likely to be present in the vicinity of the proposed marine cable route corridor includes herring, sprat, cod, mackerel and salmon (BERR, 2008).

Temporary displacement of some species can be anticipated for distances up to several hundred meters when DP is used, and smaller distances in proximity to other works. The presence of several vessels and continued noise with 24-hour operations means it is likely that the most sensitive fish will demonstrate an avoidance response early on and remain outside the zone of operations for the short duration of the installation activities. Temporary displacement of some marine fish species is anticipated, but noise levels are anticipated to be below those believed to cause physical harm.

The sensitivity of fish and shellfish species has been assessed as medium with at least a moderate capacity to absorb change from increased noise levels. Fish species may be displaced from their spawning grounds during installation, however this impact will be localised and temporary and fish are expected to return when installation activities have progressed or ended. Therefore the magnitude of the effect is considered to be low. The significance of this impact is assessed as **Minor.**

Pollution from discharge of grey water from installation vessel

During the installation operations it is possible that construction vessels will discharge grey water, sewage, food waste and drainage water outside of 12nm from the coast. Discharges can be potentially harmful to fish and shellfish species and can lead to localised organic enrichment, introduction of invasive species and a change in the balance of the food chain. Neither organic enrichment nor oxygen depletion is considered likely, due to the relatively small cumulative volume of any discharges. Fish and shellfish are therefore likely to be tolerant to routine vessel discharges associated with the installation period and sensitivity has been assessed as low.

The short timescale of the project and small cumulative volume of discharges in proportion to the total volume discharged as a result of shipping activity within the vicinity of the proposed marine cable route corridor, result in any effects being localised and temporary and the magnitude of any effect has therefore been assessed as low. Therefore the overall impact significance is assessed as **None**.

Introduction of non-native species from installation vessel ballast waters

Fish and shellfish are potentially highly sensitive to the introduction of non-native species. Vessels commissioned to undertake the installation are likely to have only been operating in northern European continental shelf waters, and are therefore unlikely to introduce invasive species from distinctly different biological areas. Therefore the possibility of invasive species being introduced is limited, and the magnitude of the impact has been assessed as negligible. The overall significance is considered to be **minor.**

Accidental hydrocarbon or chemical release from installation vessel

Data showing the probability of a hydrocarbon or chemical release from installation vessels is not available. However, analysis of data from the Advisory Committee on Protection of the Sea (ACOPS) Annual Survey of Reported Discharges shows that during the period 2002-2011 there was an average of 447 oil or chemical releases from vessels per year in the region of the North Sea through which the proposed marine cable route corridor passes (ACOPS, 2002-2011). Of these incidents the majority occurred in the UKCS related to oil and gas activities; incidents within the north east England region were within ports and harbours. During 2011 there were no reported discharges from offshore support vessels.

The running aground of a vessel or a collision could lead to a fuel release and cleaning fluids, oils and hydraulic fluids used on board cable lay vessels and during ROV operation could be released overboard or accidentally discharged. Juvenile fish species and shellfish are most susceptible to oil spills, while adult fish are more resilient, and are thought to actively avoid areas of spillages. The sensitivity of fish and shellfish has been assessed as medium. Overall, a hydrocarbon or chemical release from construction vessels is considered unlikely; especially considering the presence of marine cable installation vessels will only marginally increase the risk of a pollution incident. Therefore the magnitude of this effect has been assessed as low. The significance of this impact is assessed as **Minor**.

Substrate change due to presence of installed cable protection

The installation of external cable protection (rock berms) is limited to short sections of the route (approximately 56m^2) and will introduce new hard substrate for colonisation. This has the potential to change local fish and shellfish habitat characteristics especially in areas of soft/sandy sediments. In terms of the fish community, the hard substrate may act like an artificial reef. However, rather than changing the baseline by attracting new species to the area, it is more likely that existing species in the area will be using the new stable habitat and benefit by feeding on newly colonising fauna and flora. The sensitivity of fish and shellfish species to the presence of installed cable protection has been assessed as high as the substrate change may result in a change to the character of the fish and shellfish community. The magnitude of the effect is considered to be negligible as whilst the presence of the cable protection is permanent it will be localised to discrete sections of the cable route. In addition it is possible that the cable protection will become covered with layers of sediment, and therefore reduces the magnitude of the impact. The significance of this impact is assessed as **Minor.**

11.5.2 Operation

Electromagnetic Fields (EMF)

There is potential for electromagnetically sensitive fish species such as salmon and elasmobranchs (sharks, rays) to be present in the vicinity of the marine cable route corridor. The expected magnetic field (B-Field) to be generated by the proposed marine cable is likely to be below natural geomagnetic field levels within several metres of the cables and pelagic species able to detect magnetic fields such as salmon, will therefore be unlikely to be affected by B fields.

The potential effects on navigation and physiology of invertebrate species such as lobster, crabs, shrimps, molluscs, scallops and mussels, which inhabit the North sea, as a result of B-fields generated by cables remains uncertain, however where the cables are buried many invertebrates will be protected from the highest B-fields. Burrowing and benthic species are most likely to encounter stronger B-fields; and where the cable is surface buried and rock placement is used, it is likely that invertebrates and some fish species will colonise between the spaces between the rocks and will potentially then come into contact with stronger B-fields (CMACS, 2011a). However, any effects upon orientation behaviour are likely to be small and temporary, with normal movement and migration expected to resume once beyond the zone of influence of the B-fields.

Elasmobranchs are sensitive to electric fields (E Fields), and therefore may be able to detect induced E fields generated by the movement of water through the cables magnetic field or it has also been found that if such species swim at high enough speeds across the operating cable, then there is potential for the cable to produce an induced electric current.

Elasmobranchs are known to be repelled by strong electric fields, which has previously raised concerns that cables inducing such electric fields may act as barriers to movement (e.g. between feeding, mating and nursery areas. The potential avoidance distance is however expected to only be where fields are strongest in close vicinity to the cables and would largely be negated by burial or rock dumping.

It is clear that any species capable of moving away from the seabed into the water column would be able to cross the cable; all elasmobranch species can do this although whether predominantly benthic species would do so to pass by the cable is not known. There is however no research or evidence to suggest that they would not be able to pass the cable.

Elasmobranchs may also confuse induced E-fields with natural bioelectric fields and this may interfere with prey, predator, mate detection and navigation behaviours. Benthic species which are more likely to encounter the E-fields, induced around the HVDC cable include severally commercially important such as skates, rays, angel sharks, nursehounds and spurdogs. Induced E fields are however expected to attenuate to levels approximately comparable to background levels within a short distance of the separate cables. Confusion effects may potentially occur within these distances, but the significance of such effects is unknown.

Some species such as the basking shark are protected under the Wildlife and Countryside Act 1981 and listed on the UK Biodiversity Action Plan (BAP). For this reason the sensitivity of fish and shellfish to electromagnetic fields is considered to be high.

The impact of electromagnetic fields produced during operation of the cable will be localised to the immediate vicinity of the cable. Outside of this distance there is no effect to fish and shellfish. The magnitude of the impact has therefore been assessed as negligible. The significance of the impact is therefore **Minor**.

Heating

Calculations of sea bed temperature rises from similar HVDC cable installations to the Norway-UK Interconnector buried to a depth of 2.5m indicate that temperature raises at the seabed are likely to be a maximum of approximately 1.2ºC above background levels (NEMO, 2013). Temperatures are expected to increase above background levels to approximately 10-30cm immediately above the cable, reducing with distance from the cable.

Proposed burial depths are less for the UK-Norway Interconnector HVDC cable (minimum of 1.5m), and therefore heating may be slightly greater at the seabed surface, than with the NEMO HVDC cable. Heat will be dissipated by the presence of sea water. Fish and shellfish are unlikely to experience any adverse impact from the operation of the cable and their sensitivity has been assessed as low. The magnitude of the impact of heating to fish and shellfish is assessed as low. The significance of the impact is therefore considered to be **none.**

11.6 Mitigation Measures

11.6.1 Installation

Pollution from discharge of grey water from installation vessel

- All vessels associated with cable installation will comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations.

Introduction of non-native species from installation vessel ballast waters

- Installation vessels will follow IMO ballast water management guidelines and/or European interim strategies (prior to the entry into force of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (EMSA, 2008)), developed to reduce the risk of the introduction of non-native species into the marine environment.

Accidental hydrocarbon or chemical release from installation vessel and discharge of grey water from installation vessel

- All vessels associated with cable installation will comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations.

11.6.2 Operation

No mitigation measures are proposed.

11.7 Residual Impacts

11.7.1 Installation

Loss or disturbance of general seabed habitat and spawning grounds from cable installation

There are no mitigation measures in place to reduce the impact further. The impact is localised and effects will be temporary and minor. Minor impacts are **Not Significant.**

Loss/smothering or disturbance of demersal species and nursery grounds from cable protection

There are no mitigation measures in place to reduce the impact further. The impact is localised and effects will be temporary and minor. Minor impacts are **Not Significant.**

Suspended sediment dispersion and deposition effects on demersal spawning and nursery species

Approximately 80% of suspended sediment is expected to fall directly back in to the trench. The remaining finer particles could be transported over a wide area up to 5.6km. However, close to the shore (KP 711.2 to KP 691.0) where predicted deposition depths are greatest; the re-deposited bed substrate will be rapidly re-suspended. In this near-shore zone, the bed substrate is naturally continually re-suspended and deposited. Both tidal current and wave action contribute to this sediment re-suspension. This near-shore area is expected to have moderate to good tolerance to this level of sediment deposition. There are no mitigation measures to reduce the effects of this impact further, however the impact is considered **Not Significant.**

Suspended sediments reducing feeding success of visual species

There are no mitigation measures required for this impact. The impact is considered **Not Significant.**

Disturbance from noise and vibration during installation

There are no mitigation measures to reduce the impact further. However the impact is considered **Not Significant.**

Pollution from discharge of grey water from installation vessel

Complying with MAPOL regulations will minimise the likelihood of release from installation vessels. With this mitigation in place, the impacts to protected areas are minimised. The likelihood of pollution from project vessels is very low; there is no residual impact therefore it is considered **Not Significant.**

Introduction of non-native species from installation vessel ballast waters
With the implementation IMO ballast water management guidelines, the likelihood of the impact occurring has been reduced to ALARP and as such it has been assessed as having a minor residual impact. Minor impacts are assessed as **Not Significant.**

Accidental hydrocarbon or chemical release from installation vessel
With mitigation in place, the impacts to fish and shellfish are minimised. The likelihood of pollution from project vessels is very low, the magnitude of the impact is reduced to negligible; therefore the residual impact has been assessed as minor. Minor impacts are **Not Significant.**

11.7.2 Operation

Electromagnetic Fields (EMF) and Heating
The effects of this impact are considered to be minor and none respectively. The impacts are therefore **Not Significant.**

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12 ORNITHOLOGY

12.1 Introduction

This Section provides an overview of the marine and coastal bird species that are likely to be encountered along and adjacent to the proposed marine cable route corridor. The assessment considers the potential impacts that proposed marine cable installation and operation may have on birds and identifies mitigation measures to be implemented to avoid, prevent, reduce and offset any potential impacts.

12.2 Data Sources

Baseline conditions have been established by undertaking a desktop study of published information and through consultation with relevant bodies. Data sources used in this assessment include but are not limited to the following:

- Blyth-Cambois Wader Study Northumberland County Council commissioned study of SSSI/SPA waders in the Blyth-Cambois area (SKM Enviros, 2011).
- Northumberland Local Development Orders: Bates Site, Blyth; and East Sleekburn Sites. Nature Conservation Ecological Assessment (Including Habitat Regulations Screening) (Northumberland County Council, 2012).
- National Renewable Energy Centre (NAREC) Blyth Offshore Demonstration Project Environmental Statement, (2012).
- Block specific seabird vulnerability tables for the UK (JNCC, 1999).
- Importance of the Farne Deeps and surrounding waters off the Northumberland coast for White-beaked Dolphin and other cetaceans and seabirds of Conservation Concern. Commissioned by Natural England (Brereton et al, 2010).
- Natural England Technical Information Notes. Species Information for Marine Special Protection Area Consultations (2012).
- JNCC Atlas of Seabird Distribution in north-west European Waters (Stone et al, 1995)
- JNCC Website for SPA Descriptions (JNCC, 2001).
- Birdlife International Species Factsheets (2013).

12.3 Methods

12.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on marine and coastal birds have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

12.3.2 *Magnitude of Impact*

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential impact and takes into account the likelihood of the impact occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of impact are described in Table 12-1.

Table 12-1: Magnitude Criteria

Magnitude	Description
High	Affect an entire population in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment would not return that population, or any population dependent upon it, to its former level within several generations of the species being affected, or a moderate impact affecting a species of national or international importance.
Medium	Damage or disturbance to a population above those experienced under natural conditions, over one or more generations, but which does not threaten the integrity of that population or any population dependent on it, or a minor impact affecting a species of national or international importance.
Low	Small-scale or short-term disturbance to a species, with rapid recovery rates, and no long-term noticeable impacts above the levels of natural variation experienced in the area. The impacts are not sufficient to be observed at the population level.
Negligible	Minimal impact from the work. Very minor damage, if any or to species of low ecological importance, or with immediate recovery rates.

12.3.3 *Sensitivity or Importance of Receptor*

The sensitivity of the baseline conditions has been assessed according to the recoverability of the receptor and the relative importance of the habitat and species present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance).

The criteria provided in Table 12-2 provide a general definition for determining the sensitivity of marine and coastal bird interests.

Table 12-2: Sensitivity Criteria

Sensitivity	Description
Very High	A regularly occurring, internationally significant population/number of any internationally important species which has no or a low ability to absorb change without fundamentally altering its character
High	A regularly occurring, internationally significant population/number of any internationally important species which has at least a moderate capacity to absorb change without fundamentally altering its character. Or A regularly occurring significant population/number of any nationally important species which has no or a low ability to absorb change without fundamentally altering its character.
Medium	A regularly occurring significant population/number of any nationally important species which has at least a moderate capacity to absorb change without fundamentally altering its character.
Low	A regularly occurring population with no national or international significance which has no or a low capacity to absorb change without fundamentally altering its character.
Negligible	A regularly occurring population with no national or international significance which has at least a moderate capacity to absorb change without fundamentally altering its character.

12.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the sensitivity or importance of the receptor and the magnitude of a potential impact. The impact significance is assessed as Major, Moderate, Minor or None. The term ‘None’ denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account any mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts assessed as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. The full results of the assessment of impact significance are presented in Appendix 2.3.

12.4 Existing Conditions

12.4.1 Coastal Birds

The Northumberland coastline provides important feeding, roosting and breeding opportunities for many species of coastal birds in nationally and internationally important numbers. This is reflected in the many designations for birds found along this stretch of coast (see Section 9). Those species and protected sites which may be impacted by the installation and operation of the proposed marine cables are considered in detail here.

There are three sites designated for their bird populations in the vicinity of the proposed Cambois Beach landfall site; the Northumberland SSSI through which the proposed marine cable route passes and the Northumbria Coast SPA and Ramsar sites which are located approximately 1km to the north and 2km to the south of the proposed landfall (see Figure 12.1; Appendix 1).

Northumberland Shore SSSI

The Northumberland Shore SSSI covers most of the coastline from the Scottish border to Tynemouth and consists largely of sandy bays separated by rocky headlands, backed by dunes or soft and hard cliffs. Discrete areas of estuarine intertidal mudflats and saltmarsh are also included (Natural England (1992).

This site has been designated for providing important wintering grounds for shorebirds, and it is of international, or national significance for six wader species; purple sandpiper (*Calidris martitima*), turnstone (*Arenaria interpres*), sanderling (*Calidris alba*), golden plover (*Pluvialis apricaria*), ringed plover (*Charadrius hiaticula*) and redshank (*Tringa totanus*). Other wintering birds the site is important for include; curlew (*Numenius arquata*), oystercatcher (*Haematopus ostralegus*), dunlin (*Calidris alpina*), knot (*Calidris canutus*), bar-tailed godwit (*Limosa lapponica*) and lapwing (*Vanellus vanellus*).

Northumbria Coast SPA and Ramsar Site

The Northumbria Coast SPA and Ramsar site includes much of the coastline between the Tweed and Tees Estuaries and consists of mainly discrete sections of rocky shores with associated boulder and cobble beaches (JNCC, 2013a). This SPA has been designated for supporting populations of European importance of over-wintering purple sandpiper (*Calidris martitima*) and turnstone (*Arenaria interpres*) and during the breeding season Little Tern (*Sterna albifrons*) as shown in Table 12-4.

Table 12-4: Northumbria Coast SPA qualifying species

Qualification	Period of use	Species	Numbers	Percentage of population*
Article 4.1 Directive (79/409/EEC) Annex I species	Breeding season	Little Tern (*Sterna albifrons*)	40 pairs	1.7% of breeding population in Great Britain
Article 4.2 Directive (79/409/EEC)	Winter	Purple Sandpiper (*Calidris*	763 individuals	1.5% Eastern Atlantic wintering

Qualification	Period of use	Species	Numbers	Percentage of population*
Migratory species		*maritima)*		population
		Turnstone (*Arenaria interpres*)	1,456 individuals	2.1% Western Palearctic wintering population

* 5 year peak mean 1991/2 – 1995/6

Source (JNCC, 2013a)

Table 12-5 below summarises species information for birds that occur at nationally or internationally important levels at the SSSI, SPA and Ramsar sites discussed above.

Table 12-5: Species information for nationally and internationally important bird species

Species	Information
Little tern	
The little tern is a strongly migratory coastal seabird which usually feeds in very shallow water only a few cms deep, primarily on small fish and crustaceans. It breeds between May and June in solitary pairs or small colonies on coastal sand on shingle substrates, sometimes nesting only metres from the high tide mark. (Birdlife International, 2013; DECC, 2010). Little tern do not forage far from their breeding site, which dictates a necessity for breeding close to shallow, sheltered feeding areas where they can easily locate the variety of small fish and invertebrates that make up their diet (JNCC, 2013b). The main nesting areas within the **Northumbria Coast SPA** are the sandy beaches adjacent to the Long Nanny at Low Newton (DECC, 2010). Little tern are highly vulnerable to human disturbance at coastal and inland nesting sites which can lead to nest failures (Birdlife International, 2013)	
Purple sandpiper	
Purple sandpiper is fully migratory and breeds on Arctic coasts and upland areas and arrives in the UK from September to April to over winter or to stop off on passage. The species shows a preference for feeding on tidal rocky shores predominantly upon molluscs (especially gastropods *Littorina* spp. and mussels *Mytilus* spp.) as well as insects (e.g. beetles and Diptera), small crustaceans (e.g. amphipods), annelid worms, small fish and algae (Enteromorpha spp.). The species utilises suitable high-tide roosting areas including artificial structures such as concrete sea defences and breakwaters (Birdlife International, 2013).	
Turnstone	
Turnstone is fully migratory and breeds on Arctic coasts or islands and arrives in the UK to overwinter from September until April. Non breeding birds may remain in the UK year round. Turnstone forage on productive rocky and shingle shores and sandy beaches on insects, crustaceans, molluscs (especially mussels or cockles), annelids, echinoderms, small fish, carrion and birds eggs (Birdlife International, 2013).	
Sanderling	
Sanderling is a long distance migratory bird travelling mainly offshore and utilising a number of favoured coastal stop off points. The species breeds in the high Arctic and is a passage visitor in the UK between September - May or a non breeding resident. The species is largely coastal during the winter, inhabiting open sandy beaches exposed to the sea, the outer reaches of estuaries, rocky and muddy	

Species	Information
shores, mudflats and coral reefs, Diet consists of small molluscs, crustaceans, polychaete worms and adult, larval and pupal insects (e.g. Diptera, Coleoptera, Lepidoptera, Hemiptera and Hymenoptera), as well as occasionally fish and carrion (Birdlife International, 2013).	
Golden plover	
Golden plover are fully migratory nesting in northern Europe and Iceland. The species is a passage visitor in the UK between September and April. The species inhabits wetlands and agricultural areas and forages on tidal shores, coastal rocky outcrops, intertidal flats and salt marshes in shallow bays and estuaries. Diet consists predominantly of insects, larval Lepidoptera, locusts and grasshoppers as well as earthworms, spiders, millipedes, snails, polychaete worms, crustaceans and some plant material (Birdlife International, 2013).	
Ringed plover	
Ringed plover are largely fully migratory and breed along Arctic coasts. There is a native breeding population in the UK which may breed inland on rivers, lakes, gravel pits or reservoirs, or on short grassland, farmland, muddy plains with stones or on shores and sandbars. Ringed plovers feed on invertebrates on sand and shingle shores, sandbanks and mudflats, as well as on saltmarshes, short grassland, flooded fields and shores of artificial habitats. They roost communally in flocks, close to feeding sites along the shoreline, on sandbanks or bare arable fields, and in low vegetation. Outside of the breeding season the species inhabits muddy, sandy or pebbly coasts in the tropics and subtropics and stops in the UK on passage boosting native numbers of this species overwinter (Birdlife International, 2013).	
Redshank	
Redshank are fully migratory and travel over land and along coasts. There is a native breeding population in the north east of UK and populations remain close to their breeding grounds in coastal salt marshes, inland wet grasslands with short swards and grassy marshes and swampland adjacent to the coast. Over wintering migratory birds arrive during October until May. The species diet consists of insects, spiders and annelid worms, as well as molluscs, crustaceans and occasionally small fish and tadpoles (Birdlife International, 2013).	

Source: www.birdlife.org factsheets

A Blyth-Cambois wader study commissioned by Northumberland County Council in 2011 included the intertidal area between the Blyth and the Wansbeck estuaries where the proposed marine cable landfall is located. Key areas within the SSSI/SPA for wading birds were identified (SKM Enviros, 2011), none of which are located in the area of the landfall site.

Cambois Beach is of greatest importance to wader bird species during the autumn and winter. The highest numbers of birds recorded relate to those foraging in this area during the low tide, although there are also two high tide roosts at Blyth North Beach (Green Skeer) and East Pier. Cambois Beach holds significant numbers of turnstone, ringed plover, redshank, oystercatcher and knot. Out of the whole study area it also provided the highest counts for five species, including the two SPA qualifying species purple sandpiper and turnstone plus sanderling, oystercatcher and knot.

The highest counts of most bird species using Cambois Beach were generally obtained from rocky shore areas in the south (approximately 2km from the proposed landfall site) within the boundary of the SPA and Ramsar site as shown in Figure 12.1 (Appendix 1). The extensive areas of intertidal rock platform at the southern end of the beach provide key feeding and roosting grounds, and regularly hold significant (>50) counts of SSSI/SPA waders (SKM Enviros, 2011).

The main sandy area of Cambois Beach, which includes the location of the proposed marine cable landfall site, is less important for birds. A disturbance study undertaken as part of the Blyth-Cambois wader study recorded a high number of disturbance events on Cambois Beach. Dog walkers accounted for over 80% of disturbance, with the other main disturbances attributed to fishermen and walkers. Most of the disturbance took place in the central, sandy part of the beach which potentially explains the lower value of this area to waders. Although very low numbers of waders were also recorded during nocturnal surveys, when disturbance would have been minimal, suggesting that there may be other factors influencing why this area is not regularly used by significant numbers of waders (SKM Enviros, 2011).

The proposed marine cable landfall at Cambois Beach North is located approximately 1km south of the River Wansbeck Estuary. The Blyth-Cambois wader study recorded significant counts of redshank, lapwing and dunlin for the River Wansbeck and Castle Island. All of the counts occurred during the autumn period suggesting the site is most important for passage waders (SKM Enviros, 2011). Additionally many species of wildfowl and waders are permanent winter residents. During harsh weather conditions when most inland wetlands are frozen, the estuary becomes very important in providing open water, mudflats and marsh for feeding birds (Hancox B, *pers. comm.* 2012).

During the summer the SPA qualifying species, little tern, has been observed in the vicinity of Cambois Beach; however, no breeding pairs have been recorded (Northumberland County Council, 2012). The closest little tern breeding colony is located near the mouth of Long Nanny Burn, Beadnell Bay approximately 44km north of the proposed Cambois Beach North landfall and is within the Northumbria Coast SPA.

12.4.2 Offshore Birds

Offshore waters are important for feeding, moulting and loafing[1] seabirds and for migration routes. Sub-tidal feeding, moulting and loafing areas for aggregations of water birds such as divers, grebes, and duck while on passage or over-wintering extend beyond 12nm offshore in some areas (JNCC, 2013c).

The JNCC Atlas of Seabird Distribution in northwest European Waters indicates that the species shown in Table 12-6 have been observed in the vicinity of the proposed marine cable route corridor.

Table 12-6: Offshore Bird Species

Species	Likely Period Present
Red Throated Diver	June - September
Fulmar	May - July
Great shearwater	July - November
Sooty Shearwater	July - November
Manx Shearwater	May - October

[1] Loafing birds are defined as a general state of immobility that involves a heterogeneous set of behaviours such as sleeping, sitting, standing, resting and preening that occur outside the breeding territory

Species	Likely Period Present
Storm Petrel	September – November
Leach's Petrel	September – November
Gannet	Year round
Cormorant	May – September
Eider	January – September
Common Scoter	October – December
Velvet Scoter	October – December
Arctic Skua	Year round – peak August - October
Great Skua	July – March
Little Gull	August – November
Black-headed Gull	July - February
Common Gull	Year round – peak October - February
Lesser Black-backed Gull	Year round – peak September -
Herring Gull	Year round – peak November -
Great Black-backed Gull	Year round – peak November –
Kittiwakes	Year round - peak August – October
Sandwich tern	May - October
Commic tern	April – June peak April - June
Guillemot	Year round – peak September -
Razorbill	Year round – peak October - January
Puffin	Year round – peak June - July

Source: Stone et al (1995)

Densities of seabirds offshore are predominantly low particularly in summer. With proximity to the coast seabird densities increase to medium (see Figure 12.2; Appendix 1). Subtidal sediments are an important feeding resource for foraging sea bird species, particularly during the summer when foraging occurs closer to the shore within range of breeding colonies. Sandeel are an important component of the food web in the North Sea and are the preferred prey item of many species of seabird particularly tern and puffin and therefore may provide a valuable food resource. One area of high abundance of sandeel was identified on the proposed marine cable route (MMT, 2012). This is located approximately 45km from the Long Nanny at Low Newton and 21km from the Coquet Island Little Tern Colony, approximately 8km offshore in water depths of 20-49m, and is therefore unlikely to be an important food source for breeding pairs of Little Tern. However this area is within a medium to high summer bird density (Figure 12.2; Appendix 1), indicating it may be of some importance to diving species. Further information on the location of sandeel including the location of spawning and nursery grounds is provided in Section 11.

Whilst there are no offshore designated sites for birds in the region of the proposed marine cable route, SPA species from coastal sites further along the coast may be present in the near shore waters during the breeding season. The proposed marine cable route corridor lies within the potential foraging distances of some of the SPA species from a number of designated sites (see Table 12-7 and Table 12-8).

Table 12-7: Foraging distances of other SPA bird species which may be present in the vicinity of the proposed cable route

Species	Maximum Foraging distance
Arctic tern	30km
Common tern	30km
Roseate tern	30km
Sandwich tern	54km
Lesser black-backed gull	180km
Puffin	200km
Guillemot	200km
Kittiwake	231km
Gannet	600km
Fulmar	664km

Source: Natural England (2013)

Table 12-8: SPA bird species which may be foraging in the vicinity of the cable route during the breeding season

Species	SPA population (pairs)	Qualification	Period	Population importance
Coquet Island SPA: 19km north of cable route				
Arctic Tern	700	Annex 1	Breeding	1.6% GB
Common	740	Annex 1	Breeding	6.0%GB
Roseate Tern	31	Annex 1	Breeding	51.7% GB
Sandwich	1,590	Annex 1	Breeding	11.4%GB
Puffin	11,400	Migratory	Breeding	1.3%European
Farne Islands SPA: 51km north of cable route				
Sandwich	2,070	Annex 1	Breeding	14.8%GB
Guillemot	23,499	Migratory	Breeding	1.0% East Atlantic
Puffin	34,710	Migratory	Breeding	3.9% European
Kittiwake	-	Assemblage	Breeding	-
Forth Islands SPA: 121km north of cable				
Gannet	21,600	Migratory	Breeding	8.2% World
Lesser black-	1,500	Migratory	Breeding	1.2%
Puffin	14,000	Migratory	Breeding	1.5%
Fulmar	-	Assemblage	Breeding	-
Guillemot	-	Assemblage	Breeding	-
Kittiwake	-	Assemblage	Breeding	-
Teesmouth and Cleveland Coast SPA: 49km south of cable route				
Sandwich	2,190	Annex I	On	5.2% GB
Flamborough Head and Bempton Cliffs SPA: 134km south of cable route				
Kittiwake	83,370	Migratory	Breeding	2.6% E Atlantic
Puffin	-	Assemblage	Breeding	-
Guillemot	-	Assemblage	Breeding	-
Gannet	-	Assemblage	Breeding	-

Sources: JNCC SPA citations, www.dpea.scotland.gov.uk

After the breeding season, when young have fledged, breeding birds leave their colonies. They disperse rapidly and move offshore within the western North Sea (see Figure 12.2; Appendix 1). During winter marine birds overwinter at offshore locations, largely around the Dogger Bank in the North Sea (Frederiksen *et al*, 2012), although important aggregations of overwintering birds are found at North East Bank and Farne Deep, through which the proposed marine cable route corridor passes (Net Gain, 2011).

The Important Bird Areas (IBA) programme has identified a network of sites, at a biographic scale, which are critical for the long-term viability of bird populations. Within the UK these areas have been identified in partnership with the RSPB. Although the areas are not currently afforded any statutory protection, they do serve as a useful indication of which areas within UK waters are of particular importance to seabirds (Skov et al., 1995). The proposed marine route corridor passes through three separate IBAs; furthest offshore is the IBA 9 North East Bank followed by IBA 7 Flamborough Head and the Hills and closest to landfall is IBA 3 Moray Firth to Aberdeen Bank to Tees (see Figure 12.1; Appendix 1). These sites have recorded important offshore aggregations of marine birds which may serve as important areas for feeding, foraging and as loafing activities.

12.4.3 Seabird Vulnerability

Seabirds are sensitive to changes in the quality of the marine environment, especially to changes in fish stocks (which could affect food sources) and to oil pollution. The susceptibility of seabirds to surface pollutants (specifically hydrocarbons) following breeding and when undergoing moulting at sea, has been assessed in the immediate area adjacent to the proposed marine cable route corridor using methodology specified by JNCC (JNCC, 1999). The assessment is based upon the amount of time spent on the water, total biogeographic population, reliance on the marine environment, and potential rate of population recovery.

Figure 12-3 (Appendix 1) shows that seabird vulnerability is low offshore and increases in vulnerability from the UK/Norway median line with proximity to the Northumberland coast. At approximately 94km offshore from the coast, vulnerability is considered ‘very high’. Breakdown of the sensitivity month by month further reveals that in the region where sensitivity is ‘very high’, peak sensitivity occurs in February and between July and December.

12.5 Potential Impacts

The potential impacts on coastal and marine birds from installation and operation of the marine cables is provided below. The full results of the assessment of impact significance are presented in Appendix 2.3.

12.5.1 Installation

Disturbance to bird species in the intertidal area
Installation of the marine cables in the intertidal landfall area will be undertaken by trenching across Cambois Beach North. Mechanical diggers will be used to construct a trench from low to high water. This has the potential to impact birds present in the area through visual and noise disturbance. The Blyth-Cambois wader study identified the maximum feeding disturbance response exhibited by purple sandpiper at Cambois Beach, was 105m (SKM Enviros, 2011). From this

it is expected that marine cable installation may have an impact on intertidal birds in the immediate vicinity of the works.

Although the landfall site is within the Northumberland SSSI and approximately 1km from the Northumbria Coast SPA, the sandy area the cable route passes through is not of particular importance for the SSSI and SPA qualifying species of wintering waders. Most of the SPA/SSSI species are found at the southern rocky end of the beach near Blyth, 2km from the landfall site. However, a small number of waders may utilise the foreshore particularly at low tide for feeding and roosting.

During the summer it is unlikely that breeding little tern, a designating feature of the Northumbria Coast SPA, are likely to be present within the vicinity of the intertidal works. Although little tern have been observed in the area, no breeding pairs are known on Cambois Beach and the breeding colony within the Northumbria Coast SPA is 55km north of the landfall at Long Nanny, Beadnell Bay. This is outside the foraging range (46km) for breeding individuals.

Marine cable installation works on the foreshore is predicted to take no more than 4 weeks. During that time any displaced birds will be able to relocate to adjacent areas, including the rocky platform further along the beach. Any displacement would also take place within the context of existing sources of disturbance identified in the Blyth-Cambois wader study undertaken for Northumberland County Council i.e. dog walking, fishing, and walking.

Sensitivity of birds in the intertidal area has been assessed as medium taking into consideration the SSSI and SPA designations whilst acknowledging the low levels of designated site qualifying species in the immediate vicinity of the works and that any disturbed birds are likely to recover quickly. Any impacts on birds will be temporary and localised with alternative feeding areas available. Therefore the magnitude of the impact has been assessed as low, and the overall impact significance is assessed as **Minor**.

Disturbance to bird species at sea

Vessel activity through areas where high densities of seabirds are present on the surface of the sea (e.g. resting or surfacing between feeding dives) may result in the displacement of birds from optimal areas for feeding and loafing.

Although the offshore waters surrounding the proposed marine cable route corridor are important for marine birds, particularly winter aggregations, there are no designated sites offshore in the region of the cable route and generally marine bird populations are considered to be widely occurring with capacity to recover quickly. Taking into consideration the importance of foraging SPA species during the breeding season, from SPAs further along the coast, which may be present in the vicinity of the cable route, sensitivity of marine birds has been assessed as medium.

The cable lay vessel will be slow moving and any disturbance will take place within the context of existing sources of disturbance, such as shipping, fishing and recreational vessels in the area. Any disturbance will be temporary and localised. Given the wide area available to these birds and their wide distribution in the North Sea, any impacts are considered to be negligible. Although SPA species may forage as far as the proposed marine cable route corridor, any displaced birds are likely to be able to find alternative suitable feeding sites. Therefore the magnitude of impact to these birds is assessed as low. Overall the impact significance is assessed as **Minor**.

Depletion of intertidal prey species
Intertidal cable installation activities are likely to result in the temporary and localised depletion of invertebrate food resource from the direct loss of intertidal species within the direct installation footprint. This may result in an indirect impact on bird species which feed on benthos, from a depletion in prey items. However, the installation of the marine cables (if undertaken using trenching techniques) will only disturb a very small proportion of the intertidal food resource. The trench across the intertidal area is expected to be only 1-2m wide. Visual observations of Cambois Beach North (CMACS, 2012) suggest that the area recovers well from changes. Sensitivity of birds feeding in the intertidal area is assessed as medium taking into consideration the SSSI designation status. The loss of prey items will only result in a low level of change and occur for a short period of time. Therefore the magnitude of the impact has been assessed as low and the overall impact significance is assessed as **Minor**.

Depletion of offshore prey species
Offshore cable installation activities have the potential to indirectly impact SPA bird species as a result of the potential depletion of preferred prey items. The preferred prey items of the SPA species likely to be feeding in the vicinity of the proposed marine cable route corridor include fish such as sandeel. The sensitivity of protected birds to depletion of offshore prey species has been assessed as medium. However, no significant impacts on fish species or spawning and nursery habitat have been identified (see Section 11). The cable installation does cross an area identified as ‘a super abundance of sandeel’ (MMT, 2012). The jetting installation tool has a width of approximately 0.75m. Therefore given the widespread suitable areas for sandeel in the North Sea the installation is unlikely to have a significant impact on sandeel and other prey species. Therefore the magnitude of any indirect Impacts on SPA bird species has been assessed as low. The overall impact significance is therefore assessed as **Minor**.

Increased turbidity from suspended sediments
During cable installation some seabed sediment will be re-suspended in to the water column causing small increases in turbidity, with subsequent re-deposition on the sea bed. Increased turbidity may reduce the feeding success of underwater feeding or diving birds that rely on their vision for prey detection.

Sensitivity of seabirds has been assessed as medium taking into consideration SPA species which may be feeding in the area. However, the short-term duration of the activity will mean that the marine environment will recover quickly (within one tidal cycle) and any impacts on seabird species are expected to be temporary and localised. Therefore the magnitude of the impact has been assessed as low and the overall impact significance is assessed as **Minor**.

Accidental oil or chemical spill from cable installation vessels
Any unplanned release of surface pollutants, such as mineral oils and chemicals from vessels associated with marine cable installation operations, have the potential to affect bird communities which encounter the surface

pollutant. The feathers of seabirds landing on the sea may become contaminated with hydrocarbons, which in turn may be ingested. Seabird vulnerability to surface pollutants along the proposed marine cable route corridor is assessed as ‘very high’ closer to the coast (with peak sensitivity in February and between July and December) to ‘low’ further offshore (see Figure 12.2; Appendix 1).

The sensitivity of marine birds has been assessed as high when considering the very high vulnerability of SPA species potentially foraging in nearshore during installation. As protected species, they are likely to have less ability to absorb changes to their population as a result of an oil or chemical spill. Such unplanned events are however very rare, and therefore themagnitude of the impact has been assessed as low. The overall impact significance is therefore assessed as **Moderate**.

12.5.2 Operation

During the routine operation of the cable, no direct impacts on birds are anticipated. Should non-routine events occur such as surveys to assess cable burial, cable repairs and maintenance, there is the potential for similar impacts on birds to those described for installation, although on a smaller scale. This would include temporary and localised displacement of some seabirds due to the presence of repair/survey vessels.

12.6 Mitigation

12.6.1 Installation

The mitigation measures which will be implemented to reduce potential impacts on marine birds during installation are as follows:

Disturbance to bird species in the intertidal area.

- Within the intertidal area of the Northumberland Shore SSSI, installation activities may be undertaken outside of the winter period (October to March), when protected overwintering birds may be present in the area.
- Construction works in the intertidal area will be restricted to a designated working area within which all construction activity and plant/vehicle movement will take place.
- Restoration of intertidal habitat will occur by backfilling after installation.

Depletion of intertidal prey species.

- Installation activities will be undertaken outside of the winter months to avoid peak abundances of any overwintering birds.

Accidental oil or chemical spill from cable installation vessels

- All vessels associated with cable installation will comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations.

12.7 Residual Impacts

12.7.1 Installation

Intertidal bird species (disturbance and depletion of prey species)
The restricted working area and the timing of installation activities outside the winter months to avoid peak abundances of any over wintering SPA/SSSI species that may be present in the intertidal area means the most sensitive species are unlikely to be impacted. The magnitude of the impact is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

Birds at sea (disturbance, depletion of prey species and increased turbidity)
Any impacts on birds at sea will be temporary and localised with large areas of similar habitat available to mitigate any disturbance, depletion of prey items or increased turbidity in the vicinity of the proposed marine cable route corridor. No mitigation measures have been proposed therefore a minor residual impact will remain. Minor impacts are **Not Significant**.

Accidental oil or chemical spill from cable installation vessels
All vessels associated with cable installation will comply with MARPOL regulations and overall an oil or chemical spill from construction vessels is considered unlikely. The magnitude of the impact is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

12.8 References

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13 MARINE MAMMALS

13.1 Introduction

This Section provides an overview of the marine mammal species likely to be present along and adjacent to the proposed marine cable route corridor. It considers the potential impacts that the marine cables may have on marine mammal species and identifies appropriate mitigation measures to be implemented to avoid, reduce, and offset potential adverse impacts.

13.2 Data Sources

Baseline conditions have been established by undertaking a desktop study of published information and through consultation with relevant bodies.

The primary data sources used in the assessment of impacts on marine mammals are as follows:

- Grey and Harbour Seals Usage Maps – (Scottish Government, 2013).
- Small Cetaceans in the European Atlantic and North Sea (SCANS-II, 2005).
- Atlas of Cetacean Distribution in Northwest European Waters (Reid et al, 2003).
- Blyth Offshore Demonstration Project Environmental Statement (NAREC, 2012).
- Field Environmental Appraisal, Assessment of EMF impacts on sub tidal marine ecology (CMACS, 2012).
- Strategic Environmental Assessment 2&3 – Marine Mammals (DECC, 2001).
- Berwickshire and North Northumberland Coast European Marine Site: grey seal population status (Thompson et al, 2010).

13.3 Methods

13.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on marine mammal population levels have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

The geographic scope of the appraisal includes the area along and adjacent to the proposed marine cable route corridor as illustrated in Figure 1.1 (Appendix 1).

13.3.2 *Magnitude of Impact*

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential impact and takes into account the likelihood of the impact occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of an impact are described in Table 13.1.

Table 13-1: Magnitude Criteria

Magnitude	Description
High	Major alteration to population levels and/or impacts long-term e.g. > 5 years) and/or irreversible. Permanent physiological impact to an individual. Gross interruption of normal behaviour. Long-term over the lifetime of the development.
Medium	Appreciable alteration to population levels and/or impacts medium term (e.g. 1-5 years) and/or reversible. Temporary physiological impact to an individual. Disruption to perception and communication (e.g. masking of communication between species). Some modification of normal behaviour. Medium to long-term.
Low	Minor alteration to population levels and/or impacts short term (up to 1 year) and/or reversible. Low risk of physiological impacts (e.g. short-term stress conditions). Minor and short-term changes in behaviour.
Negligible	No measurable alteration to population levels. Slight or no obvious changes in behaviour.

13.3.3 *Sensitivity or Importance of Receptor*

The sensitivity of the baseline conditions has been assessed according to the relative importance of the marine mammal habitat and species present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance).

The sensitivity of marine mammal species has been assessed in accordance with the criteria outlined in Table 13.2

Table 13-2: Sensitivity Criteria

Sensitivity	Description
Very High	Feature is of very high environmental value, quality or rarity on an international scale and/or has little or no ability to absorb change without fundamentally altering its character.
High	Feature is of very high environmental value, quality or rarity on a national scale and/or has little or no ability to absorb change without fundamentally altering its character.
Medium	Feature is of medium environmental value, quality or rarity on a local scale and/or has a moderate capacity to absorb change without significantly altering its character.
Low	Feature is of low environmental value, quality or rarity on a site scale and is tolerant to change without detriment to its character.
Negligible	Feature is of low or no environmental value, quality or rarity on a local scale and is resistant to change.

13.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the magnitude of a potential impact and the sensitivity or importance of the receptor. Impacts are identified as Beneficial and Adverse and their significance as Major, Moderate, Minor or None.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account any mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts identified as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant.

A summary of the environmental appraisal results for the assessment of sensitivity and magnitude and significance of impacts is presented in Appendix 2.3.

13.4 Existing Conditions

Eight marine mammal species occur regularly over large parts of the North Sea. These are harbour seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*), harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhynchus albirostris*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), killer whale (*Orcinus orca*) and minke whale (*Balaenoptera acutorostrata*). A further 15 cetacean species and five pinniped species are reported less frequently (DECC, 2001).

13.4.1 Cetaceans

Cetacean numbers in the North Sea peak during the summer months. Dolphins are generalists and use echolocation to locate and capture a variety of species typical to their habitat, foraging both individually and cooperatively. Coastal animals prey on benthic invertebrates and fish, and offshore animals feed on pelagic squid and fish. Harbour porpoise is the most abundant and widely distributed cetacean species in UK waters, and the most frequently observed in the near shore section of the proposed marine cable corridor, with the greatest number occurring in March (NAREC, 2012). Observations of harbour porpoise between 1980 - 2012 are shown in Figure 13.1 (Appendix 1). This cumulative data shows the importance of certain areas to harbour porpoise, highlighting Rock Unique and offshore waters. Despite sightings, the harbour porpoise is included on the OSPAR list of threatened and declining species in need of protection in the North-East Atlantic, as it has been decreasing in abundance, dramatically in some areas. Various pressures thought to contribute to this include, predation by killer whales, unregulated shooting, bycatch and declines in important prey species such as sandeel. The exact reason for population decline is still undefined (UKMMAS, 2010). For reasons not understood, individuals in the North Sea appear to congregate in coastal areas between June and September.

North Sea sightings of bottlenose dolphins are also most frequent in coastal areas during the summer. In winter, animals move offshore and are more dispersed. They are present throughout the central North Sea, peaking during November in vicinity of the proposed marine cable route (Reid *et al*. 2003). Figure 13.2 (Appendix 1), shows distribution of bottlenose dolphin across the central North Sea (cumulative figures between 1980 – 2012) (OBIS, 2013). This data has limitations as it is dependent on observations from vessel movements and installations, and tend to aggregate data around these routes. However it does indicate the species is present in the wider region.

The Moray Firth SAC is approximately 322km north of the proposed marine cable route corridor. This SAC is the only protected area designated specifically to protect bottlenose dolphin. The semi-resident population is estimated to be around 130 individuals (JNCC, 2013). Dolphins range widely in the Moray Firth, and are known to venture as far south as St Andrews. Although, repeated long distance journeys covering up to 1076km have been recorded by bottlenose dolphins in Cornish coastal waters (Culik, 2010), it is unlikely that the Moray Firth animals will be in the vicinity of the proposed marine cable route corridor.

White-beaked dolphin occurs year round and is commonly distributed in the vicinity of the proposed marine cable corridor. Survey data indicates that white-beaked dolphin are the most numerous dolphin species in the North Sea (SCANS II, 2005), and most abundant during August (Sea Watch, 2013). Atlantic white-sided dolphin is present in the northern North Sea and are rare visitors further south inhabiting open water that is typically 40-270m in depth. They migrate seasonally and are more abundant in UK coastal waters during summer, particularly July – September. Minke whales are the most abundant baleen whale in UK waters and occur regularly in small numbers throughout the central and northern North Sea particularly in the western areas. Minke whale is likely to be in the vicinity of the proposed cable route in coastal waters during May – June and dispersing offshore July – September. Killer whale is an occasional visitor to the central North Sea and more regularly sighted in waters north east of the UK, around Shetland, the Western and Orkney Isles (Evans, 1988).

All cetaceans are European Protected Species (EPS) protected under Annex IV of the EC Habitats Directive, which lists species of Community Interest in need of strict protection. It is an offence to deliberately capture, kill, injure or deliberately disturb animals classified as EPS. The installation of the proposed marine cable may require an EPS licence in the event that:

- The local abundance and distribution of certain species could be significantly affected by the noise produced or by creation of a barrier to natural movement; or
- An EPS could be injured or killed.

Both bottlenose dolphin and harbour porpoise are listed on Annex II of the EC Habitats Directive and are designated as Species of Community Interest (SCI). The directive lists species whose conservation requires the designation of SAC. In addition, bottlenose dolphin and harbour porpoise are listed on the UK Biodiversity Action Plan (UK BAP) as a priority marine species. These species have been identified as threatened and requiring conservation action.

Cetacean species are susceptible to subsea noise. Small cetaceans are relatively insensitive to low frequencies with the exception of harbour porpoise which is able to hear low levels of low frequency noise. There are some indications that large whales may have good low frequency hearing and therefore will avoid areas of intense activity (Stone, 2003). All the dolphin species considered here are considered mid-frequency cetaceans; the minke whale is considered a low-frequency cetacean. The species auditory band widths are included in Table 13.4 below.

Table 13-3: Cetacean Auditory Band Width

Species	Estimated Auditory Band Width (Hz)	Approximate Peak Hearing Frequency (Hz)	Threshold of Hearing at Peak Frequency dB re µ1Pa
Harbour Porpoise	150-160,000	100,000-	30-60
Bottlenose Dolphin	150-160,000	50,000-80,000	40-50
White-beaked Dolphin	200-180,000	unknown	unknown
Atlantic White-sided Dolphin	200-180,000	unknown	unknown
Killer Whale	500-200,000 150	10,000-30,000	30-45
Minke Whale	15-30,000 7 -	400	unknown

Source: Talisman (2005) & Southall et al. (2007)

Cetaceans are believed to use magnetic particles (magnetite) within their own tissues in magnetic field detection (Kirshvink, 1997). Whilst the mechanism of how these organisms detect magnetic fields is still unknown it is generally acknowledged that they are able to use magnetic cues, such as the Earth's geomagnetic field, to navigate their environment during migration. Marine mammals are potentially sensitive to minor changes in magnetic fields and local variations caused by power cable electromagnetic fields.

13.4.2 Pinnipeds

The UK has two resident species of seal: about 36% of the world's population of grey seals (*Halichoerus grypus*) and about 4% of the world's population of harbour (or common) seals (*Phoca vitulina*) (UKMMAS, 2010). There are occasional sightings of five other seal species in northern UK waters. These include bearded seal (*Erignathus barbatus*), ringed seal (*Pusa hispida*), harp seal (*Pagophilus groenlandicus)*, hooded seal (*Cystophora cristata*) and walrus (*Odobenus rosmarus*). These seals are not resident in the UK and are therefore not considered further in this baseline description. Both the native species of seal species can be seen all round the UK coast, although they are considerably more abundant in some areas than others. Of the UK populations, around 90% of grey seals and 80% of harbour seals live in Scotland.

In the UK seal species are protected under the Conservation of Seals Act (1970). This prohibits certain methods of killing seals (including using poison or firearms other than a rifle) and prohibits all wilful killing, injuring and taking of seals during the breeding season (Natural England, 2013). In Scotland the Marine (Scotland) Act 2010 provides the same protection. However the Act allows exceptions only under specific licence or for animal welfare and introduces a new offence of harassment of seals at listed haul-out sites (Scottish Government, 2011). Both species of seal are listed on Annex II of the EC Habitats Directive to protect breeding colonies and moulting haul out sites. Harbour seals are a UK BAP priority marine species and have been identified as threatened and requiring conservation action. Seal distribution in the vicinity of the proposed marine cable route corridor is shown in Figures 13.3 and 13.4 (Appendix 1).

Harbour Seals (Phoca vitulina)

Harbour seals are one of the most widespread pinniped species globally, and the number around Britain is estimated to be at least 50,000 (Hammond *et al*, 2005).

Harbour seals often haul out onto tidally exposed sandbanks to rest, moult and suckle their young. Pupping tends to occur between August and September (Hammond *et al,* 2005) followed by moulting which takes approximately 4-5 weeks. During this time they are more frequently observed at haul out sites from and are less likely to be offshore. Harbour seals can be found along the east coast of Britain, with the nearest large breeding sites to the proposed marine cable route at the Firth of Tay & Eden Estuary where an SAC has been designated for this species (approximately 159km north of the proposed marine cable route corridor) (Figure 13.3). Tagging studies in the Moray Firth suggest that harbour seals do not forage more than 60km from their haul out site, so it is not expected that animals from this site will be in the vicinity of the proposed development. A small breeding population of approximately 20 individuals are present during the breeding season at Lindisfarne (approximately 59km north of the proposed marine cable route corridor), and a resident group of five to six individuals can be found in the Blyth Estuary approximately 4.5km south of the proposed cable landfall (NAREC, 2012).

Grey Seals (Halichoerus grypus)

The UK has around 182,000 grey seals (UKMMAS, 2010). After decades of increase, following the end of culling in the 1970s, total grey seal pup production appears to be levelling off in the UK and is now rising at only a small number of colonies. In the UK, grey seals typically breed on remote uninhabited islands or coasts and in small numbers in caves during autumn. Preferred breeding locations allow mothers with young pups to move inland away from busy beaches and storm surges. Grey seals are highly sensitive to disturbance by humans hence their preference for remote breeding sites. Grey seal moulting occurs approximately 3-5 months after the end of the breeding season.

In the North Sea region most grey seals spend time on land for several weeks during October to January whilst mating and pupping, and in spring during the moult (February – March). During these times most of the seal population will be on land for most of the time making densities at sea lower.

The Farne Islands fall within the Berwickshire and Northumberland Coast SAC and has cited grey seal as an Annex II species and a primary reason for selecting the area as a SAC. The Farne Islands are approximately 53km north of the proposed marine cable route corridor and are a particularly important haul out and breeding area for grey seal. Coquet Island, approximately 20km north of the proposed marine cable route corridor is also an important grey seal haul out site (Figure 13.4; Appendix 1).

Recent studies using satellite tracking show that both species of seal forage over wide areas of the western North Sea, with frequent movement between the Farnes and Isle of May/Firth of Tay haul out sites (Figure 13.4; Appendix 1) (Thompson et al, 2010; Scottish Government, 2013).

Grey seals from the Farne Islands forage over an extensive area extending from the southern North Sea to the Orkneys. Local repeated foraging trips (40km from the Farne Islands) to discrete offshore areas and long distance travel up to 2,100km indicate that grey seals are not ecologically isolated from colonies at Orkney, Shetland or further afield (Thompson *et al*, 2010). Foraging distances and distribution data (Figure 13.4; Appendix 1) indicate that grey seal may be foraging or travelling through the vicinity of the proposed marine cable route corridor in low numbers. However, their distribution is constrained by a need to return to land periodically (DECC, 2009), and is dependent on the availability and distribution of food, particularly preferred prey items such as sandeel.

Sandeel (*Ammodytes marinus*) were identified in abundance at one location along the proposed marine cable route (Figure 13.4; Appendix 1) approximately 22km from the Coquet Island during the environmental survey (MMT, 2012). Therefore there is potential for marine mammal species to be foraging in this area. This is supported by a number of sightings of grey seals, between the months of January to July, during a site specific survey conducted by Narec in the vicinity of the proposed marine cable landfall (NAREC, 2012).

Pinniped species are susceptible to subsea noise. Seals may have good low frequency hearing particularly harbour seal, and therefore may avoid areas of intense activity (Stone, 2003). The species auditory band widths are provided in Table 13-5 below.

Table 13-4: Auditory Band widths for Seal Species

Species	Auditory Band Width (Hz)	Approximate Peak Hearing Frequency (Hz)	Threshold of Hearing at Peak Frequency dB re µ1Pa
Harbour Seal	100-200,000	7,000-30,000	63-67
Grey Seal	200-200,000	20,000-30,000	61-70

Source: Talisman (2005) & Southall et al. (2007)

Although cetacean and pinniped species will be present in the vicinity of the proposed cable route corridor, in relation to other areas of the UKCS evidence suggests that this area is not of high importance overall for marine mammals.

13.5 Potential Impacts

13.5.1 Installation

Disturbance or injury from subsea noise generated from installation vessels

The area of the cable installation is not known to be highly important to marine mammal species. Based on this information it is predicted that the receptor value will be relatively low. However this may be variable depending on factors such as seasonality and food availability. Higher numbers of cetacean species will be present during the summer months, particularly in coastal waters.

Both cetaceans and pinnipeds have evolved to use sound as an important aid in navigation, communication and hunting (Richardson *et al*, 1995). It is generally accepted that exposure to anthropogenic sound can induce a range of effects on marine mammals. These range from insignificant impacts to behavioural changes and also include non-injurious type effects including masking of biologically relevant sound signals, such as communication signals. Such effects may produce a temporary reduction in hearing sensitivity (termed Temporary Threshold Shift (TTS)) which are reversible.

Activities that generate very high sound pressure levels can cause permanent auditory injuries and other types of physical injury and, in some circumstances, lead to the death of the receiver (Richardson *et al*. 1995; Southall *et al*. 2007). These impacts are considered to be permanent threshold shift (PTS) and are of particular concern (Southall *et al*, 2007).

Noise disturbance studies (reviewed by Southall *et al*, 2007), have a high degree of variation in their results and it is therefore difficult to predict the level of disturbance accurately. It is known that disturbance will vary between auditory groups.

Marine mammals are likely to be habituated to background levels of anthropogenic noise in the North Sea. Sources of background noise come from shipping, oil and gas exploration, wind farm development and operation, fishing industry and recreational activities. During the installation of the marine cables, a range of activities will generate low levels of underwater sound, including vessel activity, cable trenching, ploughing, and rock armour placement.

The highest levels of noise generated during cable installation are expected to arise from vessel dynamic positioning (DP) systems which emit noise from their main engine and thrusters. DP vessels typically emit low frequency noise in the range from 50Hz to 1000Hz at between 177dB 1uPa (Talisman, 2006), and 187.76 dB(rms) re1uPa (DECC, 2011), which is within marine mammals hearing range.

JNCC guidelines recommend using the injury criteria proposed by Southall *et al.* (2007). The criteria indicate that for marine mammals exposed to non pulse noise (such as DP vessels), that the sound pressure level at which TTS occurs is 230dB 1µPa for mid and low frequency cetaceans, and 218dB 1µPa for pinnipeds in water (Southall *et al*, 2007). DP vessels and shipping noise therefore operate below the level for TTS, which occurs in both cetaceans and pinnipeds.

Southall does not provide a specific strong avoidance threshold for non pulse sources. Marine mammal species are highly mobile and therefore have the ability to avoid noise in the immediate area surrounding the installation vessels.

Minke whale, harbour porpoise and harbour seal generally hear at the lower frequencies, and noise from installation vessels is likely to be well within their hearing range, for greater distances from the source. For harbour seal, DP vessel noise may be audible up to 20km from source, depending on the noise frequency (Thompson *et al*, 2006). It is quite possible that minke whales detect low frequency noise at considerable distances over many tens of km, and it is possible that low frequency noise sources mask communication signals within the zone of audibility. A temporary avoidance response may be provoked around the installation area for species able to hear well at lower frequencies, although evidence suggests that seals are able to habituate to anthropogenic noise.

Data suggests that there are low numbers of marine mammals present in the vicinity of the cable installation. However there is potential for low frequency communications between cetaceans to be affected, indicating that the sensitivity to the impact is medium.

Disturbance will be temporary, however the magnitude of the impact is expected to be medium due to the use of DP vessels. The significance of the impact of marine noise generated by vessels during installation has been assessed as **Minor**.

Disturbance or injury from subsea noise generated by burial of cables

There is potential for disturbance of seals within the intertidal works area as there are believed to be five or six harbour seals in the Blyth estuary, which may be present in the surrounding waters (NAREC, 2012). However no harbour seals have been observed in the waters in Cambois Bay and grey seals were observed between the months of January to July (NAREC, 2012), and therefore may be present in very small numbers.

Data suggests that there may be low numbers of marine mammals present in the vicinity of the cable installation. The presence of a harbour seal haul out approximately 4.5km from the Blyth estuary indicates that the sensitivity to the impact is medium.

There are two main sources of noise generated during the cable burial process; during cable trenching and rock placement operations. Although rock placement has a slightly greater noise level than trenching (Nedwell, 2004), its use will be restricted to the areas of cable crossing and where adequate cable burial cannot be achieved.

Trenching noise is a variable mixture of broad band noise, tonal machinery noise and transient noise, most likely associated with rock breakage and sediment type (Nedwell, 2004). A trenching noise spectrum reported in Richardson *et al.* (1995) has peak levels of 178dB re 1µPa @ 1m at 160Hz, with an overall source level 185dB re 1µPa @1m; this agrees with data reported by Nedwell *et al.* (2004). These levels are for mechanical dredging operations, and may be noisier than the fluidising equipment proposed for the cable installation. There are no measurements for the character or source sound level produced by jetting installation, (most is associated with pilling noise, which is not applicable here (Nedwell et al., 2004)). Generally, the maximum sound pressure levels related to the installation of cables are considered moderate to low (OSPAR, 2012).

When noise levels at different distances from source are compared to species specific hearing sensitivities (dB_{ht} levels) to pilling it has been found that behavioural reactions may occur in harbour porpoise up to 10m from pilling noise source (Nedwell, 2007). As cable burial activities (trenching and jetting) generate lower levels of noise than pilling, it can be concluded that no significant behavioural reactions, such as fleeing the area, are likely to occur in marine mammals during installation of cables.

Disturbance will be temporary and localised. The magnitude of the impact is therefore expected to be low. The significance of the impact of marine noise generated by burial of cables has been assessed as **Minor**.

Injury to Seals caused by ducted propellers or thrusters of offshore support vessels

In recent years a number of grey and harbour seals have been found with fatal ‘corkscrew’ injuries which is causing concern. Injuries are characterised by a deep laceration that starts at the head and spirals around the seals body (Thompson *et al.*, 2010; Bexton *et al.,* 2012). It is believed the injuries are sustained by impact with a ducted propeller, such as a Kort nozzle or some types of Azimuth thrusters, which can be found on a range of vessels including tugs, self-propelled barges and rigs, offshore support vessel, submarines and survey vessels. Ducted propellers are frequently, but not exclusively, used by vessels with a DP system. These vessels maintain their position by altering the speed and direction of their thrust. This can involve an almost stationary vessel repeatedly starting or reversing its rapidly rotating propellers. This may increase the opportunities for inquisitive animals (notably seals) to approach propellers and be drawn into them, particularly in shallow waters. No cetacean carcasses have ever been found with these injuries, therefore only seals are considered in the assessment of this impact.

DP thrusters are of higher concern in shallower waters as there is less depth for animals to avoid the thrusters. The current link between ‘corkscrew’ injuries and ducted propellers remains uncertain and contested and further research is underway to address this issue. Seals exhibiting 'corkscrew' injuries have been found in south-east Scotland, north Norfolk, and Strangford Loch, Northern Ireland.

There are concerns that the proximity of seals to cable installation vessels in shallow waters will increase risk of injury to animals. The JNCC have indicated that if all pinnipeds found with these injuries in England were harbour seals, this represents around 0.85% of the populations at the Wash and North Norfolk Coast SAC. They consider that this is a low level of impact although this is subject to review (JNCC, 2011).

The closest haul out site to the proposed marine cable route corridor is Coquet Island which is used by grey seals, approximately 20km north of the proposed cable route. The Berwickshire and Northumberland Coast SAC is approximately 25km north of the proposed marine cable route indicating a medium risk to seal populations using JNCC guidance. Therefore the sensitivity of seals to injury during installation has been assessed as medium.

There have been no reported mortalities linked to propellers or thrusters on the Northumberland coast to date. Given harbour seal foraging ranges it is possible that these mammals may be present in the vicinity of the proposed marine cable route. A site specific survey of the cable landing area conducted by Narec, did not observe harbour seal in Cambois Bay, however grey seals were identified between the months of January to July in low numbers (NAREC, 2012). Current information suggests that the densities of both grey and harbour seals in the vicinity of the proposed marine cable route corridor are fewer than 0.04 individuals km^{-2} (Scottish Government, 2013), suggesting that the cable route is not important to seal populations.

Considering the uncertainty surrounding 'corkscrew' seal fatalities and the absence of injuries on the Northumbrian coastline, the impact of collisions with ducted propellers leading to injury or death to seals is considered to be of low magnitude as seals are unlikely to be present in the vicinity of cable installation. Cable installation will be temporary and the potential impact of corkscrew injury is confined to the immediate area of the DP vessel propellers. Therefore the significance of the impact of injury to seals during installation has been assessed as **Minor**.

Collision of installation vessels with marine mammals

The cable and lay associated vessels (guard vessels, support vessels, etc.) will marginally increase the level of shipping activity in the marine environment, in an area that already contains high levels of shipping activity. However, it is unlikely that a marine mammal will collide with the slow moving installation vessel. Numbers of marine mammals crossing the route are not expected to be high. The conservation status of marine mammals indicates their sensitivity is medium.

Results of a collision with an installation vessel could be very serious and possibly life threatening for marine mammals. However the likelihood of collision is low, therefore the magnitude of this impact has been assessed as low. The significance of the impact during installation has been assessed as **Minor**.

Accidental hydrocarbon or chemical release from installation vessels

Any unplanned release of surface pollutants, such as mineral oils and chemicals from vessels associated with marine cable installation operations, have the potential to affect marine mammals which encounter the surface pollutant. Marine mammals must surface to breathe, and the vulnerability of seals to surface pollutants is assessed as high, taking in to consideration the high vulnerability in the near shore waters close within foraging range of haul outs, and out of the breeding season when the density of seals in the water are higher, However, numbers of marine mammals crossing the route are not expected to be high.

Data showing the probability of a hydrocarbon or chemical release from installation vessels are not available. However, analysis of data from the Advisory Committee on Protection of the Sea (ACOPS) Annual Survey of Reported Discharges shows that during the period 2002-2011 there was an average of 447 oil or chemical releases from vessels per year in the NSN region of the North Sea (ACOPS, 2002-2011). Of these incidents the majority occurred in the UKCS related to oil and gas activities; incidents within the north east England region were within ports and harbours. During 2011, there were no reported discharges from offshore support vessels. Such unplanned events are very rare and taking likelihood into consideration the magnitude of the effect has been assessed as low. The overall impact significance is therefore assessed as **Moderate**.

13.5.2 Operation

Collision of maintenance/survey vessels and marine mammals

Similar to installation activity, cable maintenance and survey vessels will marginally increase the level of shipping activity in the marine environment at any one time. However, it is unlikely that a marine mammal will collide with the slow moving maintenance vessel. Collision of marine mammals with installation vessels may inflict serious injury or death to marine mammals, indicating their sensitivity to this impact is high. Collision will only affect individual animals and not populations, therefore the magnitude of this impact has been assessed as low. The significance of this impact is assessed as **Minor**.

Disturbance or injury from subsea noise generated from maintenance/survey vessels

Similar to installation activity, the presence of maintenance or survey vessels may disturb marine mammals present in the waters around the marine cables. Survey and maintenance vessels will be occasional, and only marginally increase the level of vessel activity along the cable route. This may temporarily alter natural behaviour or obstruct migration routes, depending on the extent of maintenance works. Therefore marine mammal sensitivity to noise generated from maintenance/survey vessels is assessed as medium. Any disruption is likely to be to individual animals and will be temporary and localised; recoverability is expected to be good. Therefore the magnitude of this impact has been assessed as negligible. The significance of this impact is assessed as **None**.

Accidental hydrocarbon or chemical release from maintenance/survey vessels

As in the installation phase, the running aground of a vessel or a collision could lead to a fuel release and cleaning fluids, oils and hydraulic fluids used onboard maintenance and survey vessels and during ROV operation could be accidentally released overboard. Marine mammals must surface to breathe, at which point they could become exposed to a hydrocarbon or chemical release on the surface. Therefore their sensitivity has been assessed as high. Overall, a hydrocarbon or chemical release from maintenance and survey vessels is considered unlikely, and the presence of marine cable installation vessels will only marginally increase the risk of a pollution incident, Therefore the magnitude of this impact has been assessed as minor indicating an overall significance to marine mammals of **Moderate**.

Magnetic Fields (B-fields) interfering with cetacean navigation

Of the eight frequently occurring marine mammal species, the most frequently observed species (in near shore waters) are the harbour porpoise and bottlenose dolphin (both of which are listed in Annex II of the Habitats Directive).

The expected magnetic field (B-field) to be generated by the proposed marine cables is likely to attenuate to background geomagnetic field levels within several metres of the cables. The magnitude and persistence of the generated magnetic field has potential to cause temporary changes in swim direction or greater detours during migration (Gill et al. 2005). This will affect animals crossing the cables or passing along their length, and therefore may intermittently interfere with their natural navigational ability. The implications for loss of navigation skills for cetaceans are not fully understood. However, there have been no reported impacts to the migration of harbour porpoise over existing interconnector cables. For this reason the sensitivity of cetaceans to magnetic fields is considered to be medium.

There is no current evidence to suggest that pinnipeds are directly influenced by, sensitive to, or use magnetic fields.

The impact of magnetic fields produced during operation of the cable will be localised with the effect occurring only within a short distance of the cables. Outside of this distance there is no effect to marine mammal navigation. The magnitude of the impact has therefore been assessed as low. The significance of the impact is therefore **Minor**.

13.6 Mitigation Measures

13.6.1 Installation

Disturbance or injury from subsea noise (installation vessels and cable burial)

- The developer will require that all contractors follow the JNCC guidelines for The Deliberate Disturbance of Marine European Protected Species (JNCC, 2010a).

- Where possible, inshore installation activities will be scheduled during the least sensitive period of the year for marine mammals (August – December)

Injury to Seals caused by ducted propellers or thrusters of offshore support vessels

- NGNSNLL and SSF will liaise with JNCC/SNH on the Regulator Guidance for the avoidance of ducted propeller injuries (SNH, 2011). Potential mitigation that could be employed includes:
  - A timing restriction on the use of vessels with ducted propellers or thrusters during the period thought to be of key sensitivity (i.e. the pupping period);
  - The use of Marine Mammal Observers to maintain an exclusion zone, with the authority to request a delay to propeller/thrusters operation if seals are observed within this zone and to request a shut-off if required.
  - Shoreline and stranding searches.

Collision of installation vessels with marine mammals

- Where possible, installation vessels will not exceed 14 knots.

Accidental hydrocarbon or chemical release from installation vessels

- All vessels associated with cable installation will comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations.

13.6.2 Operation

Collision of maintenance/survey vessels and marine mammals

- Maintenance vessels will not exceed 14 knots, where possible.
- Where possible, inshore maintenance activities will be scheduled during the least sensitive period of the year for marine mammals (August – December).

Disturbance or injury from subsea noise generated from maintenance/survey vessels

- The developer will require that all contractors follow the JNCC guidelines for The Deliberate Disturbance of Marine European Protected Species (JNCC 2010a).

Accidental hydrocarbon or chemical release from maintenance/survey vessels

- All vessels associated with cable maintenance will comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations.

13.7 Residual Impacts

13.7.1 Installation

Disturbance or injury from subsea noise (installation vessels and cable burial)

The implementation of the above mitigation measures will minimise the likelihood of disturbance to marine mammals from noise during cable installation. The impact is therefore minor. Minor impacts are considered **Not Significant.**

Injury to seals caused by ducted propellers or thrusters of offshore support vessels

Installation is anticipated to take place during the least sensitive months (August – December), during which seals may be hauled out, thereby reducing the numbers of animals in the water, and decreasing the likelihood of individuals coming within close proximity of installation vessels. Implementation of further mitigation measures (if considered to be required) based on Regulator Guidance for the avoidance of ducted propeller injuries (SNH, 2011) will reduce the impact further. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

Collision of installation vessels with marine mammals

Vessel speed restrictions further protect against marine mammal collision and reduce the potential for collision. The magnitude of the effect is reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

Accidental hydrocarbon or chemical release from installation vessels

Complying with MARPOL regulations reduces the likelihood of an oil or chemical release from construction vessels. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

13.7.2 Operation

Collision of maintenance/survey vessels and marine mammals

As with collision with marine mammals during installation, collision is unlikely. The magnitude is reduced to negligible and the impact is considered none and **Not Significant.**

Disturbance or injury from subsea noise generated from maintenance/survey vessels

Maintenance and/or survey vessels are unlikely to produce noise at low enough frequency or volume to affect marine mammals. However following mitigation measures will ensure impacts are minimised. This activity is considered to be **Not Significant.**

Accidental hydrocarbon or chemical release from maintenance/survey vessels

As with vessels operating during the installation phase, complying with MARPOL regulations minimises the likelihood of the event occurring. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

Magnetic Fields (B-fields) interfering with cetacean navigation

With the exception of mitigation by design (cable burial or bundling), there are no mitigation measures available to reduce the impact of magnetic B-fields from the operating cable. The impact remains as minor. Minor impacts are **Not Significant.**

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14 CULTURE AND ARCHEAOLOGY

14.1 Introduction

This Section provides an overview of the archaeological features that are likely to be encountered along and adjacent to the proposed marine cable route corridor. The assessment considers the potential impacts that the proposed marine cable installation and operation may have on archaeology, and identifies mitigation measures to be implemented to avoid, prevent, reduce and offset any potential impacts.

14.2 Data Sources

Data sources used in this section include but are not limited to the following:

- Information held by English Heritage on designated wrecks and the National Monuments record (NMR – maritime section);
- Information on sites and monuments held by Northumberland County Historic Environment Record (HER);
- Databases of designated cultural heritage assets maintained by Historic Scotland including designated wrecks;
- Maritime records held by the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS);
- UK Hydrographic Office Wrecks and Obstructions Database (SeaZone);
- Ministry of Defence (MoD) (Information on protected wreck remains and military losses);
- Records held with the Receiver of Wreck (RoW) (Maritime and Coastguard Agency);
- Records held with the Archaeology Data Service (ADS);
- Marine Environment Data information Network (MEDIN);
- North East Rapid Coastal Zone Assessment (NERCZA);
- British Geological Survey regional guide and previous work in the area;
- Results of geophysical surveys undertaken by MMT (MMT 2012; 2013)

14.3 Methods

14.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on archaeological features have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

The magnitude of the potential effect incorporating likelihood, level of change, geographic extent and duration; and

The sensitivity and/or importance of the receiving environment or receptor

The geographic scope of the appraisal includes the area within 1km from the proposed cable route as illustrated in Figure 1.1 (Appendix 1).

14.3.2 Magnitude of Impact

The magnitude of an effect considers the scale of the predicted change to baseline conditions resulting from a given potential effect and takes into account the likelihood of the effect occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of effect are described in Table 14-1.

Table 14-1: Magnitude Criteria

Magnitude	Description
High	Total loss or major alteration of the cultural heritage asset
Medium	Loss of, or alteration to, one or more key elements of the cultural heritage asset
Low	Slight alteration of the cultural heritage asset
Negligible	Very slight or negligible alteration of the cultural heritage asset

14.3.3 Sensitivity or Importance of Receptor

The sensitivity of a cultural heritage asset reflects the level of cultural significance assigned to it by statutory designation or, in the case of undesignated assets, the professional judgement of the assessor.

Designated wrecks and submerged prehistoric landscapes are considered to be cultural heritage assets of high sensitivity in this assessment. Unknown and potential wreck sites and seabed debris are treated on a case by case basis according to professional judgement. Known wrecks and seabed debris of regional importance are considered of medium sensitivity, while modern wrecks and obstructions of local importance and debris associated with the same are considered of low or negligible sensitivity.

The sensitivity of the baseline conditions has been assessed according to the relative importance of the protected sites present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance).

Table 14-2: Sensitivity Criteria

Sensitivity	Description
Very High	Cultural heritage assets of international importance.
High	Designated wrecks and scheduled monuments. Cultural heritage assets of national importance. Maritime losses where the position is known and positively identified. Targets of high archaeological potential identified in the geophysical survey.
Medium	Cultural heritage assets of regional importance. Targets of medium archaeological potential identified in the geophysical survey. Obstructions that could be indicative of wreckage or submerged features.
Low	Targets of low potential identified in the geophysical survey. Stray archaeological find spots.
Negligible	Targets identified through the assessment of geophysical and geotechnical data is likely to represent a natural feature.

14.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the sensitivity or importance of the receptor and the magnitude of a potential effect. The impact significance is assessed as Major, Moderate, Minor or None. The term ‘None’ denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account any mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts assessed as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. The full results of the assessment of impact significance are presented in Appendix 2.3.

14.4 Existing Conditions

14.4.1 Submerged palaeolandscapes and their potential

The initial occupation of what is now recognised as mainland Britain is believed to have occurred c. 700,000 before the present (BP), although mainland Britain at this time was an attached low-lying peninsula appended to continental Europe. Since this time a number of glacial episodes have resulted in major sea level changes, and it is certain that most of the offshore areas examined for the cable route options would have been exposed as dry land at some point since man’s first presence in the North Sea basin region, and may preserve associated palaeo-environmental remains.

It is following the last glacial maximum that the position of former coastlines and areas of dry land becomes easier to predict.

- The first ~10km of the cable route (KP 714 – KP 706) has been submerged since 6,000 BP. Before then, it was largely dry land as far back as around 16,000 BP. Beyond this time, the shoreline was likely to resemble that of present day as far back as the last glacial maximum (LGM).
- The following ~100km (KP 706 – KP 606) has been submerged since the LGM, 22,000 BP, or shortly after.
- The outer ~300km (KP 606 to median line) has been submerged since around 6,000 BP, but was largely dry land from the LGM at 22,000 BP.

Excluding some exposed bedrock near the UK shore, the proposed marine cable will be laid in deposits of Middle Pleistocene age or later.

The search for prehistoric submerged sites of interest generally focuses on the identification of water courses, based on the assumption that these would form a focus for past human activity and also their relative ease of identification. Even given this, there is a difficulty in predicting which channels might have the greatest potential for remains. Isolated channels could have a high potential as they may have been the nearest source of fresh water, whilst clusters of channels may be less attractive through the difficulty they pose in crossing the landscape. The identification of sites that have high potential relies to a degree on understanding the form and setting of such features, within the prehistoric landscape. The extent of the surveys for the proposed marine cable route corridor does not assist in the process of grading the heritage potential of channels.

14.4.2 The Potential for Unrecorded Cultural Heritage Assets

While there have been no reliably reported Palaeolithic finds or deposits of archaeological significance from the proposed marine cable route corridor, general flints, spear-heads, and mammal remains have been dredged and trawled from locations throughout the entire North Sea, although principally reported around the Dogger Bank to the south. Known and potential sites of archaeological importance identifies across the route are identified in figure 14.1 (Appendix 1).

Potential prehistoric occupation of submerged landscapes

The baseline study has also identified palaeochannels with a range of potential that intersect the proposed cable line. These are shown on Figure 14.2 (Appendix 1). Few near shore channels have been identified with all bar one over 100km from the shore. The assessment of geophysical and geotechnical data available for study identified 44 sites of palaeochannels thought to be of some notable potential for archaeological interest. Channels are useful indicators for prehistoric remains, and a ranking system has been applied to these sites in order to best steer the focus for any further archaeological involvement with the works ahead. A series of the geotechnical samples were found to contain organic remains but not to any significant extent in any location so far tested along the cable route.

Whilst there are no confirmed finds of later prehistoric date within the proposed marine cable route corridor there is a high potential for previously unknown cultural heritage remains in the nearshore, foreshore and dunes on the basis of discoveries further up and down the North Sea coast.

By the Neolithic period, the modern day coast line had become established and activity in the vicinity is attested by a Neolithic standing stone approximately 500m north of Cambois Beach proposed landing point. From this period onwards there is a reasonable potential for finds of Bronze Age date, based on the discovery of a cairn site in the sand quarry at Amble.

It is known from the Bronze Age onwards that sea travel began to become established, however, the discovery of remains of vessels from this or even later date is rare up until the late Post-medieval period. This is less the case on the shoreline where structures of historic date or earlier may survive e.g. the remains of several medieval buildings are recorded just inshore from the proposed landfall at Cambois Beach, suggesting this foreshore may well have been a location of maritime activity during this time. To a lesser extent, there is cartographic evidence of medieval structures at the Cambois Beach proposed landfall.

With respect to Post-medieval and later vessels over 50 wrecks are thought from the various heritage records to reside in the 1km buffer along the NSN cable route. The majority of these are close to the shore, upon which the vessels were presumably wrecked. The Cambois Beach North cable landing site is close to historically busy fishing ports, increasing the likelihood of encountering remains. Similarly however, trawling activities associated with these areas will certainly have dispersed wrecks in the area so that they cannot be recognised easily as such from geophysical surveys. It was not until the 20th century that metal hulls came into use in the herring trade and many of the earlier losses of wooden vessels are likely to be highly degraded and difficult to detect now.

A large number of identified shipwrecks in the seas around the east coast of England are the result of military activity during World War 1 and 2. Initial losses during World War 1 were caused by the extinguishing of coastal lights which resulted in numerous wrecks concentrated along the shoreline, followed by attacks by the German navy. Given the historic volume of maritime traffic, it is unsurprising that there is a numerous and diverse range of vessels resting on the seabed within this region. Also there is a large concentration of offshore aircraft losses along the east coast of England resulting from military operations. A number of air bases operational since WW1 are located in the vicinity, including the operational bases at Alnwick, Tynemouth, Whitley Bay and Seaton Carew. No locations for aircraft remains are specifically placed in the OSA, but as with vessels lost, the degree of precision for these is very low. There are numerous WW2 aircraft losses in the (comparatively) near vicinity of the cable route through the North Sea, principally those of allied aircraft lost on missions to Norway.

The NMR and HER databases for this area of Northumberland contain a huge number of military remains, particularly from WW2. These include aircraft remains, trench systems and military camps close to the shoreline of the area. Given the amount of military activity that this area contained it is possible that there are a number of objects and debris relating to this activity below the high and low water marks.

14.4.3 Previously recorded maritime cultural heritage

It needs to be acknowledged that the accuracy with which records of submerged assets were made is heavily dependent on the date of the wreck, when the record was made and for the most part the fact that it is 19th century or later in date (with very few contemporary records being made before this). It is important to acknowledge that location information can be both poorly defined and inaccurate on occasion.

All UKHO entries within 1km of the proposed marine cable route including ‘dead’ entries have been considered because even where vessels have failed to show up on recent geophysical surveys, the locations may still contain remains of cultural heritage interest. In some cases, however, it is clear from the details of the entry that there is no reason to believe that there are now or ever have been archaeological remains.

Definitions of the state of wrecks and obstructions in the SeaZone database (UKHO, 2013) are as follows:

- **Live:** all wrecks and anomalies found by UKHO survey;
- **Dead:** not detected by repeated surveys, therefore since considered no longer to exist;
- **Lift:** a salvaged wreck.

The baseline environment has been sub-divided into the following categories, each of which is addressed individually below:

- Known wrecks and obstructions from UKHO Database/ Receiver of Wreck and from the RCAHMS (RCAHMS, 2012).
- Maritime sites and losses listed by English Heritage and Historic Scotland (EH, 2013 HS,2012)).
- Sites/ potential sites identified through the assessment of marine geophysical data (MMT, 2012, 2013).

The baseline assessment has identified 35 ‘Live’ wrecks and four ‘Dead’ wrecks within the cable route(s) corridor. The identity of 19 of these wreck sites has been either confirmed or postulated, 10 having been lost during WW1 and four having gone down during WW2. Three are relatively modern losses (two during 1978 and one in 1992). The remaining 20 recorded wrecks are unknown wrecks that have been identified by survey or admiralty records.

14.5 Potential Impacts

The potential impacts on archaeology from installation and operation of the marine cables is described below. The full results of the assessment of impact significance are presented in Appendix 2.6.

14.5.1 Installation

Removal of archaeological features through pre-sweeping

The marine cables will be buried into the seabed for protection from environmental conditions and third-party interactions, such as fishing operations. The types of burial machines expected to be used have a limited ability to work on inclines, where their stability is affected.

The proposed method for laying the cable is to be jetting. This requires a relatively level and flat seabed. Route design has aimed to avoid areas of significant incline, however in some areas where sand waves cannot be avoided pre-sweeping may be required in order for the burial techniques to be employed effectively. The occurrence of sand waves has been identified over the part of the route that traverses the Northeast banks near KP 643 however, these have a magnitude of only 0.75m. In such instances it is likely that jetting could be carried out without pre-sweeping, although greater undulations in the sea bed would require it.

In the event that pre-sweeping is employed this would involve either dredging a passage through the sand wave or ‘clipping’ off a part of it to give a smoother overall profile.

The proposed marine cable route corridor crosses some areas of sand waves where the seabed incline may be outside the capability range of the equipment. In these areas the excessive inclines will be removed with a dredger or mass flow excavator to create a flatter profile, or ‘working profile’, for the burial machine. The “footprint” of this operation is likely to be approximately 20-30m wide.

Sensitivity of archaeological features has been assessed as medium taking into consideration known and suspected targets within 100m of the proposed cable route. The magnitude of the effect has been assessed as low and the overall impact significance is considered to be **Minor**.

Disturbance or removal of archaeological feature by cable installation

The proposed marine cable route has been planned to avoid known archaeological features of interest. The expected depth for burial is between 1m to 2m below the seabed, although this will vary depending on the nature of the seabed; rock placement may be used where target burial depth cannot be achieved.

Sensitivity of archaeological features has been assessed as medium taking into consideration known and suspected targets within 100m of the proposed cable run. However, this does not preclude a need to establish mitigation measures that both take into account the locations of known or suspected heritage assets near to the proposed marine cable route or the presence of assets that are not identified through the methods employed as part of the assessment. Therefore the magnitude of the effect has been assessed as low and the overall impact significance is assessed as **Minor**.

14.5.2 Operation

Disturbance or removal of archaeological feature by cable maintenance

It is unlikely that non-routine events such as surveys to assess cable burial and cable repairs and maintenance will have an impact on archaeological assets. Any significant assets will have been identified during installation and micro-routing will have been undertaken to avoid them indicating the sensitivity to this impact is medium.

Archaeological assets will be identified during installation and are therefore unlikely to be disturbed during maintenance and survey operations, and the magnitude of this impact is considered to be negligible, and the overall impact significance is assessed as **None.**

14.6 Mitigation

14.6.1 Installation

Removal of archaeological features through pre-sweeping

- All sites of cultural heritage interest included in this report will be avoided where possible by micro-routing of the marine cables.
- All operations will follow and abide by the Joint Nautical Archaeology Policy Committee (JNAPC) code of practice for seabed development (JNAPC, 2008).

Disturbance or removal of archaeological feature by cable installation

- Should there be a requirement to place anchors outside of the surveyed corridor, the anchor placement location will be surveyed during the pre-installation survey, or immediately before anchor placement and the anchors will not be placed on any sizable surface structures which could potentially be of cultural heritage interest.
- Temporary exclusion zones will be implemented around any sites that may be directly affected by cable installation and associated activities e.g. anchoring (KP 374 – KP 458 and KP 601 - UK LW mark).
- The size of the proposed exclusion zone depends on the sensitivity of the site. Exclusion zones of at least 100m will be established around sites identified as being of high sensitivity in this assessment while an exclusion zone of a minimum of 50m will be established around those of medium sensitivity.
- The implementation of the protocol set out within the Written Scheme of Investigation (WSI) during installation activities will be agreed with the relevant bodies (English Heritage, Scottish Natural Heritage and Northumberland County Council) prior to installation works being conducted.

Mitigation for the project will be developed with a written scheme of investigation to be agreed with English Heritage, Historic Scotland and

Northumberland County Council and will be in place prior to any further intrusive works being carried out, including any further geophysical and/or geotechnical surveys; and for all pre- installation and installation activities when the final cable route and installation methodology is established. The WSI should include a protocol for unexpected archaeological discoveries as well as the following measures;

- Exclusion zones around the known extents of recorded wreck sites identified in this report.
- Exclusion zones around the known extents of sites considered to be of medium archaeological potential that could potentially be impacted, pending further investigation;
- An archaeological input into planning for any further geophysical and/or geotechnical surveys to be carried out, and for all pre-installation and installation activities when the installation methodology and final infrastructure is established.
- Intertidal and foreshore coring to establish whether any deposits of archaeological significance are present;
- An intertidal watching brief;
- Archaeological monitoring during intrusive activities with a visual aspect prior to and during installation.

14.7 Residual Impacts

Disturbance or removal of archaeological feature by cable installation

All residual impacts have been minimised through careful planning of the cable route (see mitigation above) so that archaeological sites and other assets are avoided by a sufficient distance to not be affected by these. There is a possibility that unknown archaeological sites and assets could be affected so a **minor** impact is acknowledged here.

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15 COMMERCIAL FISHERIES

15.1 Introduction

This Section provides an overview of commercial fisheries interests along and adjacent to the proposed marine cable route corridor. It has been informed by the specialist fisheries assessment commissioned for the Environmental Appraisal undertaken by Network Services (2011). The Section considers the potential impacts that the marine cables may have on commercial fisheries and identifies appropriate mitigation measures to avoid, reduce, or offset potential adverse impacts or enhance potential beneficial impacts.

15.2 Data Sources

The primary data sources used in the assessment of impacts on commercial fisheries are as follows:

- Desk Based Fishing Report undertaken by Network Services, (2011)
- MMO Seafish Statistics (2012)
- Northumberland Inshore Fisheries & Conservation Authority (NIFCA 2010, 2012, 2013)
- Cable Route Shipping Vessel Activity Review (Anatec, 2012)

15.3 Methods

15.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on commercial fisheries interests have been assessed, using the methodology described in Section 6. In order to assess the overall significance of an impact it was necessary to establish:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

The geographic scope of the appraisal includes the area along and adjacent to the proposed marine cable route corridor as illustrated in Figure 1.1 (Appendix 1).

15.3.2 Magnitude of Impact

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential impact, and takes into account the likelihood of the impact occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of impact are described in Table 15-1.

Table 15-1: Magnitude Criteria

Magnitude	Description
High	National or international scale / Long-term 15-50 years / Viability of fishing vessels at a regional level threatened / Fishing impractical or impossible.
Medium	Regional – limited to NSN Route corridor / Medium term 5-15 years or reversible in similar timescale / Viability of some local fishing threatened; earnings of a vessel at regional level affected / Regional disruption to established fishing practices.
Low	Within 5km of proposed cable route corridor / Short term lasting 1-5 years or reversible in similar timescale / Reduced earnings for some local vessels; economic viability unaffected / Local changes to established fishing practices required.
Negligible	Within proposed cable route corridor / Reversible in less than 1 year / No discernible impact on any commercial fishing / No measureable or recognised interference with fishing.

15.3.3 *Sensitivity or Importance of Receptor*

The sensitivity of the baseline conditions has been assessed according to the relative importance of existing fisheries interests on or near to the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance), or by the sensitivity of receptors which would potentially be affected by marine cables installation and operation.

The sensitivity of commercial fisheries has been assessed in accordance with the criteria outlined in Table 15.2

Table 15-2: Sensitivity Criteria

Sensitivity	Description
Very High	The receptor has little or no capacity to absorb change without fundamentally altering its present character, is of very high fisheries interest, or of international importance.
High	The receptor has low capacity to absorb change without fundamentally altering its present character, is of high fisheries interest, or of national importance.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some fisheries interest, or is of national importance.
Low	The receptor is tolerant of change without detriment to its character, is low fisheries interest, or local importance.
Negligible	The receptor is resistant to change and is of little fisheries interest.

15.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the magnitude of a potential impact and the sensitivity or importance of the receptor. Impacts are identified as Beneficial or Adverse and their significance as Major, Moderate, Minor or None. The term 'None' denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account any mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts identified as Minor or Negligible are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. A summary of the environmental appraisal results for the assessment of sensitivity and magnitude and significance of impacts is presented in Appendix 2.3.

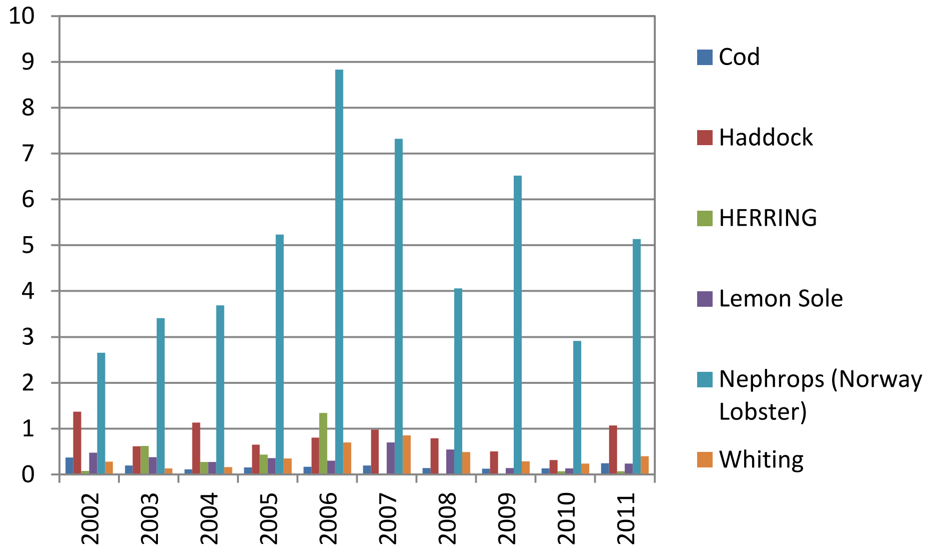
15.4 Existing conditions

The proposed marine cable route corridor passes through some important commercial fishing areas in the Central and Northern North Sea, notably the Farne Deeps, the Holes and Montrose Ground.

Historically demersal fin fish species (haddock, cod, and plaice) have been important catch species in the vicinity of the proposed cable route corridor. However, demersal trawling activity by European Union (EU) member state fishing fleets has changed in recent years due to the introduction of Government fisheries regulations. These are designed to control fishing effort and regulate the amount of fish that can be landed. This has impacted how trawler fleets operate in the North Sea, with many of the demersal trawlers now concentrating effort on fishing for shellfish particularly Norway lobster (*Nephrops*). Overall, shellfish now form the most important component of fisheries landings in the vicinity of the proposed cable route, both in volume and value (MMO, 2012).

Figure 15.1 provides a summary of fish and shellfish landings from the North Sea in the vicinity of the proposed marine cable route corridor, by value for the period 2002-2011 (MMO, 2012). These values illustrate the importance of the Norway lobster (*Nephrops*) fishery, in comparison to the value of other fisheries in the area. Other fisheries in the vicinity include trawling and beam trawling for whitefish (demersal fish with fins i.e. cod, whiting and haddock). The average annual value of total recorded catch in the vicinity of the proposed marine cable corridor is around £9.5 million and the average annual tonnage is around 6,367 tonnes.

Figure 15-1: Value of Catch per species (£ million) 2002-2011



Source: MMO (2012)

Information on the seasonality of commercial landings into UK ports was not collected. However, the dominance of the Nephrops industry in recent years, and the increased seasonal effort for this species between October and April indicates that the greatest volume of landings and therefore the period of greatest importance to the fishing industry falls within the winter months.

Prior to 2006 there was no statutory requirement for boats <10m in length to report their landings. Therefore landings from smaller vessels are not included in these statistics. Consultation with fishermen and sightings data from the Northumberland Inshore fisheries and Conservation Authority (NIFCA) has provided information on smaller vessel activity and information on locally important inshore shellfisheries for crab, lobster and whelk within 3nm of the proposed marine cable route corridor (Network Services, 2011, NIFCA 2012).

15.4.1 Vessel Activity and Fisheries Surveillance

Satellite vessel monitoring system (VMS) data (MMO, 2012) provides information and tracking data for vessels (>15 m). This provides a useful indicator of areas of greater fishing activity, although it does not include smaller vessels nor can it discriminate between active fishing and travel to and from fishing grounds.

Fishing vessel surveillance information collected between 2005-2009 (Anatec, 2012) shows that the majority of fishing vessels operating within the vicinity of the proposed marine cable route corridor are UK based (96%), with small numbers of Danish, French, Dutch and Norwegian vessels. The main fishing method was found to be unspecified trawling, accounting for approximately 63% of all sightings, demersal trawlers (18%) and potter/whelking activity (16%), (Anatec, 2012).

The Anatec UK database 'ShipRoutes' was used to provide vessel data on the ICES rectangles adjacent to the proposed marine cable route. Information included vessel position, activity, fishing gear type and nationality. The sightings data were imported into a GIS for mapping and analysis. Analysis clearly identifies the inshore region as being dominated by static gear fisheries (potter/whelker activity), with trawling/demersal trawling becoming more dominant with distance from the shore (Anatec, 2012), which supports the MMO landings data for the proposed marine cable route corridor. The analysis also indicates areas of higher fishing intensity (due to vessel presence) notably the Farne Deep, Devils Hole and Montrose Ground, which are established fishing grounds in the vicinity of the proposed cable route (Figure 15-2; Appendix 1).

The target species and the gear types used along the proposed marine cable route corridor are summarised in Table 15.4, and described further in the text below.

Table 15-3: Commercial Fishing Activity Summary Table

Method	Target Species	Location
Potting & Creels	Edible crab & lobster	Inshore along rocky outcrops.
Netting (static/drift trammel, tangle or mesh)	High value finfish – Salmon, bass, dogfish	From approximately 3 nm to deeper water. Inshore at Lyne Bay.
Scallop Dredger	Scallop, shellfish	Inshore to 3 nm on patchy hard ground.
Demersal Otter Trawling	Mixed demersal fish, whitefish and *Nephrops*	From approximately 6nm offshore to deeper waters -Middle & East Bank Grounds.
Twin Rig Trawling	*Nephrops*, Mixed whitefish	The 'Holes'.
Fly Seine Netting	Mixed demersal fish	Farne Deeps east to Swallow Hole, UK/Norway median line.
Pair Seining	Mixed demersal fish	Montrose Ground, east of Devils Hole & Norwegian sector.

Source: Network Services (2011)

15.4.2 *Inshore*

The inshore waters in the vicinity of the proposed cable landfall at Cambois Beach are important for local commercial fishermen operating out of Blyth, and Newbiggin. These fishermen fish on the hard ground (which extends to approximately 3 nm offshore) for lobster and whelk using static gear, and trawl for *Nephrops* up to 6 nm offshore, to the edge of the Farne Deep trawling ground (Network Services, 2011).

At Blyth there are approximately 6 inshore gill netters that work along the shore in the vicinity of the proposed marine cable route corridor. The use of static gear at inshore areas is largely dependent on government regulations and quota allocations. Inshore fishermen alternate their activity throughout the year between fishing with static gear and trawling.

Pots and Creels

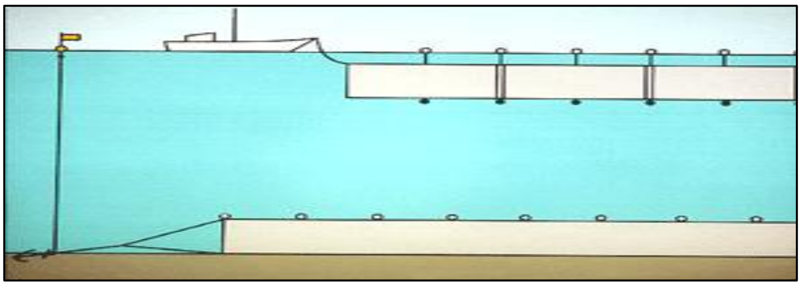
Pots & creels are static gear used year round to catch shellfish along the inshore areas of the proposed marine cable route corridor. The pots used in the area differ in shape, size and construction materials according to the target species, and local practices.

They all have one or more ‘funnel’ style entrances making it easy for the shellfish to get in but very difficult to escape again. They are baited and set on the bottom singly or in “fleets” of several pots with a marker buoy (“dahn”) at each end of the fleet. Surface dahns are typically 200-300 m apart for a fleet of pots. Blyth has approximately eleven potting vessels, fishing for mostly lobster, brown crab, and velvet crab and occasionally prawn (NIFCA, 2010). The main potting area in the vicinity of the proposed cable route are the inshore waters around Blyth, north of Beacon Point and out to approximately 3 nm (Figure 15-3; Appendix 1) (NIFCA, 2013).

Gill Nets/Drift Nets

Gill nets are vertical panels of netting normally set in a straight line, and are either fixed or trawled or drifted through the water (Figure 15-4). Fish may be caught by gill nets in three different ways – wedged, gilled, or tangled. Gillnets are so effective that their use is closely monitored and regulated. Mesh size, twine strength, as well as net length and depth are all closely regulated to reduce by-catch of non-target species. The location of placed gill nets are marked by surface buoys at either end of the net. A fleet of six small vessels based at Blyth, use gill nets in the inshore areas adjacent to the proposed marine cable route corridor (Figure 15-5; Appendix 1). These vessels are particularly active between April to August when there is a permitted salmon, trout and bass fishery. The vessels usually work outside the 3 nm (5.5km) limit when trawling; however there are some areas where local trawlers will fish to approximately 1 nm (1.8km) from the beach. The closest fixed net is deployed approximately 250m north of the proposed cable land fall at Cambois Beach North (NIFCA, 2013).

Figure 15-4: Gill Net

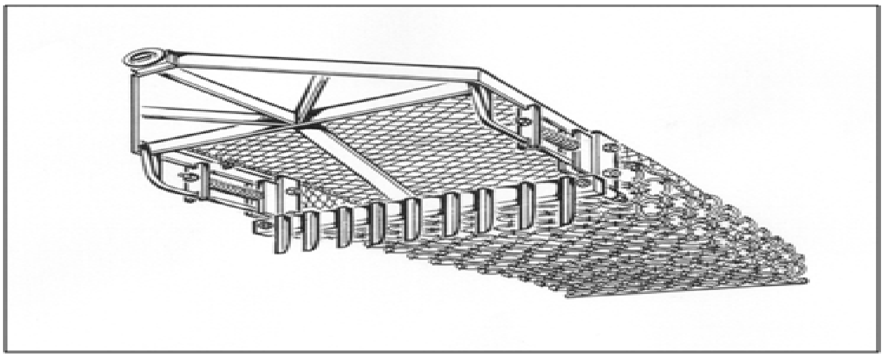


Source: Food & Agriculture Organisation of the United Nations (2012)

Scallop Dredges

Scallops are caught using a spring loaded toothed dredge (illustrated in Figure 15-6). Each dredge typically has a width of 0.75 m and teeth up to 12 cm long at the mouth of the dredge. The teeth penetrate the sea bed to sift out scallops. The dredges have a 'belly' of steel rings, and each may weigh as much as 150 kg. The dredges are attached to a steel beam and fished as 'gangs'. The size of the 'gang' depends on the power of the towing vessel and in the Blyth area is restricted to 10 dredges in total at a time. Scallop dredging is carried out by a small number of local inshore trawlers based in Blyth, and takes place on the patchy hard ground that extends out to approximately 3 nm offshore. The distribution of scallop fishing effort is illustrated in Figure 15-7 (Appendix 1) (NIFCA, 2013).

Figure 15-6: Scallop Dredger



Source: Andrews (2011)

15.4.3 *Offshore*

An important target species in offshore waters in the region of the proposed cable marine cable route corridor are Norway Lobster (*Nephrops*). *Nephrops* are a species of small crustacean that live in burrows, excavated in muddy areas of sediment found in the deep muddy grounds of the Farne Deep. A fleet of at least fifty prawn trawlers from the North East, North West, Scotland, and Northern Ireland regularly trawl this ground for *Nephrops* over the winter months (September – April) (Network Services, 2011).

Demersal Otter Trawling

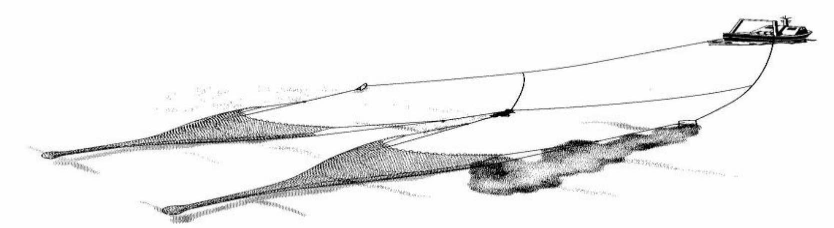
Demersal otter board trawling is the most common method of trawling used in the North Sea. The design and size of the gear varies and is dependent on the seabed contours, vessel size and species sought. The trawl net is towed over the sea bed to catch bottom feeding species.

Twin Rig Trawling

Twin rig trawls are typically used to catch *Nephrops* in the North Sea, but also whitefish on the harder ground areas. This gear is essentially two small conventional otter trawl nets that are fished side by side (Figure 15.8). The benefits of twin rigged gear is to increase the area of seabed swept by the gear without increasing the drag of the gear. The mouths of the nets are kept open by a pair of otter boards (also known as trawl doors), attached by bridles to the outer edge of each net. The lower edge of the trawl doors and the clump weight are dragged along the seabed throughout fishing operations.

Depending on the seabed characteristics, trawl doors can create furrows up to 30 cm deep in the seabed. Trawl board size varies with vessel size and target species. Some Dutch and Danish vessels now use triple rigged gear.

Figure 15-8: Twin Rigged Otter Trawl



Source: Seafish (2005)

Pair Trawling

Pair trawling has declined in the North Sea over the past 20 years due to reductions in fish quotas and decommissioning of older vessels. Pair trawlers still operate in the region of the 'Holes' searching for whitefish, and at the UK/Norway median line (RSS, 2012). This method of fishing involves two vessels towing one large trawl. Trawl boards are not used with pair trawls as the vessels themselves keep the trawl open during the towing process.

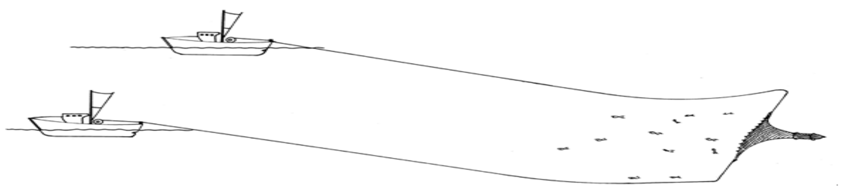
Fly Seine Netting

This method of fishing uses a similar net to a demersal trawl which is set over the sea bed using two long ropes connected to the vessel, one attached to either side of the net. Once set the net is trawled across the sea bed by winching in the ropes. No boards or heavy components are used with this method of fishing. There are a number of seine trawlers based in the North East which fish with fly seine gear on small areas of ground in the vicinity of the proposed marine cable route corridor (Farne Deeps and east to the Swallow Hole). The UK/Norway median line in the vicinity of the proposed cable route is also important for Dutch fly seine vessels during June to December (RSS, 2012).

Pair Seining

Pair seining was developed using two vessels, winches and a much larger seine (trawl) net (Figure 15.9). The pair seine vessels tow the trawl shaped net with the seine ropes that can extend up to 1000 m astern, and maintain a distance of 0.5 nm distance from one another. This is an efficient way of catching bulk fish. There are approximately 10 pairs of pair seine vessels operating out of UK ports. These vessels usually fish in the northern North Sea, and occasionally operate in the Montrose Ground in the vicinity of the proposed marine cable route corridor (Network Services, 2011).

Figure 15-9: Pair Seine



Source: Food & Agriculture Organisation of the United Nations (2012)

Beam Trawling

The beam trawl consists of a net bag (trawl) suspended from a tubular steel beam with steel shoes supporting the beam at either end. Vessel horsepower and fisheries regulations determine the length of beam permissible. Beam trawling has significantly declined in the North Sea in recent years, although this method is still permitted over most of the North Sea. There is currently little known beam trawling activity in the vicinity of the proposed marine cable route corridor by UK vessels. However, Dutch beam trawlers may operate at the UK/Norway median line in the vicinity of the proposed cable route (RSS, 2012).

15.5 Potential Impacts

15.5.1 Installation

Displacement of fishing activity by cable installation activities

During installation there will be a statutory 500 m (radius) mobile exclusion zone around the cable laying spread, moving at the rate of installation which will be typically 300 m per hour. The marine cable will be buried simultaneously during jetting operations. In areas where adequate cable burial is not possible and protection is required (such as at cable and pipeline crossings, and areas of hard seabed), the cable may remain unprotected on the seabed for up to 6-8 weeks.

The nature of towed gear such as trawls and dredges requires that vessels operating such gear be excluded from any unprotected or unburied sections of the cable. Any static fishing gear lying directly on the route of the marine cables would need to be moved to another location during the installation period, which would particularly impact inshore static gear fisheries. Therefore the sensitivity of commercial fisheries to displacement has been assessed as medium. It is estimated that such areas will be restricted to small areas of the cable route at any given time and the cable laying schedule will be designed to minimise exclusion periods. Once installation is complete, static gear can be re-deployed in the area if desired.

The magnitude of the impact has been assessed as low, due to the temporary, transient and localised nature of the installation and exclusion zone. Therefore the overall impact has been assessed as **Minor.**

Seabed obstructions (berms, trenches and anchor mounds created during installation)

The preferred installation method is by jetting. There is little or no trench created by the jetting machine in fluidised sands, and the seabed is normally left to naturally backfill. Therefore a small scar may be present but not likely to be an obstruction to commercial fishing interests.

Dynamically positioned vessels (DP) are planned to be used for installation purposes, therefore no impacts from anchors are likely. In the near shore, the cable will be installed by trenching and backfilling over the laid cable. A cable lay barge may be required to lay and bury the cables, which will use anchors to maintain position. There is a possibility that anchor mounds may be created. Such mounds have the potential to damage gear and may pose a safety risk to fishing vessels using towed gear. Therefore the sensitivity of fishermen to seabed obstructions has been assessed as high.

Impacts from anchor mounds are only likely in the near shore, by use of cable lay barges. Anchor mounds are created when using anchors in stiffer clays and sediments. Sediments in the inshore section of the proposed route corridor where anchors may be used, are comprised of sandy mud and muddy sand. Therefore it is unlikely that mounds will be created in such sediments. Undulations, if created during installation will be localised, and likely to be dispersed quickly by wave and tidal action. Therefore the magnitude of the impact has been assessed as negligible. The significance of the impact is assessed as **Minor.**

Seabed obstructions (cables on the sea bed)

The marine cables will be simultaneously laid and buried. However, in certain cases a section of cable may remain unprotected on the seabed for up to 6-8 weeks where cable burial operations take longer due to the nature of the seabed. The exposed cable on the sea bed could present a safety risk to vessels fishing in the vicinity, as fishing vessels which snag their gear on the exposed cable could potentially be pulled down by the weight of the cable and sunk. Despite the 500m exclusion zone around unburied cables, the sensitivity of fishermen to the safety risks posed by unburied cables on the seabed has been assessed as high, due to the use of trawl gar in the region (deployed astern). The magnitude of this potential impact has been assessed as low as the exclusion zone will be temporary (up to 8 weeks). Therefore the impact of seabed obstructions during installation to commercial fisheries has been assessed as **Moderate.**

Seabed obstructions (cable protection)

Where adequate cable burial depth is unable to be achieved (in areas of cable crossings and shallow sediments), some additional cable protection may be required. Approximately 2.8% (9.6 km) of the 340 km route is expected to require rock placement as additional cable protection.

There are 21 cable crossings within UK waters. Rock protection berms are designed to protect the cable and have an over-trawlable profile to enable the cable to be buried beneath the area penetrated by heavy fishing gear (up to 0.4m). Cable protection is not predicted to be required within the highest intensity fishing grounds (RSS, 2012). The design and location of the cable protection indicates that sensitivity to cable protection is low.

The magnitude of the impact has been assessed as negligible due to the small extent and localised nature of cable protection. Therefore the impact of cable protection to commercial fishing has been assessed as **None**.

Operation

Exposed cable (safety risk)

Should any section of the marine cable become exposed during operation, this could present a safety risk to vessel fishing in the vicinity. Exposed cable presents a significant hazard to fishing vessels and can result in the loss of gear or even the capsize and sinking of vessels. The sensitivity of fishermen to the safety risks associated with the possible exposure of buried cable has been assessed as high.

The magnitude of this potential impact has however been assessed as low as it is unlikely in the Central North Sea that the marine cables will become exposed after installation. The significance of this impact has been assessed as **Moderate.**

Disruption of fishing activity from repairs/maintenance work

Should maintenance, survey or repair activities be required for the marine cables during their lifetime, it may be necessary to impose a temporary exclusion zone to all fishing vessels similar to that during installation activities, although on a smaller scale. The sensitivity of fishermen to disruption caused by maintenance, survey or repair works has been assessed as high as seasonal fishing cannot be avoided if maintenance work becomes necessary. The magnitude of the potential impact has been assessed as low due to the short duration of these activities and the small area which may be affected at any one time. Therefore the significance of the impact has been assessed as **Moderate.**

15.6 Mitigation

15.6.1 Installation

Displacement of fishing activity by cable installation activities

- All vessels (including commercial fishing vessels) will be required to adhere to the safety exclusion zone around the cable lay vessels and unburied cable spread during cable installation. During these periods guard vessels will be deployed to protect the cable and to ensure that other sea users are aware of the potential cable hazard.
- Appointment of a Fisheries Liaison Officer (FLO) during the project who will maintain communication with fisheries representatives and fishermen throughout construction and installation. The use of a FLO will continue during the installation stage according to the recommendations for fisheries liaison published by the UK Government (BERR, 2008).
- Local fishermen will be informed in advance via Kingfisher notice to mariners, of operations to ensure that fishermen using static gear can lift and redeploy it.

Seabed obstructions (berms, trenches and anchor mounds created during installation)

- All seabed obstructions created by installation of the marine cables, that are considered to pose a risk to the fishing industry will be made safe for towed fishing gear - trawlers.
- Rock berms will be installed where adequate cable burial has not been possible. They will be designed to have a smooth over-trawlable profile so that they do not present an obstruction to fishing activity (1 in 3 slope profile).

Seabed obstructions – cables on the seabed

- Appointment of a Fisheries Liaison Officer (FLO) during the project who will maintain communication with fisheries representatives and organisations throughout construction and installation. The use of a FLO will continue during the installation stage according to the recommendations for fisheries liaison published by the UK Government (BERR, 2008).

- Guard vessels will be used for any sections of marine cables left temporarily unburied or unprotected during installation operations. A fisheries liaison officer (FLO) will be on board guard vessels for an unburied cable.
- All vessels (including commercial fishing vessels) will be required to adhere to the safety exclusion zone around the cable lay spread during cable installation

15.6.2 Operation

Exposed cable (safety risk) and repairs/maintenance work

- The as-laid coordinates of the cable will be issued to the UK Hydrographic Office (UKHO) and Kingfisher Information Service for inclusion on admiralty and cable awareness (KISCA) charts.
- A depth of burial survey will be undertaken post installation to ensure that the cables remain adequately buried.
- Monitoring surveys will be undertaken to check burial depths during the lifespan of the cable.
- Areas where sediment movement may occur that reduce the depth of cable burial will be identified in the burial depth surveys. Such areas may be subject to more frequent monitoring surveys than the remainder of the route.
- Fishermen will be informed of any specific areas where additional protection using rock placement and / or mattressing will be used.
- The schedule of repair and maintenance work activities will be published to fishermen in advance, and the duration of these activities will be kept to a minimum to reduce the exclusion to fishing grounds.

15.7 Residual Impacts

15.7.1 Installation

Displacement of fishing activity by cable installation activities

Good communication between the installation and commercial fishing interests will enable construction activities, minimising displacement. Exclusion of fishing activities from any particular area of seabed will be temporary. It is considered likely that fishermen will be able to deploy gear on alternative grounds without loss of productivity. Following the above mitigation measures reduces the magnitude of the impact to negligible. Therefore this impact has been assessed as none and therefore **Not Significant.**

Seabed obstructions (trenches and anchor mounds created during installation)

All seabed obstructions, that pose a risk to commercial fishing, including trenches and anchor mounds, will be removed or made safe for towed fishing gear. The sensitivity of commercial fisheries to seabed obstructions is therefore reduced to low if the obstruction is removed/made safe. Following the mitigation measures reduces the impact to minor, which is considered **Not Significant**.

Seabed obstructions – cables on the seabed

The magnitude of the impact is reduced by following the mitigation measures and is assessed as negligible. Therefore the residual impact is considered minor. Minor impacts are **Not Significant.**

15.7.2 Operation

Exposed cable (safety risk) and repairs/maintenance work

With the above mitigation measures in place, the magnitude of the impact has been reduced to negligible. Therefore the sensitivity of the impact is minor. Minor impacts are **Not Significant.**

Displacement of fishing activity by cable repairs and maintenance work

As during installation, exclusion of fishing activities from any particular area of seabed for maintenance activities will be temporary. Following the above mitigation measures reduces the magnitude of the impact to minor. Therefore this impact has been assessed as minor and therefore **Not Significant.**

15.8 References

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16 SHIPPING AND NAVIGATION

16.1 Introduction

This Section provides an overview of shipping activity along the proposed marine cable route corridor and identifies and assesses the potential impacts that cable installation and operation may have on commercial shipping and navigation. It identifies the mitigation measures to be implemented to avoid, reduce or offset any potential adverse impacts.

Fishing and recreational fishing vessel activity is covered separately in Sections 16 and 19.

16.2 Data Sources

A desk based review of issues associated with the proposed Norway-Interconnector cable route has been undertaken (Anatec, 2013) in relation to shipping and navigation. This Section summarises the findings of that review. The full report is presented in Appendix 2.7.

Baseline data were collated within 10nm of the proposed cable route corridor and landfall location, to identify the following:

- Shipping Routes and Vessels Types.
- Shipping Density.
- Navigational Features and Anchoring

This data was obtained using the ShipRoutes database, which has been developed by Anatec UK Ltd, for the area around the cable route in UK waters. The data within ShipRoutes is taken from a number of sources such as Automatic Information System (AIS), radar, satellite vessel tracking (VMS), vessel passage plans, consultation with ports and pilots and admiralty charts.

Analysis of shipping data in the vicinity of the study corridor was based on 28 days of Automatic Information System (AIS) data (14 days each from summer and winter 2011). This has been used to validate the shipping routes identified from the ShipRoutes database. AIS is now fitted on the majority of commercial ships operating in UK waters including all passenger ships and other ships of 300Gt upwards engaged on international voyages, which covers the vast majority of merchant shipping activity passing through the area. Due to the location of the proposed cable, there is not enough AIS data available to have good coverage throughout the entire area. A large section of the route is out of range of receivers for AIS transmitted data. There is good AIS coverage up to approximately 35nm off the east coast of England and coverage received from various off shore platforms located in the North Sea which the proposed cable passes close to.

A Navigation Risk Assessment has also been undertaken based on the information provided in the Anatec desk based review (Intertek, 2013).

16.3 Methods

16.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on shipping and navigation have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential effect incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

16.3.2 Magnitude of Effect

The magnitude of an effect considers the scale of the predicted change to baseline conditions resulting from a given potential effect and takes into account the likelihood of the effect occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of effect are described in Table 16-1.

Table 16-1: Magnitude of Effect

Magnitude	Description
High	Permanent or long term (life of project i.e. tens of years up to and beyond 40 years duration) disturbance to commercial shipping activity.
Medium	Medium-term (several years duration) disturbance to commercial shipping activity
Low	Short-term (a return to normal conditions following marine cable installation) disturbance to commercial shipping activity.
Negligible	The development will result in no disturbance to commercial shipping activity.

16.3.3 Sensitivity or Importance of Receptor

The sensitivity of the baseline conditions has been assessed according to the recoverability of the receptor and the relative importance of the shipping and navigation activities present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance).

The criteria provided in Table 16-2 provide a general definition for determining the sensitivity of shipping and navigation interests.

Table 16-2: Sensitivity of Receptor

Sensitivity	Description
Very High	The receptor has little or no capacity to absorb change without fundamentally altering its present character, has very high shipping usage e.g. shipping density per day >=8
High	The receptor has low capacity to absorb change without fundamentally altering its present character, has high shipping usage e.g. shipping density per day 6-8
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some shipping usage e.g. shipping density per day 4-6
Low	The receptor is tolerant of change without detriment to its character, has low shipping usage e.g. shipping density per day 2-4
Negligible	The receptor is resistant to change and is of little value, has very low shipping usage e.g. shipping density per day <=2

16.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the sensitivity or importance of the receptor and the magnitude of a potential effect. The impact significance is assessed as Major, Moderate, Minor or None. The term ‘None’ denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account the mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts identified as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. The full results of the assessment of impact significance are presented in Appendix 2.3.

16.4 Existing conditions

16.4.1 Shipping Routes and Vessel Types

An overview of shipping traffic within 10nm of the proposed cable route based on Anatec’s ShipRoutes database is presented in Figure 16-1. Analysis of data from ShipRoutes indicates that over 13,000 vessels per year pass within 10nm of the cable route corresponding to an average of 36 vessels per day. Of this annual traffic, cargo vessels were the most common vessel type (51%) followed by tankers (30%) and ferries (9%). Over half of all vessels were between 1,500 and 5,000 deadweight tonnes (DWT), with only a small number (6%) of large vessels greater than 40,000 dwt.

Figure 16-1: Shipping routes crossing the cable route within a 10nm buffer

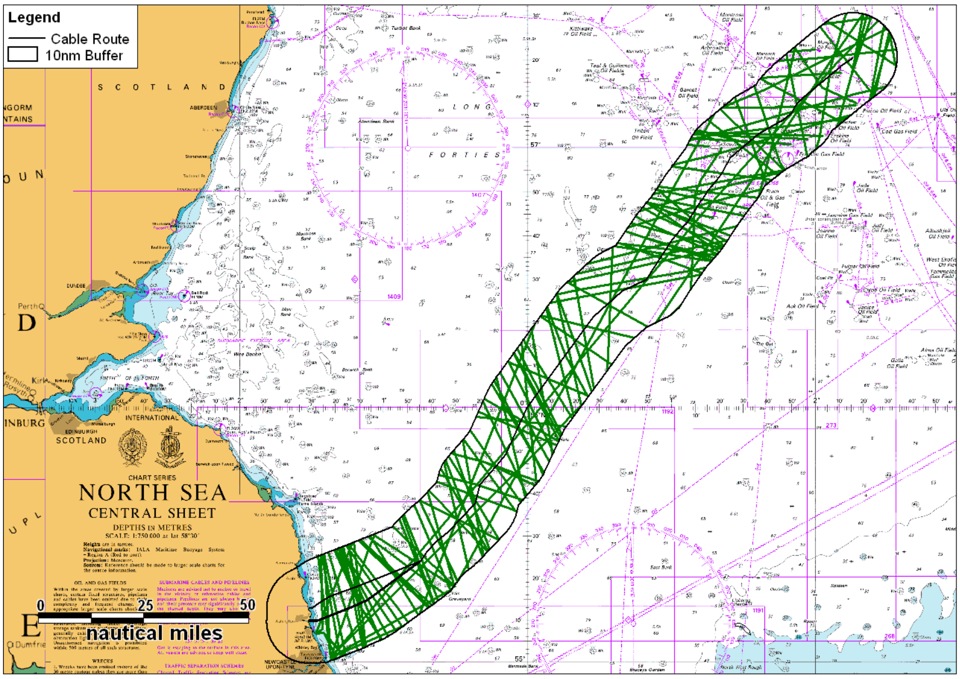
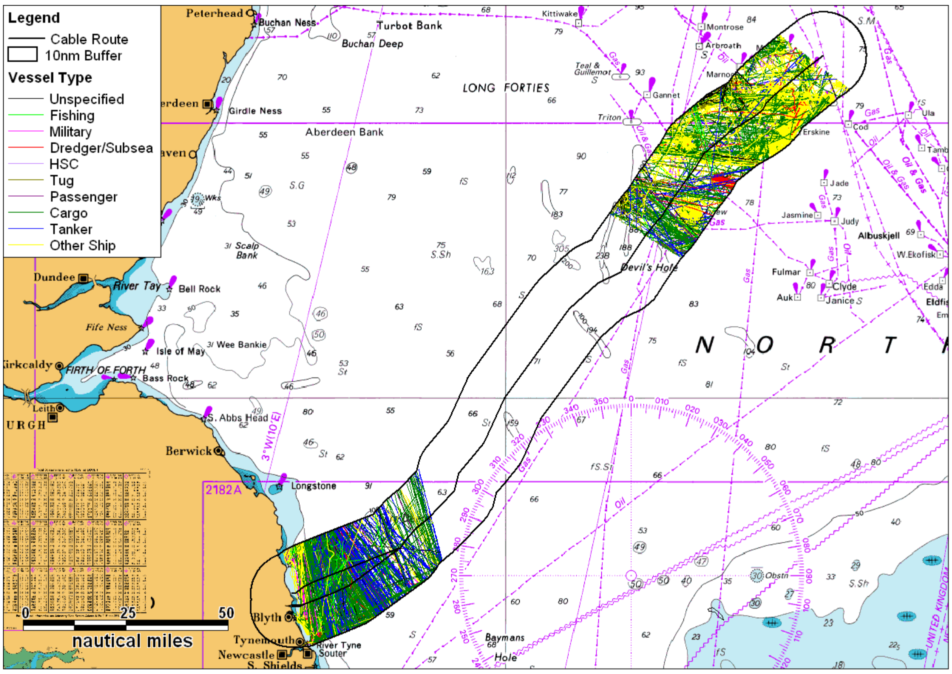


Figure 16-2 presents the areas where AIS coverage is available within 10nm of the cable route during the 28 day survey period and is colour coded by vessel type.

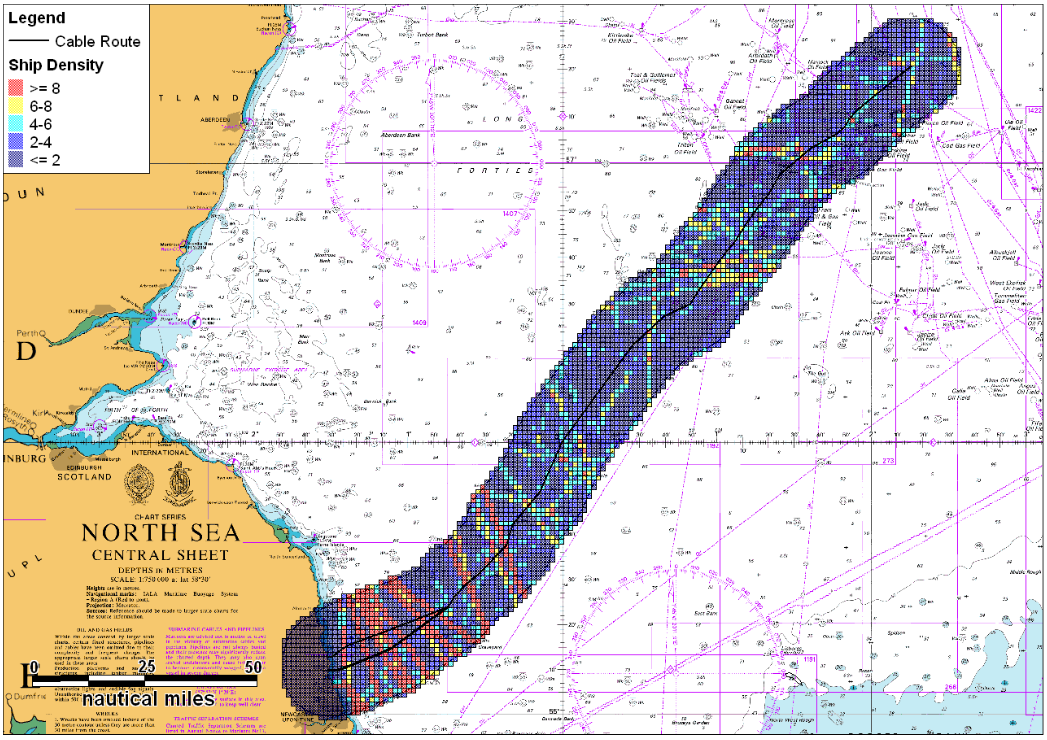
Figure 16-2: Overview Chart of AIS Tracks by Vessel Type within 10nm of Cable Route



16.4.2 Shipping Density

Overall shipping density along the cable route is presented in Figure 16-3. This analysis identifies the highest density of shipping passing over and adjacent to the cable route is close to the east coast of England. Vessels recorded in transit around this area include cargo vessels, tankers and ferries travelling to various ports along the east coast of the UK. There is also a reasonably high density of shipping recorded around the offshore oil fields located towards the UK/Norway median line.

Figure 16-3: Ship densities within 10nm of cable route



16.4.3 Navigational Features and Anchoring

The approach to the Cambois Beach North landfall is not located within of any ports or harbour limits on the east coast of England; the nearest port is Blyth which is 5km to the south. There are no International Maritime Organisation (IMO) routing measures in the vicinity of the proposed cable route.

During the AIS survey period an average of five vessels per day were recorded at anchor within 10nm of the proposed cable route. The vast majority of these were cargo vessels anchored towards the mouth of the River Tyne, approximately 8.8nm south of the Cambois Slipway landing. There were also two anchored cargo vessels recorded off the east coast of Blyth approximately 5km south of the Cambois Beach North landfall.

There were several vessels recorded at anchor close to the offshore platforms, with the closest vessel recorded at anchor 0.4nm south-east of the proposed cable route corridor. AIS data is not available for the areas between the landing approaches and the offshore oil and gas platforms and the area close to the median line. Therefore it is not possible to state with confidence the levels of anchoring in these regions of the cable route. However, because these regions are within open sea with little shelter and large water depths, very little planned anchorages would be expected in these areas.

16.4.4 Port infrastructure

The Port of Blyth

The closest port to the proposed cable route is the Port of Blyth, which is located just over 5km to the south of the Cambois Beach North landfall.

Blyth is a tidal port accommodating vessels up to 30,000 DWT at berth within 0.5 miles of the open sea and without the need for locking in or out. The maximum size of vessel that can be berthed is approximately 200m LOA, 9.5m draft and 50m beam. The port has no air draft restrictions. Access to Blyth is virtually all weather, 24 hour 7 day.

At present Blyth is relatively small handling an average of 350 vessels per year. However, traffic is likely to increase in the future as a 100MW biomass power station is planned to be built within the port and fuel for this will be imported in bulk by sea.

There is no designated anchorage area indicated on the Admiralty Chart, although vessels do occasionally anchor off the entrance to the port, awaiting a berth due to adverse weather. These vessels anchor in the vicinity of the fairway buoy (Figure 16.1; Appendix1). No anchoring was reported by the Harbour Master in the vicinity of the proposed cable routes.

16.5 Potential Impacts

The potential impacts on commercial shipping and navigation from installation and operation of the marine cables is provided below. The full results of the assessment of impact significance are presented in Appendix 2.3.

Impacts on fishing and recreational vessel activity are considered separately in Sections 16 and 19.

The shipping review (Anatec, 2013) and Navigation Risk Assessment (Intertek, 2013) identified two areas along the cable route (the UK nearshore section close to the Port of Blyth and the UK offshore oil and gas region of the route near the UK/Norway median line) where sensitivity to shipping is considered to be medium. Sensitivity to shipping along the rest of the route is generally considered to be low. For the purposes of this assessment the overall sensitivity to shipping along the route has been assessed as medium.

16.5.1 Installation

Displacement of shipping vessels from the area surrounding the cable laying spread

It is expected that a temporary Safety Zone of 500m by 1000m with the major axis lying along the direction of travel will be in force during the cable installation at any one time and that the rate of cable lay will be in the range of 250m to 1000m per hour depending on the installation method.

Due to their limited ability to manoeuvre, offshore cable installation vessels require an exclusion zone within which no other vessel can enter. The presence of cable installation vessels along the proposed marine cable route corridor may therefore cause disruption to shipping activity in the area by requiring alteration of planned routes. This will apply to both routine traffic (e.g. freighters and tankers) and non-routine traffic (e.g. fishing vessels and recreational craft – covered separately in Sections 15 and 19). As the installation vessels will be moving along the cable route, they will not affect any individual existing shipping route for long periods of time.

Consultation has been undertaken with the Port of Blyth regarding both cable installation and operation. The Port of Blyth is supportive of the project and has not sited any specific concerns.

Commercial vessels in the region of the cable route are considered to have medium sensitivity to disruption. However, the magnitude of the potential effect has been assessed as low due to the temporary and localised nature of any disruption. The significance of the impact is therefore assessed as **Minor**.

Collisions between commercial and installation vessels

There will be a temporary risk of a ship-to-ship collision between third party vessels and the vessels involved in the marine cable installation works. Areas which have a higher probability of ship collisions are the UK near shore section and areas near the oil and gas fields towards the UK/Norway median line. The sensitivity of commercial vessels to ship-to-ship collisions has been assessed as medium. The magnitude of the potential effect has been assessed as low due to the low likelihood of a collision occurring. The significance of the impacts is therefore assessed as **Minor**.

Accidental anchoring on unburied cable during installation

During marine cable installation there may be a period of time between cable lay and post lay burial where the marine cables are left exposed on the seabed. Without appropriate mitigation measures, there is a risk that vessels could anchor over a cable, snagging their anchors on it. This could result in damage to the vessel, its anchoring equipment (such as the windlass or the anchor chain) and or potentially loss of the anchor. Commercial vessels have been assessed to have medium sensitivity to accidental anchoring on unburied cable along the route. The magnitude of the potential effect has been assessed as low due to the low likelihood of accidental anchoring occurring. The overall significance of the impact has therefore been assessed as **Minor**.

16.5.2 Operation

Anchor dragging and snagging the cable

There is a potential risk that a ship anchoring in the vicinity of the cable may drag anchor towards and over the cable. Anchor impact energies depend on the type and mass of anchor. Penetration depths depend on other factors, most notably the nature of the seabed (sediment type and mobility). Soft sand or mud will generally be penetrated very easily by anchors. A detailed assessment of the seabed composition along the cable would be needed to estimate penetration depths but it is likely that sandy areas could be penetrated by the largest anchors by at least 1-2m. This could result in the anchor snagging on the cable.

Anchor drag normally occurs through laying out insufficient anchor chain in the prevailing conditions, or when forces acting on the vessel become greater than the holding power of the anchor, possibly following deterioration of weather conditions. The Navigation Risk Assessment identified two potential areas where anchor dragging may be a risk:

- Inshore area near Blyth.

- The oil and gas region of the cable route close to the UK/Norway median line.

Under normal weather conditions, when the vessels first anchor, the distance an anchor will drag is less than 60m (DONG Energy, 2012). However, in poor weather conditions, anchors have been known to drag for 1-5km. Such instances tend to be a result of a combination of factors including poor weather, human error and equipment failure. Therefore the likelihood of the impact occurring is further reduced. Even in such conditions, it is unlikely for a vessel anchored outside Blyth to drag its anchor to affect the cable because the predominant wind direction in the region is in the south-west direction away from the cable (UKHO, 1995).

In the oil and gas region of the cable route where some oil and gas vessels anchor, it is unlikely that these types of vessels will drag their anchors as their crew are highly trained. This is due to the many pipelines in the region and the negative consequences of damaging them. Therefore the probability of such events occurring is extremely low.

In both cases the risk has been assessed as tolerable, providing appropriate risk control measures are in place to reduce the risks to as low as is reasonably practicable (ALARP).

The sensitivity of commercial vessels has been assessed as medium. The magnitude of the effect is assessed as low, due to the very low likelihood of vessels anchor dragging over the cable. The overall impact significance is therefore assessed as **Minor**.

Emergency anchoring on the cable

There is a potential risk of a ship anchoring over the cable in an emergency situation and snagging the cable. In an emergency situation, a ship may anchor to stop or slow down its rate of drift when heading towards a hazard e.g. a grounding risk or an offshore installation. A vessel does not immediately drop an anchor when it encounters engine problems. It drifts for a period while trying to recover from the engine problem. If unrecoverable, it slows down to approximately 1 knot before dropping an anchor. Anchoring at speeds above 1 knot will most likely lead to vessel structural damage. In the worst case scenario, this effect could result in damage to the vessel, anchor equipment (such as windlass or anchor chain) and / or loss of the anchor.

The risk of ship-to-cable interaction in the event of emergency anchoring for both UK nearshore and offshore areas has been assessed as ‘Tolerable’ providing control measures are in place to reduce the risks to ALARP.

Commercial vessels are considered to have medium sensitivity to anchoring on marine cables along the route in an emergency. The magnitude of the potential effect is assessed as low due to the low likelihood of the effect occurring. Therefore the overall significance of the impact is assessed as **Minor**.

Compass deviation to ships navigating with magnetic compasses

The electromagnetic field (EMF) that will be generated by the marine cables during operation will have a small localised effect which could potentially cause compass deviation in ships using magnetic compasses. The degree of compass deviation can vary depending on the alignment of the cable relative to the Earth's magnetic field, the proximity of the two marine cables, and the water depth. Commercial vessels and recreational craft navigating with magnetic compasses are considered to be able to make the necessary adjustments to a slight deviation in compass reading and sensitivity has therefore been assessed as medium. The magnitude of the potential effect has been assessed as low as the EMF emanating from the cables will have temporary and localised effect on individual vessels Therefore, the overall significance of the impact is assessed as **Minor**.

EMF interference with inertial navigation systems (INS) and Global Positioning Systems (GPS)

Submarine HVDC cables generate magnetic fields due to the current flowing along the marine cables. The magnitude of the magnetic fields produced is directly dependent upon the amount of current flowing through the cables. The cable sheathing used to prevent the propagation of electric fields into the surrounding environment is permeable to magnetic fields, which therefore emanate into the surrounding environment. The movement of sea water or marine organisms through the static magnetic fields will create small, localised induced electric fields. The Ministry of Defence (MOD) has expressed slight concerns on similar projects that electric and magnetic fields emanating from the operating cables could interfere with inertial navigation systems and GPS. Commercial vessels and military craft navigating using inertial navigation systems and GPS have negligible sensitivity to EMF emanating from the operational cables. One of the main advantages of marine gyrocompasses (used in inertial navigation systems) over magnetic compasses is that they are unaffected by external magnetic fields which can deflect normal compasses. Modern inertial navigation systems generally use laser technology and resonating quartz devices and are self-contained. As a result EMF will have no or a negligible effect on their function. GPS use radio signals which again will be subject to no or negligible effects from EMF emanating from the cables. As these systems are unaffected by external magnetic fields the magnitude of this potential effect is also negligible. Therefore the overall impact significance is assessed as **None**.

Disruption from maintenance, repair and cable surveys post installation

During normal operation there will be a limited effect on shipping from regular (though not frequent) survey of the buried cable route using side-scan sonar and possibly remotely operated vehicles (ROVs), to monitor the depth of burial. These surveys will be carried out from a vessel that will travel the entire cable route. Surveys are anticipated to take place on a regular basis in the early years of operation, and this may reduce when sufficient information has been gained on sediment movement. Normal shipping traffic may have to make minor diversions to avoid the survey vessel. Commercial vessels are considered to have medium sensitivity to disruption from the presence of survey vessels. The magnitude of the potential effect is low due to the localised and temporary nature of the exclusion zone required. Therefore the overall significance of the impact is assessed as **Minor.**

Collision between commercial and maintenance/repair/survey vessels

There will be a temporary risk of a ship-to-ship collision between third party vessels and the vessels involved in the maintenance/survey works. Commercial vessels are considered to have medium sensitivity to ship-to-ship collisions. The magnitude of the potential effect has been assessed as low due to the low likelihood of a collision occurring. Therefore the overall significance of the impact is assessed as **Minor.**

Accidental anchoring on the cable

There is a small risk that vessels could anchor over the cable, and potentially snag their anchors on it. Commercial vessels are assessed as having medium sensitivity to accidental anchoring on cable along the cable route. The magnitude of the potential effect has been assessed as low due to the low likelihood of accidental anchoring occurring. Therefore the overall significance of the impact is assessed as **Minor.**

16.6 Mitigation

16.6.1 Installation

Displacement of shipping vessels / collisions between commercial and installation vessels

- Vessels to comply with the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs) – as amended, particularly with respect to the display of lights, shapes and signals.
- Any jack up barges / vessels utilised during the works/laying of the cable, when jacked up, should exhibit signals in accordance with the UK Standard Marking Schedule for Offshore Installations.
- To minimise the potential for disruption and/or accidents during cable-laying operations, notice will be given to shipping in the area via Navtex and NAVAREA warnings.
- A method statement and risk assessment will be prepared by the Contractor for approval by the Port of Blyth prior to undertaking any cable installation works.
- Procedures to minimise disruption near high density shipping areas will include, for example, avoidance of anchoring near busy areas when installation vessels are waiting on weather; and the presence of a guard vessel when required.
- In periods of poor visibility, especially in high-density shipping areas, restrictions such as a temporary cessation of installation activity may be considered to reduce the risk of collisions.
- The appointed Contractor will liaise with all navigational stakeholders before and during all stages of installation. This will include local ports (Blyth), and the operators/developers of NAREC Blyth Offshore Demonstration Project and oil and gas infrastructure.
- The appointed Contractor, NGIL and SSF will maintain full communications with the relevant ports authorities during cable installation and maintenance work, and will ensure that the appropriate radio navigation warnings are broadcast. Notices to Mariners will be issued six weeks prior to installation works commencing.

- Guard vessels will be used during cable-laying to communicate with third party vessels in the vicinity of any sections of cable that remain unburied between cable lay and post lay burial.
- Installation vessels will have passage planning procedures, holding positions (e.g. if waiting on weather), traffic monitoring (radar, AIS and visual), means of communications with third party vessels and emergency response in the event of a vessel approaching on a collision course.
- Notices to Mariners will be issued six weeks prior to installation work commencing.

Accidental anchoring on unburied cable during installation

- Guard vessels will be employed for any unburied/unprotected cable sections to communicate with third party vessels and warn them to stay clear of the cable in this location.

16.6.2 Operation

Anchor dragging and snagging the cable / emergency anchoring on the cable

- The cable will be buried along the majority of the route to a depth of 1-2m. A depth of burial survey will be undertaken post installation to ensure that the cables have remained adequately buried.
- Sections of the cable in seabed conditions which are easily penetrated by anchors may be subject to deeper burial or cable protection.
- Regular burial depth surveys will be undertaken during the operational phase.
- Rock berms or mattresses will be installed over any section of the cable where burial has not been possible.
- 'As laid' co-ordinates of the cable route will be recorded and circulated to the UK Hydrographic Office (UKHO) and Kingfisher to for inclusion on Admiralty Charts and fishermen's awareness charts (paper and electronic format).
- The appointed Contractor, NGIL and SSF will liaise with the relevant ports authorities regarding the risk of anchor dragging.

Compass deviation to ships navigating with magnetic compasses

- In accordance with Maritime and Coastguard Agency (MCA) requirements cable design criteria will ensure that compass deviation at the sea surface will not exceed 3 degrees for 95% of the route. For the remaining 5% of the cable route no more than five degrees will be attained
- 'As laid' co-ordinates of the cable route will be recorded and circulated to the UKHO and Kingfisher to ensure inclusion on Admiralty Charts and Kingfisher Information Service – Cable Awareness (KISCA) charts (paper and electronic format).

EMF interference with inertial navigation systems (INS) and Global Positioning Systems (GPS)

No mitigation is proposed as EMF effects on INS and GPS have been assessed as negligible.

Disruption from maintenance/repair to cable post installation, disruption from surveys after installation, and collisions between commercial and maintenance/repair/survey vessels

- Details of the proposed activity will be circulated to the appropriate authorities and maritime community prior to work commencing.
- The proposed route has been designed to limit the potential for damage during operation of the cable by seeking to have it buried for the majority of its length. This will reduce the likelihood of repair works being necessary.
- In periods of poor visibility, especially in high-density shipping areas, restrictions such as a temporary cessation of maintenance, repair or survey activity may be considered to reduce the risk of collisions.
- The appointed Contractor, NGIL and SSF will maintain full communications with the relevant ports authorities during cable maintenance work, and will ensure that the appropriate radio navigation warnings are broadcast. Notices to Mariners will be issued in advance of maintenance or repair works.

Accidental anchoring on cable

- Areas where sediment movement may occur and reduce the depth of cable burial will be identified in the burial depth surveys, these areas may be subject to more frequent surveys than the remainder of the route.
- 'As laid' co-ordinates of the cable route will be recorded and circulated to the UKHO and Kingfisher to ensure inclusion on Admiralty Charts and Kingfisher Information Service – Cable Awareness (KISCA) charts (paper and electronic format).
- The appointed Contractor, NGIL and SSF will liaise with the relevant port authorities regarding the risk of accidental anchoring upon the cable.

16.7 Residual Impacts

16.7.1 Installation

Displacement of shipping vessels from the area surrounding the cable lay spread

Due to the localised and mobile nature of the temporary exclusion zone, the potential for disruption to shipping has been assessed as minor significance. Whilst mitigation measures will make third party vessels aware of the safety zone, this will not reduce the potential for disruption. Therefore there is still a Minor residual impact. Minor impacts are however **Not Significant**.

Collisions between commercial and installation vessels

To minimise the risk of collision mariners will be pre-warned about installation operations via Notices to Mariners, Navtex and NAVAREA warnings, liaison with ports and radio broadcasts during operation. The working vessels will have procedures regarding passage planning, holding operations (e.g. if waiting on weather), traffic monitoring (radar, AIS and visual), means of communicating with third party vessels and emergency response in the event of a vessel approaching on a collision course. With the above mitigation measures in place the likelihood of a collision occurring is extremely low. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant**.

Accidental anchoring on unburied cable during installation

With mitigation measures in place it is considered unlikely that this impact will occur. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

16.7.2 Operation

Anchor dragging and snagging the cable

The risk of ship-to-cable interaction near Blyth and in the region of the oil and gas infrastructure near the UK/Norway median line has been assessed based on the shipping/ review (Anatec, 2013) as tolerable (intermediate risk), providing appropriate risk control measures are in place. With the implementation of effective mitigation measures, the likelihood of the effect occurring has been reduced to ALARP. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

Emergency anchoring on the cable

The risk of emergency anchoring over the installed cable has been assessed as tolerable providing appropriate control measures are in place. This can be achieved through the use of suitable cable protection, burial to appropriate depths taking account of seabed characteristics, and the inclusion of the 'as-laid' cables on Admiralty charts. With the implementation of effective mitigation measures, the likelihood of the effect occurring has been reduced to ALARP. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

Compass deviation to ships navigating with magnetic compasses

The magnetic field that will be generated by the cables during operation will have a small localised effect, causing compass deviation as the vessel passes over the cable. The level of deviation at the sea surface will vary according to cable configuration, alignment and water depth but as a requirement of the cable design criteria will not exceed 5 degrees for 95% of the route

The 'as-laid' coordinates of the cable route will be included on Admiralty and Kingfisher Information Service – Cable Awareness (KISCA) charts to make mariners aware of its position and allow them to account for possible compass deviation. The impact on navigating ships will be localised and with the mitigation measures described above in place and accounting for the satellite navigation equipment fitted to modern vessels the magnitude of the effect is reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant**.

EMF interference with inertial navigation systems (INS) and Global Positioning Systems (GPS)

No mitigation measures are required as any impact is negligible or will not occur at al. The impact is therefore **Not Significant**.

Disruption from maintenance, repair and cable surveys post installation

Whilst mitigation measures that are in place will make the maritime community aware of potential disruption it will not reduce the level of disruption therefore there is still a minor residual impact which will be temporary and localised. Minor impacts are **Not Significant**.

Collisions between commercial and maintenance/repair/survey vessels

The presence of maintenance, repair or survey vessels may present a collision risk. With warnings and collision avoidance procedures in place collisions are considered unlikely. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

Accidental anchoring on cable

The risk of accidental anchoring over the cable during operation has been assessed as low. Cable burial beyond the penetration depth of anchors, frequent cable burial surveys and circulation of the ‘as laid’ coordinates of the cable route further mitigate this risk. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

16.8 References

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Intertek (2013), Norway – UK Interconnector UK Navigation Risk Assessment . Report Ref: P1568_R3473

UKHO (1995), North Sea (West) Pilot – East Coasts of Scotland And England From Rattray Head To Southwold, United Kingdom Hydrographic Office.

17 OFFSHORE INFRASTRUCTURE

17.1 Introduction

This Section provides an overview of offshore infrastructure, including cables and pipelines crossed by the proposed marine cables, and oil and gas and offshore wind infrastructure in the vicinity of the proposed marine cable route corridor. The assessment considers the potential impacts that marine cable installation and operation may have on offshore infrastructure. It identifies the mitigation measures to be implemented to avoid, reduce, or offset potential impacts.

17.2 Data Sources

The primary data sources used in the assessment of impacts on offshore infrastructure are as follows:

- NAREC Blyth-Offshore Demonstration Project Environmental Statement
- UKDEAL Digital data
- Oil and Gas company websites
- Stakeholder consultation responses

17.3 Methods

17.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on offshore infrastructure have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential effect incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

17.3.2 Magnitude of Effect

The magnitude of an effect considers the scale of the predicted change to baseline conditions resulting from a given potential effect and takes into account the likelihood of the effect occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of effect are described in Table 17.1.

Table 17-1: Magnitude of Effect

Magnitude	Description
High	Permanent or long term (life of project i.e. tens of years up to and beyond 40 years duration) impact to the structure/integrity of offshore infrastructure
Medium	Medium-term (several years duration) impact to the structure/integrity of offshore infrastructure
Low	Short-term (a return to normal conditions following cessation of marine cable installation) to the structure/integrity of offshore infrastructure
Negligible	The development will result in no impact to the structure/integrity of offshore infrastructure

17.3.3 Sensitivity or Importance of Receptor

The sensitivity of the baseline conditions has been assessed according to the recoverability of the receptor and the relative importance of the offshore infrastructure present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance).

The criteria provided in Table 17-2 provide a general definition for determining the sensitivity of different types of offshore infrastructure.

Table 17-2: Sensitivity of Receptor

Sensitivity	Description
Very High	The receptor has little or no capacity to absorb change without fundamentally altering its present character, is of very high value / international importance e.g. telecoms cables, interconnectors or pipelines
High	The receptor has low capacity to absorb change without fundamentally altering its present character, is of high value / national importance e.g. wind farm inter-array/export cables
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some value / national importance e.g. wind farm construction and maintenance activities
Low	The receptor is tolerant of change without detriment to its character, is low value, or local importance
Negligible	The receptor is resistant to change and is of little infrastructural importance

17.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the sensitivity or importance of the receptor and the magnitude of a potential effect. The impact significance is assessed as Major, Moderate, Minor or None. The term 'None' denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account the mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts identified as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant.

The full results of the assessment of impact significance are presented in Appendix 2.3.

17.4 Existing conditions

17.4.1 Cables and Pipelines

The proposed marine cable route corridor crosses one active cable: the CNS Fibre Optic telecom cable, which runs from Zandvoort, the Netherlands, to Lowestoft, England and is operated by the Central North Sea Fibre Telecommunications Company Limited (CNSFTC) – a BP owned subsidiary. The proposed Norway-UK Interconnector route crosses the CNS Fibre Optic cable approximately 4.73km from the UK/Norway Median line.

In addition to this, in English waters the cable route crosses two out of use cables: Newbiggin-Marstrand No1 and Newbiggin-Marstrand No2. The exact position of these cables is not known, however they are likely to be between KP 509 and 558.

Scottish Hydro Electric (SHE) Transmission plc, a subsidiary of Scottish and Southern Energy (SSE), and National Grid Electricity Transmission plc (NGET) plan to develop an Eastern HVDC Subsea Link between Peterhead on Scotland's north east coast and north east England. The proposed marine cable route corridor crosses the route of the planned Eastern HVDC Link approximately 27km east of the Northumberland coast. The Eastern HVDC Link is currently planned to be operational by 2018. It is unlikely that the Eastern HVDC Link will be installed before the Norway-UK Interconnector.

Details of the cables and locations of the crossings are provided in Table 17-6 and Figure 17.1 (Appendix 1).

Table 17-3: Summary of Cable Crossings

Cable Name	Operator	Route	Service	Status
CNS Fibre Optic	BP	Lowestoft, England – Zandvoort, Netherlands	Telecom	Active
Newbiggin-Marstrand No1	BT	Newbiggin-Marstrand	Telecom	Out Of Service
Newbiggin-Marstrand No2	BT	Newbiggin-Marstrand	Telecom	Out Of Service
Eastern HVDC Link	NGET & SHETL	Peterhead, Scotland – North- east England	Power	Planned

The proposed marine cable route corridor crosses 11 oil and gas pipelines, as listed in Table 17-7. All the pipelines are within Scottish offshore waters. In addition to these existing pipelines, BG Group is also planning to develop some new pipelines within the Lomand field which are likely to cross the proposed route of the Norway-UK Interconnector. These pipelines are still in the appraisal phase of development and if approved construction will start in 2014/2015 (BG Group *pers. comm.* 2012).

Table 17-4: Summary of Pipeline Crossings

Pipeline Name	Operator	Diameter (inches)	Fluid	Status
Lomond to Everest CATS riser Platform	BG Group	8	Oil	Active
Lomond to Everest (CATS Riser)	BG Group	20	Gas	Active
Machar production umbilical	BP	6		Active
ETAP/Machar start-up	BP	16	Oil	Active
Everest to Teesside (CATS trunkline)	BP	36	Gas	Active
Elgin to ETAP	BP	24	Oil	Active
ETAP to Machar	BP	6	Gas	Active
Langeled pipeline	GASSCO	44	Gas	Active
Kyle DC to Curlew	Maersk	12.75	Mixed hydrocarbon	Active
Gannet A to Fulmar A	Shell UK	16	Oil	Active
Fulmar A to St. Fergus	Shell UK	20	Gas	Active

17.4.2 Oil and Gas Infrastructure

Within the section of the proposed cable route in Scottish waters, towards the UK/Norway median line, there is a high concentration of oil and gas infrastructure (see Figure 17.1; Appendix 1). Here, the proposed marine cable route corridor passes through three hydrocarbon fields: the Lomond hydrocarbon production field, the Culzean 22/25a discovery field and the Heron oil field.

The Lomond gas condensate field is located in UKCS block 23/21 and owned and operated by BG Group. Gas from Lomond and Everest field is exported via the Central Area Transmission System (CATS) pipeline into Britain's Teesside gas terminal, and produced fluids are exported via the Forties pipeline to Kinneil terminal at Grangemouth (bg-group.com, 2013).

The Culzean discovery field is located in block 22/25a and is operated by Maersk Oil UK. In 2011 Maersk Oil's high pressure high temperature (HPHT) appraisal well 22/25a-10z confirmed the presence of significant hydrocarbon accumulation. The Culzean field is currently undergoing further appraisal drilling and studies are ongoing for development concept selection (DECC, 2013).

The Heron field is a HPHT oil field located in UKCS blocks 22/29 and 22/30 and is within the Eastern Trough Area Project (ETAP), an integrated development of nine different reservoirs with differing ownership and operatorship. Three of these fields are operated by Shell including the Heron field. The various fields are grouped into six areas called clusters. BP operates the Heron cluster facilities while Shell remains responsible for any drilling, reservoir intervention or non-routine maintenance. Heron produces through a subsea wellhead cluster tied back to the ETAP central processing facility (CPF). The CPF consists of a processing, drilling and riser (PdR) platform linked to the Marnock platform. Oil is exported via the Forties Pipeline System to Kinneil terminal (BP, 2003).

Within 1km of the proposed route there are 14 current, oil and gas licence blocks (see Figure 17.1; Appendix 1), and three wells: 22/25a-9 Maersk exploration well, 22/25a-10 Maersk appraisal well and 23/21-1 BG Group, Lomond field, exploration well. The closest platform is the Lomond production and drilling platform which is located 2.25km south-east of the proposed marine cable route corridor.

17.4.3 Offshore Wind Farm Developments

Blyth offshore wind farm project (pre-round 1) is currently the only offshore wind farm within 100km of the proposed cable route and is located approximately 1km south of the proposed route. The wind farm consists of two 2MW turbines which were the first turbines to be constructed in UK waters.

The National Renewable Energy Centre (NAREC) was awarded a government grant in 2010 to put infrastructure in place for a grid connected offshore demonstration platform, with the capacity to accommodate 100MW of offshore wind power. NAREC is proposing to develop the Blyth Offshore Demonstration Project (BODP) situated between 5.7km and 13.8km off the east coast of Blyth (see Figure 17.1; Appendix 1). The proposed demonstration facility for pre commercial prototype offshore wind turbines will enable manufacturers and wind farm developers to trial new approaches and turbine technologies. The demonstration project will comprise an anemometry hub installed 6km offshore Blyth and a maximum of 15 wind turbine generators constructed across three arrays, with a maximum number of five turbines per array.

Timing of this project is important as the purpose of the site is to enable demonstration of wind farms ahead of round three. Export cable construction for the project is planned for 2014 followed by installation of the arrays is, ahead of the proposed Norway-UK Interconnector installation.

The closest part of the proposed Cambois Beach North landfall route is 1.3km south of Array No. 3a, 1.38km north of Array No. 2 and 1.8km north of Array No. 4 and crosses one proposed export cable route to Array No. 3a.

17.5 Potential Impacts

The potential impacts on offshore infrastructure from the installation and operation of the marine cables is provided below. The full results of the assessment of impact significance are presented in Appendix 2.3.

17.5.1 Installation

Interference with the operation of existing cables and pipelines

There is potential for the installation of the proposed marine cable to damage existing marine cables and pipelines at crossing locations; or to cross, or run parallel to, existing marine cables or pipelines in a manner which would compromise the owner's ability to maintain and/or repair them. Marine cable and pipeline owners are highly sensitive to interference with the operation of their infrastructure. During the design stage of the project, potential interactions with existing cables and pipelines have been identified and the route design has ensured appropriate distances from infrastructure running parallel are maintained along the proposed route. As interference with the operation of existing cables and pipelines is not expected to occur the magnitude of the effect is assessed as negligible. The significance of the impact is therefore assessed as **Minor.**

Interaction between cable installation vessels and oil and gas industry vessels

As discussed in Chapter 16 Shipping and Navigation, the proposed cable installation vessels have the potential to interact with oil and gas industry vessels, in the region of the proposed cable route within Scottish waters, where oil and gas infrastructure is concentrated. In particular, there may be interaction with supply and other vessels travelling to and from the Lomond platform, which is located only 2.25km away from the cable route at the nearest point. This may result in a temporary risk of ship to ship collision and may cause disruption due to the presence of the cable installation safety zone by requiring alteration of vessel's planned routes.

Oil and gas operators and contractors are considered to have a medium sensitivity to interaction between their vessels and marine cable installation vessels with a moderate capacity to tolerate any temporary disruption. The magnitude of the potential effect is low due to the likelihood of a collision being low and the temporary and localised nature of the exclusion zone required. The significance of the impact is therefore assessed as **Minor.**

Interaction between cable installation and other planned cables and pipelines projects

The installation of the proposed marine cables has limited potential to interfere with the installation of the planned Eastern HVDC Link should both parties install cables within close vicinity to each other during the same installation window. There is potential that temporary safety zones could overlap. The sensitivity of Eastern HVDC Link project is considered to be medium. However, the installation of the planned Eastern HVDC Link is unlikely to interfere with the installation of the proposed NSN marine cables as the separate project teams are working together to avoid installation conflicts and the Eastern HVDC Link has an earlier installation timeline. The magnitude of the potential effect has therefore been assessed as negligible. Therefore the overall impact significance is assessed as **None.**

BG Group plans to develop some new pipelines within the Lomond Field which are likely to cross the proposed marine cable route corridor. According to the current planned programme of development these pipelines will be installed before the NSN installation programme commences. Should the programme encounter delays there is the potential for the projects to overlap and there is potential for interaction between the vessels of each project. Pipeline developers are considered to have a medium sensitivity to interaction between their vessels and marine cable installation vessels. The magnitude of the potential effect is low due to the likelihood of a collision being low and the temporary and localised nature of the exclusion zone required. The significance of the impact is assessed as **Minor.**

Interaction between cable installation and wind farm construction and maintenance activities

The project installation vessels have the potential to interact with the construction of the NAREC Blyth Offshore Demonstration Project (BODP), wind farm developers utilising the BODP and the existing Blyth offshore wind farm maintenance vessels. Wind farm developers and associated contractors and the Blyth wind farm operator are considered to have a medium sensitivity to interaction between their vessels and marine cable installation vessels.

The installation programme for the proposed NSN marine cables and planned construction timeline of the BODP are such that cable installation and construction of the BODP is unlikely to overlap. However, in the event that the projects overlap the likelihood of collision is considered to be low and due to the temporary and localised nature of the exclusion zone required for the cable installation spread the magnitude of the effect has been assessed as low. The significance of the impact is therefore assessed as **Minor.**

17.5.2 Operation

Interaction between cable survey/maintenance/repair vessels and oil and gas industry vessels and wind farm developers vessels

The presence of survey/maintenance/repair vessels along the proposed cable route may cause a temporary increased risk of ship to ship collision and disruption to: oil and gas vessels travelling to and from the Lomond platform, vessels associated with future drilling operations at new wells vessels associated with the Blyth Offshore Wind Farm / Blyth Offshore Demonstration Project.

Oil and gas operators and wind farm developers and their contractors are considered to have a medium sensitivity to interaction between their vessels and marine cable maintenance vessels. The magnitude of the potential effect is low due to a collision being unlikely and the localised and temporary nature of the exclusion zone. The significance of the impact is therefore assessed as **Minor.**

17.6 Mitigation

17.6.1 Installation

Interference with the operation of existing cables and pipelines

- NGIL and SSF are in the process of negotiating formal Crossing Agreements with cable and pipeline owners and are liaising with Subsea Cables UK (formerly the United Kingdom Cable protection Committee) on working methods. The Crossing Agreement will describe the rights and responsibilities of the parties and also the detailed physical design of the crossing. Crossing design will be in line with industry standard criteria using procedures and techniques agreed with the cable and pipeline owners.
- A minimum vertical separation, typically 300mm, will be agreed with the cable owners, the crossing will be engineered to achieve the agreed vertical separation distance. Depending on the "as-found" burial depth of the crossed cable, the proposed marine cable will be jetted into the seabed or surface laid. Where a natural minimum separation is not possible (due to the shallow burial of the underlying cable) a protective sleeve may be required on the cable.
- Where the proposed marine cable runs parallel, and within 2km proximity, to existing cables, appropriate liaison will be undertaken with the cable owners regarding; installation, maintenance and access issues.
- In the case of pipeline crossings, the aim is to maintain a minimum vertical separation, typically of 300mm, between the proposed marine cables and crossed infrastructure to ensure stability and protection of the cables. The design will vary depending on the burial depth of the pipeline but in general the crossing will consist of building a bridge over the pipeline, by rock or concrete mattress placement, upon which the cables are laid. Following cable installation a layer of rock or concrete mattresses will be placed over the cables to protect them.

Interaction between cable installation vessels and oil and gas industry vessels

- To minimise the potential for disruption and/or accidents during cable-laying operations, notice will be given to shipping in the area via Navtex and NAVAREA warnings.

- In periods of poor visibility restrictions, such as a temporary cessation of installation activity, may be considered to reduce the risk of collisions.
- Liaison will be maintained with all navigational stakeholders before and during all stages of installation. This will include local ports (e.g. Port of Blyth).
- Full communication will be maintained with the relevant ports authorities during cable installation and maintenance work, and the required radio navigation warnings will be broadcast. Notices to Mariners will be issued six weeks prior to installation work commencing.
- Guard vessels will be used during cable-laying to communicate with 3rd party vessels in the vicinity for any sections of cable that remain unburied between cable lay and post lay burial.

Interaction between cable installation and other planned cables and pipelines

In addition to the mitigation measures listed above for oil and gas, this will be managed through communication with SHET and NGET (for the planned Eastern HVDC Link), BG Group (for the planned new pipelines in the Lomond field) and local port authorities.

Interaction between cable installation and wind farm developers' vessels

In addition to the mitigation measures listed above for oil and gas this will be managed through communication with NAREC, wind farm developers, the Blyth Offshore Wind Farm operator and local port authorities.

17.6.2 Operation

Interaction between cable survey/maintenance/repair vessels and oil and gas industry vessels and wind farm developers' vessels

- To minimise the potential for disruption and/or accidents during any cable maintenance operations, notice will be given to shipping in the area via Navtex and NAVAREA warnings.
- During periods of poor visibility restrictions, such as a temporary cessation of installation activity, may be considered to reduce the risk of collisions.
- Liaison will be maintained with all navigational stakeholders before and during all stages of installation. This will include local ports (e.g. Port of Blyth).
- Full communication will be maintained with the relevant ports authorities during maintenance work, and the required radio navigation warnings will be broadcast. Notices to Mariners will be issued in advance of maintenance works.
- During maintenance operations guard vessels will be used to communicate and keep 3rd party vessels away from any unburied sections of cable.

17.7 Residual Impacts

17.7.1 Installation and Operation

Interference with the operation of existing cables and pipelines

With formal crossing agreements in place, which follow industry standard criteria, and use procedures and techniques agreed with the cable and pipeline owners, in combination with liaison with owners of cables and pipelines which are in close vicinity to the proposed marine cables, the magnitude of this effect is minor. Minor impacts are **Not Significant**.

Interaction between cable installation/maintenance vessels and oil and gas industry vessels, planned cable and pipeline installation vessels, offshore wind farm developers' vessels

Whilst disruption to vessels from the presence of the safety zone around the installation/maintenance vessels cannot be prevented, the effect will be temporary and localised and with effective communication and mitigation measures in place the risk of ship to ship collision will be reduced to ALARP. The magnitude of the effect is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

17.8 References

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18 DREDGING AND DISPOSAL AREAS, AND MILITARY PRACTICE AREAS

18.1 Introduction

This Section provides an overview of the dredging and disposal areas and Ministry of Defence (MOD) military practice and exercise areas along and adjacent to the proposed marine cable route corridor and identifies and assesses the potential impacts that marine cable installation and operation may have on these areas and the activities carried out within them. It identifies the mitigation measures to be implemented to avoid, reduce, and offset any potential impacts.

18.2 Data Sources

Primary data sources used in the assessment include:

- CEFAS disposal sites.
- JNCC Coastal Directories Region 5 (JNCC, 1995).
- SeaZone digital data on military practice and exercise areas.
- Northumberland and North Tyneside Shoreline Management Plan.

18.3 Methods

18.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on dredging and disposal areas and military practice areas have been assessed using the methodology described in Section 6.In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

18.3.2 Magnitude of Impact

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential impact and takes into account the likelihood of the impact occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of impact are described in Table 18-1.

Table 18-1: Magnitude of Impact

Magnitude	Description
High	Permanent or long term (life of project i.e. tens of years up to and beyond 40 years duration) impact to existing licensed, consented or designated activities; major material financial loss; a permanent loss of resource; a permanent block in access to resource
Medium	Medium-term (several years duration) impact to existing licensed, consented or designated activities; moderate financial loss; loss of access to resource
Low	Short-term (a return to normal conditions following cessation of marine cable installation works) to existing licensed, consented or designated activities; small-scale financial loss; temporary loss of access to resource
Negligible	The development will result in no impact to existing licensed, consented or designated activities

18.3.3 Sensitivity or Importance of Receptor

The sensitivity of the baseline conditions has been assessed according to the recoverability of the receptor and the relative importance of the dredging and disposal activities present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance).

The sensitivity of dredging and disposal activities have been assessed in accordance with the criteria outlined in Table 18-2

Table 18-2: Sensitivity of Receptor

Sensitivity	Description
Very High	The receptor has little or no capacity to absorb change without fundamentally altering its present character, is of very high value / international importance.
High	The receptor has low capacity to absorb change without fundamentally altering its present character, is of high value / national importance.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some value / national importance
Low	The receptor is tolerant of change without detriment to its character, is low value, or local importance
Negligable	The receptor is resistant to change and is of little importance

18.3.4 Significance of Impacts

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the sensitivity or importance of the receptor and the magnitude of a potential impact. The impact significance is assessed as Major, Moderate, Minor or None. The term 'None denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account the mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts identified as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. The full results of the assessment of impact significance are presented in Appendix 2.3.

18.4 Existing conditions

18.4.1 Aggregate Dredging

There are no aggregate extraction areas in the vicinity of the proposed cable route.

18.4.2 Disposal Sites

In the past large quantities of solid wastes from a number of sources have been dumped over many years either directly onto the shore or some miles off the north-east coast of England. Waste from coastal collieries in Northumberland was tipped directly on the foreshore where it has been dispersed by wave action (Eagle et al 1979). Mining was active at Cambois where colliery waste was tipped onto the foreshore from 1920 to 1968 (Royal Haskoning, 2009). Whilst wastes from other collieries, fly ash from coal fired power stations and harbour dredging have been dumped offshore from disposal vessels. This disposal started in most cases well before statutory control (Eagle, 1979).

During the 1990s, the disposal of most types of waste (e.g. sewage sludge, radioactive waste, industrial waste) at sea was prohibited and therefore active sites are used only for the disposal of dredged material from ports, navigation channels and coastal engineering projects.

The cable route passes through the northern tip of one active spoil ground which is used as a maintenance dredging disposal site (see Figure 18.1; Appendix 1). Maintenance dredging is the regular dredging of existing ports and their approaches to maintain safe navigation. The dredged material dumped at sea can range in composition from silts to boulder clay and rock (Barne J *et al* 1995).

18.4.3 Military Practice Areas

There are five military Practice and Exercise Areas (PEXA) within the vicinity of the proposed marine cable route corridor (see Figure 18.1; Appendix 1 and Table 18-2).

Table 18-3: Pexa areas which the NSN cable route passes through

ID No.	Name of Area	Authority	Description of Area
1	D513 Druridge Bay	RAF	Firing danger area
2	D613	RAF	Area of intense aerial activity
3	Unknown	Navy	Submarine exercise area
4	D323	RAF	Area of intense aerial activity
5	D412 Staxton	RAF	Firing danger area

The proposed cable route passes directly through three of these (D513 Druridge Bay, D613 and an unknown submarine exercise area) encompassing 70% of the UK section of the proposed marine cable route corridor.

There are no restrictions placed on the right to transit the Druridge Bay Firing practice areas at any time. Exercise and firing only take place when the areas are considered to be clear of all shipping (Anatec, 2013). D613 is used by the Royal Air Force for aerial activity. There is no available information for the unknown submarine area. The MoD raised no objections to the proposed marine cables during consultation.

18.5 Potential Impacts

The potential impacts on disposal areas and military practice from installation and operation of the marine cables is provided below. The full results of the assessment of impact significance are presented in Appendix 2.3.

Impacts on sediment and water quality associated with disturbance to sediments in disposal areas are considered separately in Section 8 - Water and Sediment Quality.

18.5.1 Installation

Displacement of dredge disposal vessels from the area surrounding the cable laying spread

As discussed in Section 16.5.1, due to their limited ability to manoeuvre, offshore cable installation vessels will require an exclusion zone within which no other vessels should enter. The presence of marine cable installation vessels along the route may therefore cause temporary disruption to dredge disposal vessels travelling to and from the open disposal site and require the vessels to alter their planned routes. Dredge disposal operators are considered to have a medium sensitivity to interaction between their vessels and marine cable installation vessels. The magnitude of the potential impact is low due to the localised and temporary nature of the exclusion zone required. The significance of the impact is therefore assessed as **Minor**.

Displacement of MOD practice and exercise vessels from the area surrounding the cable laying spread

The presence of marine cable installation vessels within PEXA has the potential to interact with MOD vessel movements and training exercises. As the cable laying spread moves along the cable route the mobile safety zone will present a temporary exclusion zone to the MOD. MOD vessels are considered to have a medium sensitivity to interaction between their vessels and marine cable installation vessels. The magnitude of the potential impact is low due to the localised and temporary nature of exclusion zone. The significance of the impact is therefore assessed as **Minor**.

18.5.2 Operation

Displacement of dredge disposal vessels from the area surrounding the survey vessels or cable maintenance vessels

In the event that maintenance or repair of the cable is required or as part of routine surveys to monitor cable burial depth, vessels to perform this work will be required along the proposed marine cable route corridor. The position and amount of maintenance and the complexity of any repair will determine the length of time any vessels need to be present along the route. Vessels carrying out any repairs would need to be avoided by other traffic including those travelling to and from the active disposal site. Dredge disposal operators have a medium sensitivity to interaction between their vessels and maintenance and survey vessels. The magnitude of the impact has been assessed as low due to the localised and temporary nature of the exclusion zones required. The significance of the impact is therefore assessed as **Minor**.

Displacement of MOD practice and exercise vessels from the area surrounding cable maintenance vessels or survey vessels

The presence of maintenance or survey vessels within PEXA has the potential to interact with MOD vessel movements and training exercises. Vessels carrying out any repairs would need to be avoided by other traffic including MOD vessels. MOD vessels have a medium sensitivity to interaction between their vessels and maintenance and survey vessels. The magnitude of the potential impact has been assessed as low due to the localised and temporary nature of the exclusion zones required. The significance of the impact is therefore assessed as **Minor.**

18.6 Mitigation

18.6.1 Installation

Displacement of dredge disposal vessels from the area surrounding the cable laying spread

- To minimise the potential for disruption and/or accidents during cable-laying operations, notice will be given to shipping in the area via Navtex and NAVAREA warnings.
- In periods of poor visibility restrictions such as a temporary cessation to installation activity may be considered to reduce the risk of collisions.

- Liaison will be undertaken with all navigational stakeholders before and during all stages of installation. This will include local ports (Port of Blyth).
- Full communication will be maintained with the relevant ports authorities during cable installation and maintenance work, and will ensure that the appropriate notices to mariners and radio navigation warnings are promulgated.
- Guard vessels will be used during cable-laying to communicate with third party vessels in the vicinity for any sections of cable that remain unburied between cable lay and post lay burial.

Displacement of MOD practice and exercise vessels from the area surrounding the cable laying spread

- As laid coordinates of the cable route will be supplied to the MOD.
- The approval of the MOD will be sought prior to any installation activities being undertaken in PEXA.

18.6.2 Operation

Displacement of dredge disposal vessels/MOD practice and exercise vessels from the area surrounding the survey vessels or cable maintenance vessels

The same mitigation measures outlined for installation will apply.

18.7 Residual Impacts

18.7.1 Installation

Displacement of dredge disposal vessels from the area surrounding the cable laying spread

The implementation of mitigation measures including warning notices will make the operator of the open disposal site aware of the safety zone and may allow forward planning to reduce the potential for vessel interaction and disruption. The frequency of disposal operations may also be such that no interaction with installation vessels will occur. The magnitude of the impact is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

Displacement of MOD practice and exercise vessels from the area surrounding the cable laying spread

Although the route crosses a large area designated as military exercise areas, with prior consultation it is not anticipated that the installation of the marine cables will have an impact on MOD activities. The magnitude of the impact is therefore reduced to negligible and the impact assessed as having no residual significance. The impact is therefore **Not Significant.**

18.7.2 Operation

Displacement of dredge disposal vessels from the area surrounding survey/maintenance vessels

As with installation activities after the implementation of mitigation measures any impact is assessed as **Not Significant**.

Displacement of MOD practice and exercise vessels from the area surrounding survey/maintenance vessels

As with installation activities after the implementation of mitigation measures any impact is assessed as **Not Significant.**

18.8 References

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19 RECREATION & TOURISM

19.1 Introduction

This Section provides an overview of recreation and tourism activities in the vicinity of the proposed landfall and along the proposed marine cable route corridor. It considers the potential impacts that the marine cables may have on recreation and tourism and identifies appropriate mitigation measures to avoid, reduce or offset any potential adverse impacts.

19.2 Data Sources

The primary data sources used in the assessment of impacts on recreation and tourism areas are as follows:

- Anatec Shipping/Vessel Activity Review (2013)
- JNCC Coastal Directories Region 5 (JNCC, 1995)
- Northumberland County Council (NCC, 2013)
- Newcastle Wildfowlers Association (NWA, 2012)

19.3 Methods

19.3.1 Assessment Guidelines

The potential impacts of the installation and operation of the proposed marine cables on recreation and tourism have been assessed using the methodology described in Section 6. In order to establish the overall significance of an impact it was necessary to assess:

- The magnitude of the potential impact incorporating likelihood, level of change, geographic extent and duration; and
- The sensitivity and/or importance of the receiving environment or receptor

19.3.2 Magnitude of Impact

The magnitude of an impact considers the scale of the predicted change to baseline conditions resulting from a given potential impact and takes into account the likelihood of the impact occurring, the spatial extent over which it occurs, the level of change with respect to baseline conditions and the duration of the impact prior to recovery. Criteria for describing the magnitude of impact are described in Table 19-1.

Table 19-1: Magnitude Criteria

Magnitude	Description
High	Permanent or long term (life of project i.e. tens of years up to and beyond 40 years duration) disturbance to recreation or tourism activity.
Medium	Medium-term (several years duration) disturbance to recreation or tourism activity.
Low	Short-term (a return to normal conditions following cessation of marine cable installation works) disturbance

Magnitude	Description
	to recreation and tourism activity.
Negligible	The development will result in no disturbance to recreation or tourism activity.

19.3.3 *Sensitivity or Importance of Receptor*

The sensitivity of the baseline conditions has been assessed according to the recoverability of the receptor and the relative importance of recreation and tourism present in the vicinity of the proposed marine cable route corridor (e.g. whether it is of national, regional or local importance).

The criteria provided in Table 19-2 provide a general definition for determining the sensitivity of shipping and navigation interests.

Table 19-2: Sensitivity Criteria

Sensitivity	Description
Very High	The receptor has little or no capacity to absorb change without fundamentally altering its present character, is of very high value / international importance
High	The receptor has low capacity to absorb change without fundamentally altering its present character, is of high value / national importance e.g. heavy recreational craft usage
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some value / national importance e.g. medium recreational craft usage
Low	The receptor is tolerant of change without detriment to its character, is low value, or local importance e.g. light recreational craft usage
Negligible	The receptor is resistant to change and is of little importance

19.3.4 *Significance of Impacts*

A qualitative approach has been taken to the assessment broadly following the approach illustrated in Table 6-4 and also using professional judgement. The significance of a given impact is based on a combination of the magnitude of a potential impact and the sensitivity or importance of the receptor. Impacts are identified as Beneficial or Adverse and their significance as Major, Moderate, Minor or None. The term 'None' denotes no significant impact.

The results of this assessment are presented as residual impacts; that is the remaining impact taking into account the mitigation measures that are incorporated into the proposed marine cable route design as well as measures to be implemented during installation and operation. Mitigation has been developed based on current best practice and established marine cable installation techniques.

Residual impacts identified as Minor or None are considered Not Significant; residual impacts assessed as Moderate or Major are considered to be Significant. A summary of the environmental appraisal results for the assessment of sensitivity and magnitude and significance of impacts is presented in Appendix 2.3.

19.4 Existing conditions

The natural scenery and unspoilt coastal environment along the Northumberland coastline provide an important resource for outdoor activities in this region (Barne *et al.,* 1995). A diverse range of recreational activities takes place along this coastline including walking, camping, sea angling, bird watching, water sports (water-skiing, sailing, windsurfing and canoeing) and general use of amenity beaches. As well as attracting a large number of day trippers, a sizable population of summer visitors stay in caravan sites and other accommodation along the coast.

The proposed cable route landfall is located on the south bank at the entrance of the River Wansbeck Estuary, approximately 2.1km north of the River Blyth. The beach adjacent to the cable route corridor and landfall is a large stretch of sandy beach backed by dunes and a freight railway. Access to the beach is via foot paths across the dunes, or via a low bridge under the railway line. The former back drop of the Blyth Power Station and a large foundry has now gone (the power station was decommissioned and pulled down in 2001), making the beach more pleasant to visit, however, the beach remains relatively quiet. The beach and coastal path is very popular with dog walkers and is used by walkers, sea anglers, bathers and tourists. Cambois Beach is not an EU designated bathing water. The closest EU designated bathing water areas are Newbiggin South (2.5km north) and Newbiggin North (3.1km north) and Blyth South Beach approximately 5km to the south.

The Cambois shoreline is a popular fishing venue for shore anglers. The Newbiggin and District Sea Angling Club hosts match competitions in and around the Newbiggin area, including Cambois which it lists as a top fishing spot. The disused hot water outflow pipe which crosses the beach just north of the landing site, is a popular spot because although the hot water outflow pipe and power station were decommissioned in 2001, the legacy of 40 years of operation, when millions of gallons of hot seawater was pumped out daily, has resulted in a resident bass population and flatfish hotspot (Total-fishing 2003).

The River Wansbeck Estuary, whilst not a key area of international or national importance for birds, is locally important for the many species of wildfowl and waders it supports. The estuary is particularly important in providing open water, mudflats and marsh for feeding during the harsh winter months when most inland wetlands are frozen (Hancox B *pers. comm*. 2012).The Wansbeck attracts many species of wildfowl and wading birds and is a popular resource for recreational wildfowling. Wildfowling is licenced in England Wales and Scotland between 1st September until 31st January above mean high water (MHW), and until 20th February below MHW (BSAC, 2013).

19.4.1 Surrounding areas of recreational interest

The surrounding area of Cambois is a mix of heavy industrial, agriculture and residential. Areas with more interest for recreation and tourism are found north and south of Cambois Beach.

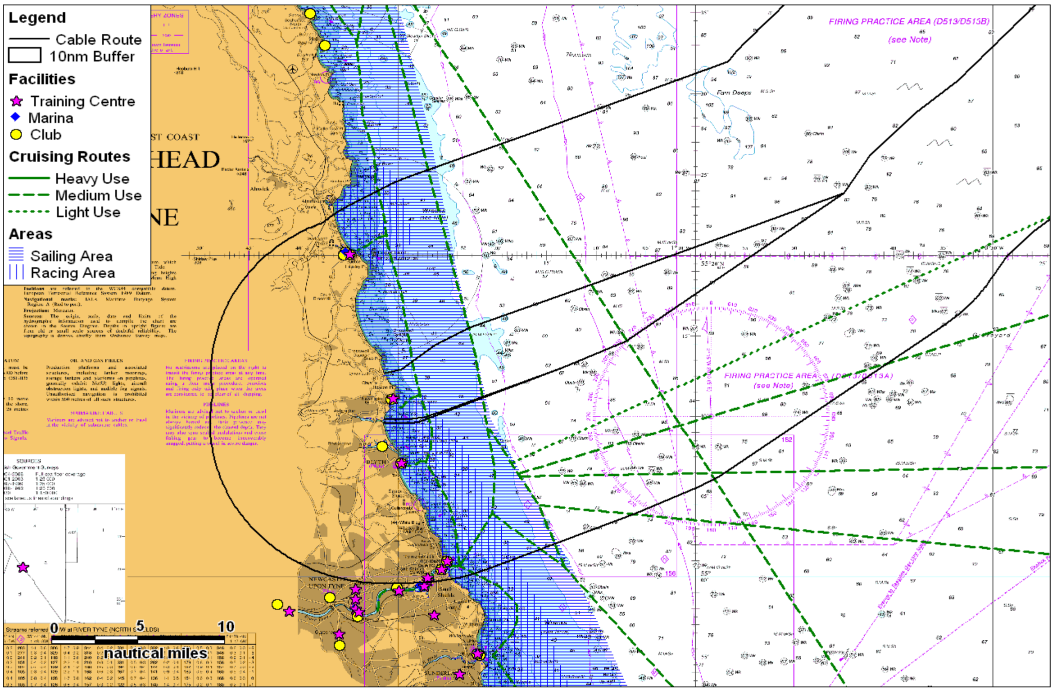
On the north side of the estuary at Sandy Bay there is a large caravan park, Sandy Bay Holiday Park in North Seaton (www.park-resorts.com 2013) and a little further north at Newbiggin-by-the-sea there is Newbiggin bay and promenade, a golf course and a maritime centre.

To the south of Cambois there is the Blyth and Hartley links local nature reserve which is a dune system between Blyth and Seaton Sluice, recognised for its diverse flora and fauna. Access through the dunes is via a track which is part of the National Cycleway network and is well used by walkers, joggers and cyclists. Blyth bay is a popular location for water sports with Blyth Personal Watercraft (jet ski) Club operating the launch facility for power craft at the north end of the promenade and the Blyth Kayak Club for surfing and sea kayaking. Additionally kite surfing takes place in the bay with surfers encouraged to launch from the beach behind the car park away from the main bathing areas and powered craft (Northumberland County Council 2013).

19.4.2 Offshore

The coastal waters surrounding the NSN cable route are likely to be frequently used by recreational vessels. The closest sailing clubs to the proposed Cambois Beach North landfall site (Figure 19.1) are Royal Northumberland Yacht Club which is approximately 4.7km to the south and Newbiggin-by-sea, approximately 3.1km to the north. The closest marinas are Royal Quays Marina which is 18.7km to the south and Amble which is 20.1km to the north.

Figure 19-1: Coastal recreational activity in the vicinity of the proposed cable route

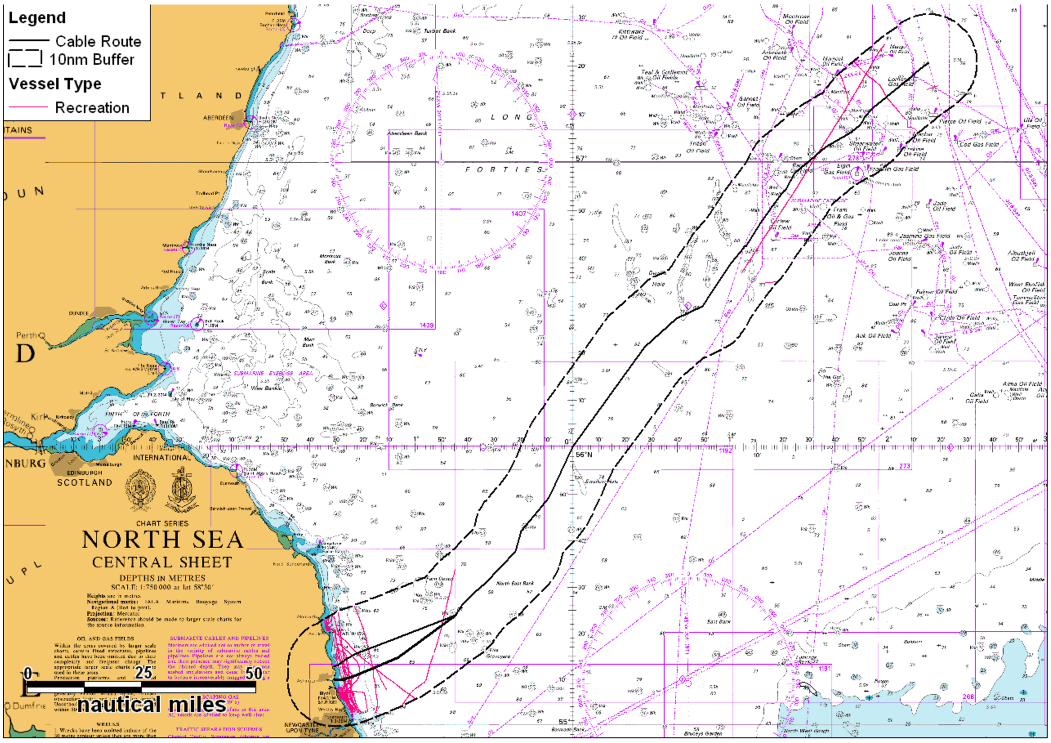


(Source: Anatec, 2013)

There are three recreational yacht cruising routes crossing the proposed cable route, all of which are classified as medium use (popular routes on which some recreational craft will be seen at most times during summer daylight hours) (Anatec, 2013).

Figure 19.2 presents the recreational vessels recorded in the vicinity of the cable route during 28 days of survey to record AIS data (14 days each from summer and winter 2011). It can be seen that the majority of recreational crafts were recorded just off the east coast of England. In Figure 19.1 it can be seen that this area includes an area classified by the RYA as a general sailing area used for general day-sailing by a range of recreational craft and the North East England Racing Area which stretches along the coast from Newbiggin-by-the-Sea, Northumberland to north Easington, County Durham, and is likely to be used for organised races and events. There were also several recreational crafts recorded in close proximity to the offshore platforms.

Figure 19-2: Overview of recreational vessels recorded within 10nm (18.5km) of the proposed cable route



(Source: Anatec, 2013)

19.5 Potential Impacts

19.5.1 Installation

Restricted access to Cambois Beach at Cambois Beach North landfall

Access across the beach at Cambois Beach North landfall will be restricted during cable installation work. Beach works at the landfall are expected to take approximately one week, likely to be during the summer months to avoid disturbance to overwintering birds. Beach users are considered to have a medium sensitivity to access restrictions as other areas of the beach adjacent to the landfall will be available. The magnitude of the potential impact has been assessed as low as only a narrow area along the beach profile will be closed off and access restrictions will be temporary. The significance of the impact is therefore assessed as **Minor**.

Disturbance of wildfowling in Wansbeck Estuary from beach works at Cambois Beach North landfall

The Cambois Beach North Landfall site is located to the southern side of the Wansbeck Estuary. It is noted that this estuary is important to the Newcastle Wildfowlers Association. Whilst the landfall site is located away from the estuary, installation works have the potential to disturb wildfowl in the area. However as the installation in the intertidal are is likely to take place in the summer months to avoid overwintering protected bird species, wildfowlers are considered to have a low sensitivity to cable installation works. The magnitude of the potential impact is low due to the localised and temporary nature of the disturbance. The significance of the impact is therefore assessed as **None.**

Displacement of recreational vessels from the area surrounding the cable laying spread

As discussed in Section 16, due to their limited ability to manoeuvre, offshore cable installation vessels will require a temporary 500m exclusion zone within which no other vessels should enter. This will also apply to the intertidal area and public slipway at the Cambios Beach Slipway landfall. The presence of installation vessels along the cable route may cause disruption to recreational craft activity by requiring alteration of planned routes.

As the installation vessels will be moving along the cable route at approximately 300m per hour, they will not affect any individual cruising route for long periods of time. Installation in inshore waters is likely to have the greatest effect to recreational vessels close to the shore. Installation is likely to be during the summer months (to avoid sensitivities of overwintering birds), which is when most water recreation occurs. The effects to recreational craft from the 500m exclusion zone (1km in diameter), may mean a large deviation from routes or a barrier to routes parallel to the coast during the inshore installation period. Recreational vessels are therefore considered to have a high sensitivity to interaction with cable installation vessels. The magnitude of the potential impact is low due to the localised and temporary nature of the exclusion zone required. The significance of the impact is therefore assessed as **Moderate**.

19.5.2 Operation

Disruption to recreational vessels during surveys/maintenance/repair to cable post installation

In the event that maintenance or repair of the cable is required or during routine cable burial surveys, vessels to perform this work will be required along the cable route. The position and amount of maintenance and the complexity of any repair will determine the length of time any vessels need to be present along the route. Maintenance and survey vessels would have a 500m exclusion zone as with installation vessels. The impacts are therefore likely to be similar to those during installation, although on a smaller scale. Recreational vessels have a medium sensitivity to interaction with maintenance and survey vessels as they are likely to have the ability to select alternative routes. The magnitude of the potential impact is low due to the localised and temporary nature of any exclusion zones required. The significance of the impact is therefore assessed as **Minor**.

Compass deviation to recreational vessels navigating with magnetic compasses

Only in very limited shallow nearshore areas does the calculated magnetic compass deviation require reduced cable spacing to meet a nominal maximum 3 degrees compass deviation in line with MCA requirements. To achieve this cables will be laid with a separation distance of 20m out to the 12nm limit. All other sections of the route will have a 3 degrees or less compass deviation with a cable separation of 50m. Most recreational vessels navigate using GPS for positional information which is not sensitive to magnetic variations. Magnetic compass is occasionally used as back-up should the GPS fail. Recreational vessels using automatic pilots depend on a fluxgate compass and would be affected. However deviations of 3 degrees or less for a short period of time would have only a very minor impact. Recreational vessels are considered to be able to make the necessary adjustments to a slight deviation in compass reading and sensitivity has therefore been assessed as medium.

The magnetic field emanating from the cables will have a temporary and localised impact therefore the magnitude of the potential impact has been assessed as low. The significance of the impact is therefore assessed as **Minor**.

Restricted access to the beach and nearshore area during repair to installed cables

In the event that a repair is required to the shore-end section of the cables at Cambois Beach, access to the beach and nearshore area may be restricted. Depending on the location of the fault, beach access and water sports could be restricted for up to 6 weeks while repairs are undertaken. Beach users are considered to have a medium sensitivity to access restrictions during repair works as other areas of the beach adjacent to the landfall will be available. The magnitude of the potential impact has been assessed as low due to the narrow corridor that would be closed off in the event that repairs are required. The significance of the impact is therefore assessed as **Minor**.

Disturbance of wildfowling in Wansbeck Estuary from beach works at Cambois Beach North landfall

In the event that a repair is required to the shore-end section of the cables at Cambois Beach North landfall, wildfowl in the adjacent estuary may be disturbed. This estuary is important to the Newcastle Wildfowlers Association. Depending on the location of the fault, repair works may take up to six weeks. Wildfowlers are considered to have a medium sensitivity to cable installation works. The magnitude of the potential impact is low due to the localised and temporary nature of the disturbance. The significance of the impact is therefore assessed as **Minor**.

19.6 Mitigation

19.6.1 Installation

Restricted access to Cambois Beach at Cambois Beach North landfall

- The duration of installation works on the beach at Cambois Beach will be minimised as much as practicable.
- Work areas will be appropriately demarcated and warning signs will be erected.

Displacement of recreational vessels from the area surrounding the cable laying spread

- To minimise the potential for disruption and/or accidents during cable-laying operations, notice will be given to shipping in the area via Navtex and NAVAREA warnings, broadcasted by the Maritime and Coastguard Agency (MCA).
- Notices to Mariners will be issued prior to works commencing. Notices to Mariners are issued by the UK Hydrographic Office (UKHO), which maintains an online Leisure Notices to Mariners service. This service is updated weekly.
- A guard vessel will be used to protect recreational craft from installation activities. Vessels approaching the 500m exclusion zone will be contacted by VHF radio.
- The cable installation vessel will be appropriately lit and will broadcast sound warnings during poor visibility periods.

19.6.2 Operation

Disruption to recreational vessels during surveys/maintenance/repair to cable post installation

- To minimise the potential for disruption and/or accidents during maintenance/repair operations, notice will be given to shipping in the area via Navtex and NAVAREA warnings, broadcasted by the MCA.
- Notices to Mariners will be issued prior to works commencing. Notices to Mariners are issued by the UKHO, which maintains an online Leisure Notices to Mariners service. This service is updated weekly.
- A guard vessel will be used to protect recreational craft from maintenance/survey activities. Vessels approaching the 500m exclusion zone will be contacted by VHF radio.
- The cable maintenance/survey vessel will be appropriately lit and will broadcast sound warnings during poor visibility periods.

Compass deviation to recreational vessels navigating with magnetic compasses

- Cable design criteria will, where practicable ensure that compass deviation at the sea surface will not exceed 5 degrees.

- The as-laid cable route will be marked on charts, so that mariners are aware of the location of the cable and can take account of any compass deviation impacts.

Restricted access to the beach and nearshore area during repair to installed cables

- The duration of repair works on the beach and nearshore area at Cambois Beach will be minimised as much as practicable.
- Work areas will be appropriately demarcated and warning signs will be erected.
- Local authorities and residents will be informed of repair works.
- Public notices will be placed at various points close to the repair works.

Disturbance of wildfowling in Wansbeck Estuary from repair works at Cambois Beach North landfall

- It is noted that the estuary is particularly important in providing open waters, mudflats and marsh for feeding during the harsh winter months when inland wetlands are frozen. Where practicable, planned maintenance/survey activities in the intertidal area will be timed to avoid sensitive periods.
- The duration of repair works on the beach and nearshore area at Cambois Beach North landfall will be minimised as much as practicable to further reduce disturbance to birds.

19.7 Residual Impacts

19.7.1 Installation

Restricted access to Cambois Beach at Cambois Beach North landfall

The restricted area at Cambois Beach landfall will form only a narrow corridor along the beach profile and public access to the majority of the beach will be maintained. The potential impact has therefore been assessed as minor significance. Whilst appropriate measures will be in place to fence off the work area and inform the public this will not reduce the restricted access. Therefore there will be a minor residual impact. Minor impacts are **Not Significant**.

Displacement of recreational vessels from the area surrounding the cable laying spread

The restricted area at Cambois Beach slipway is expected to be up to two weeks during the summer months. During this time the slipway and adjacent beach and waters will be excluded from use by recreational craft. Installation at the slipway and intertidal area is anticipated to take up to 2 weeks. However the exclusion zone indicates that recreational craft will be excluded from the area for an additional number of days as installation progresses at 300m per day. Whilst mitigation measures will make recreational vessel users aware of the safety zone, this will not reduce the potential for disruption. Therefore there is still a moderate residual impact. Minor impacts are **Not Significant**.

19.7.2 Operation

Disruption to recreational vessels during surveys/maintenance/repair to cable post installation

Due to the localised and mobile nature of the temporary exclusion zone, the potential for disruption to recreational vessels has been assessed as minor significance. Whilst mitigation measures will make recreational vessel users aware of the safety zone, this will not reduce the potential for disruption. Therefore there is still a minor residual impact. Minor impacts are **Not Significant**.

Compass deviation to recreational vessels navigating with magnetic compasses

Most recreational vessels do not rely on magnetic compasses, however cable design will ensure compass deviation does not exceed 5 degrees and mitigation measures in place will notify mariners of the location of the cable, the magnitude of the potential impact has been reduced to negligible. The impact is therefore assessed as **Not Significant**.

Restricted access to the beach and nearshore area during repair to installed cables

The restricted area at Cambois Beach landfall will form only a narrow corridor along the beach profile and public access to the majority of the beach will be maintained. The potential impact has therefore been assessed as minor significance. Whilst appropriate measures will be in place to fence off the work area and inform the public this will not reduce the restricted access. Therefore there will be a minor residual impact. Minor impacts are **Not Significant**.

Disturbance of wildfowling in Wansbeck Estuary from beach works at Cambois Beach North landfall

If maintenance works can avoid periods when birds are most frequently present in the estuary, during harsh weather, disturbance to wildfowl will be minimal however, a minor residual impact will remain. Minor impacts are **Not Significant**.

19.8 References

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20 CUMULATIVE IMPACTS

20.1 Introduction

20.1.1 *Cumulative Effects*

This Section provides an overview of the cumulative effects likely to be present along and adjacent to the proposed marine cable route corridor. It considers the potential impacts that the marine cables may have in combination with other subsea cable projects and other sea users generating similar effects. While a single activity may itself result in an insignificant impact, it may when combined with other impacts in the same geographical area, and occurring at the same time, result in a cumulative impact that is significant. Other development in the region which may lead to cumulative effects includes:

- Offshore Wind – EMF and construction noise
- Commercial Fishing – suspended sediment and seabed disturbance
- Oil and gas developments – pipeline installation and maintenance

The proposed developments in the region which will be considered within cumulative impacts include:

20.1.2 *Wind Farm Development Areas*

The Blyth offshore demonstration wind farm project was awarded planning consent in October 2013 and is scheduled to be completed by 2015. Construction of the proposed interconnector will start at the earliest during 2018. Therefore installation of the proposed marine cable is unlikely to overlap. The installation and construction of both developments will include cable laying, in close proximity for approximately 2.6km.

Dogger Bank Creyke Beck and Teeside A-D windfarm (approx. 127km south east) and Sea Green Firth of Fourth windfarm (approx. 128km north west) are planned to begin construction in 2016–2021 and 2015–2019 respectively. These construction timescales do overlap the proposed marine cable route installation phase.

Oil and Gas developments

BG Group plans to develop some new pipelines within the Lomond Field which are likely to cross the proposed marine cable route corridor. According to the current planned programme of development these pipelines will be installed before the proposed marine cable route installation programme commences. Should the programme encounter delays there is the potential for the projects to overlap and produce cumulative effects.

20.1.3 *Transboundary effects*

Transboundary environmental effects can arise where a project in one country has significant impact on the environment in one or more countries. Examples commonly evaluated include emission impacts to air quality down wind and waste discharge effects to water quality. Overall there are no significant transboundary effects anticipated and this has not been discussed further in this Section.

20.2 Cumulative Effects

20.2.1 *Physical Environment*

Geology and Geomorphology

The proposed marine cable route corridor crosses existing infrastructure at 14 locations. The use of rock placement at crossings, or at areas along the cable route where adequate burial may not be achievable, has the potential to create a localised cumulative effect on seabed conditions where rock placement occurs adjacent to installation protection measures used for existing cables and pipelines. At the crossing locations a small localised cumulative impact on sea bed conditions may arise. However these are expected to be very limited in extent.

Water and Sediment Quality

Due to the localised nature of any potential effects resulting from installation it is unlikely that any cumulative effects on water and sediment quality will arise.

20.2.2 *Biological Environment*

Protected sites and Species

The proposed marine cable route passes through a SSSI offering protection to breeding little tern (*Sterna albifrons*), whilst in winter the mixture of rocky and sandy shore supports large numbers of turnstone (*Arenaria interpres*) and purple sandpiper (*Calidris maritime*). It is also passes through two rMCZ and one pMPA. It is also close to an SPA and RAMSAR site designated for breeding birds at the cable landfall.

The cumulative effects of the installation and operation of the proposed marine cables in combination with other existing and proposed developments in the study area are described below in relation to the species and habitats that are protected within these sites. A negligible cumulative effect has been identified on the interest features of the designated sites.

Benthic and Intertidal Ecology

The installation works will result in some unavoidable localised seabed disturbance. In terms of cumulative effects during installation, activities which could result in similar disturbances include those from fishing vessels engaged in demersal fishing and the installation of the export cable for the Blyth demonstration wind farm.

A number of demersal fishing methods are employed in the vicinity of the proposed cable route corridor, which are described in Chapter 15. In summary there is trawling for Nephrops from 6nm offshore out to deeper water, further offshore trawlers target whitefish in addition to Nephrops. These fisheries use gear that penetrate seabed sediments and generate localised sediment suspension, causing both direct and indirect disturbance to benthic habitat. Demersal fishing activities will be excluded from the installation area and are therefore be likely to be conducted in waters adjacent to the installation area. In combination, the habitat disturbance from cable installation may temporarily and locally increase the level of habitat disturbance in the area. However in the context of existing fishing activity, habitat disturbance from installation of the proposed marine cable will present a small and localised increase to sediment disturbance against background levels. A negligible cumulative effect to intertidal and benthic ecology is anticipated.

Fish and Shellfish

The installation of the proposed marine cable will marginally increase the level of vessel activity in the marine environment at any one time, in an area that already contains moderate shipping activity. This will result in a very slight increase in the risk of a collision between installation vessels and basking sharks. In the context of the background shipping activity in the region this contribution to a cumulative effect is considered to be negligible.

Marine cable installation will generate noise from a variety of sources, including; vessel activity, cable trenching, ploughing, and rock armour placement. Noise generated during cable installation could create a cumulative effect with noise generated during the construction of Dogger Bank Creyke Beck and Teeside A-D windfarms planned to begin construction in 2016 – 2021 (Forewind, 2014) and the Sea Green Firth of Forth windfarm (Seagreen, 2014).

Noise levels generated during cable installation will be significantly lower than during wind farm construction. Any fish species displaced will be able to relocate to a nearby suitable habitat. Installation of the proposed marine cables would therefore only be expected to make a minor contribution to the cumulative effects of noise to fish species.

Ornithology

The construction stages for the Blyth Offshore Demonstration Project and the proposed marine cable route do not overlap. There is potential for cable installation activities to occur in successive seasons, however, as the area has not been identified as an important feeding area for birds, no significant cumulative impacts are anticipated to birds within the Northumberland Shore SSSI and Northumbria Coast SPA during construction works.

Marine Mammals

Marine Noise

The windfarm development sites Dogger Bank Creyke Beck and Teeside A-D and Sea Green Firth of Forth are at great distances from the proposed cable route. However there is a possibility that pilling noise has potential to reach the vicinity of the proposed marine cable, and is therefore considered as a potential cumulative impact. This noise is likely to be of low frequency and audible to baleen whales. Installation of the proposed marine cable will contribute to marine noise from dynamic positioning thrusters on vessels, the jetting installation tool and vessel noise. This has been assessed to have no significant impact to marine mammals. The effect of construction noise from wind farms is not anticipated to be in the same audible bands for cetaceans and therefore is unlikely to produce a significant cumulative effect to marine mammals during installation.

Electromagnetic Fields (EMF)

During operation, HVDC and windfarm export cables produce EMF. The nearest wind farm export cable to the proposed route is the Blyth export cable (NAREC). EMF levels from the proposed marine cables are expected to attenuate to background levels within approximately 3.5-4.5m from the seabed above the interconnector, assuming a cable separation of 50m. As a 2.6km section of the cable in proximity to the Narec export cables are within 20m the EMF is likely to be reduced to a minimum or amplified depending on the direction of the current.

The proposed marine cable route corridor has no crossings with other HVDC cables. Cables crossing each other are required to do so perpendicularly to prevent induced currents (iE field) resulting in thermal hotspots and de-rating of the cable. All crossings with existing infrastructure are planned to cross the interconnector perpendicularly and thus such interactions should be largely negated. Whilst the two overlapping cables will, never-the-less, create a slightly larger area in which EMF is generated above background levels (effectively a cross rather than linearly at the intersecting location), potential impacts upon marine fauna would still be limited to within close proximity of the cables.

Since the effects of EMF are expected to be limited to within close proximity of the interconnector cabling, no cumulative effects will occur with the offshore wind farm cabling.

20.2.3 *Human Environment*

Fisheries

Early consultation with commercial fishermen has enabled the route design to avoid the most intensively fished areas. Cable installation activities are not scheduled to occur at the same time as the Blyth Demonstration Project. If these two activities were to coincide, there would be a short lived and temporary cumulative impact from exclusion to inshore fishermen. Therefore there will be negligible cumulative effects expected to the fishing industry from installation of the interconnector and wind farm.

BG Group plans to develop some new pipelines within the Lomond Field which are likely to cross the proposed marine cable route corridor. The current planned programme of development indicates that the Lomond Field pipelines will be installed before the proposed marine cable installation programme commences. Should the programme encounter delays there is the potential for the projects to overlap and there is potential for interaction between the vessels of each project. The overlap is unlikely and would result in short lived and temporary restriction area to commercial fishing around installation vessels. Therefore there will be negligible cumulative effects expected to the fishing industry from interaction with oil and gas activities.

There are 15 crossings which will be covered with rock berms designed to have an over-trawlable profile to enable the cable to be buried beneath the area penetrated by heavy fishing gear (up to 0.4m). Cable protection is not predicted to be required within the highest intensity fishing grounds, minimising the potential risks to fishing vessels. The as-laid coordinates of the cable will be issued to the UK Hydrographic Office (UKHO) and Kingfisher Information

Service for inclusion on admiralty and cable awareness (KISCA) charts. Therefore no cumulative effects are anticipated to commercial fishing activities.

Tourism and Recreation

As the Blyth offshore wind farm construction is not planned to be installed at the same time, therefore no cumulative effects to water sports and recreational activities are expected from the temporary safety zone applied around the installation.

Navigation

There are no cumulative effects to navigation anticipated during the installation or operation of the Norway-UK interconnector.

Archaeology

Based on the information presented in the archaeology section, cumulative effects to the archaeological interest are predicted to be negligible. A written scheme of investigation will be undertaken prior to installation to identify procedures to be taken should archaeological remains be identified.

20.3 References

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21 SUMMARY AND CONCLUSIONS

21.1 Introduction

This Section summarises the results of the assessment of the potential impacts of installation and operation of the marine cables along the proposed marine cable corridor between the UK-Norway median line and the landfall at Cambois Beach North Slipway, near Blyth on the Northumberland Coast.

The routing and siting studies considered a range of environmental, technical and economic constraints influencing the development of the Norway-UK Interconnector. This was a constraints driven option appraisal which included the development and assessment of alternative converter station sites and land and marine cable routes concluding with the identification of a 'Preferred Option' with four alternative landfall options.

The preferred option has subsequently been surveyed as part of the EIA, and developed into the final proposed marine cable route which is considered, on balance to be the most technically feasible and least environmentally disturbing option.

21.2 Summary

Following the environmental assessment of the residual impacts on the physical, biological and human environments, the following can be concluded:

- The main impacts associated with the project are predicted to be the minor temporary disturbance to the seabed during the installation, with the resultant minor impacts on benthic and intertidal communities and fish species.
- The presence of the cable installation vessels will cause a temporary disturbance to fishing and shipping in the vicinity of cable installation operations.
- A minor, localised, but long-term effect from electromagnetic fields will be caused during cable operation. This will cause a minor effect on the magnetic compasses of ships, fishing boats and recreational vessels as they pass directly over the marine cables, but will not interfere with navigational safety. Whilst certain fish and mammal species are sensitive to electromagnetic fields no impact to prey location, navigation or migration patterns are expected.
- It is also concluded that there will be no significant cumulative environmental impacts with other existing and proposed marine developments during both the installation and operation of the Norway-UK Interconnector. Landfall installation works and the construction of onshore elements of the cable may have short-term and minor cumulative impacts on recreation and tourism.
- Any impacts from decommissioning activities (marine cable removal) will be broadly similar to those during installation. The appropriate method of cable decommissioning will be considered

towards the end of the cable life. This will consider hazards presented by leaving the cable in situ and potential disturbances if removed entirely. The effects of removal are predicted to be minor and temporary in nature, and will be considered thoroughly at the time of removal.